Squirrels

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DISTRIBUTION AND ABUNDANCE OF THE GRAY SQUIRREL IN ILLINOIS

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In Illinois the gray squirrel[1] apparently began declining in abundance almost as soon as the first white settlers began to clear the wilderness forests (Kennicott 1857). Gray squirrels seem to prefer extensive forests (Shelford 1963) in contrast to the woodlots and hedgerows to which fox squirrels adapted (Bakken 1952; Packard 1956). In all published comparisons of habitat preferences of these species, fox squirrels are found in open forests or in areas having a diversity of tree species of various ages (Brown & Yeager 1945; Bakken 1952; Packard 1956; Taylor 1974; and Chesemore 1975). Niche occupancy by gray and fox squirrels appears to function through habitat specialization rather than food-finding methods or dietary differences (Smith & Follmer 1972).

In Illinois extensive clearing of the virgin forests led to the virtual disappearance of gray squirrels in many of the central and northern counties (Ellsworth 1880; Hall 1916; Polson 1968). A marked reduction in overall numbers of gray squirrels also occurred throughout their entire range, particularly in the Ohio River valley, after pioneer settlement began in the 18th century (Bailey 1946; Schorger 1949).

Our objectives were (1) to determine the present distribution and relative abundance of gray squirrels throughout Illinois, (2) to determine characteristics of forest environments needed to support gray squirrels, and (3) to evaluate the future prospects of gray squirrels in the state.

We thank the many individuals who contributed information on the present status of the gray squirrel. Conservation officers, district wildlife biologists (particularly William Allen), and the district foresters of the Illinois Department of Conservation provided information from their respective areas. In Illinois Loraine Funk of Liberty, Mary Hartley and her students at Black Hawk College in Moline, and Adrian Lundeen of Fulton all helped to verify isolated populations of gray squirrels. Similar assistance was provided by Drs. Richard R. Graber, Jean W. Graber, and Carl Mohr (retired), Illinois Natural History Survey. Jack White, Director, Illinois Natural Areas Inventory, kindly allowed us access to his unpublished *Presettlement Vegetation Atlas of Illinois*. Drs. Richard and Jean Graber permitted us to use their tree inventory data from several bottomland forests in southern Illinois. We also thank the many landowners throughout central and northern Illinois who allowed us access to their forests.

We also received generous assistance from Dr. Glen C. Sanderson, Head, Section of Wildlife Research, Dr. William R. Edwards, Wildlife Specialist, both of the Illinois Natural History Survey, and Dr. Henry Shugart, Oak Ridge National Laboratory, who reviewed the manuscript. Helen C. Schultz, Section of Wildlife Research, copy-edited the first draft of the manuscript. Lloyd LeMere, Larry Farlow, and Robert M. Zewadski, Illinois Natural History Survey Technical Illustrator, Technical Photographer, and Technical Editor, respectively, provided the finished maps, figures, and final editing.

METHODS

We used county boundaries in delineating the major watersheds of Illinois (Fig. 1) because supportive data, such as the amount of forested land, human densities, and squirrel harvests, are available only by counties. We asked cooperators in each watershed to indicate townships presently "occupied" by gray squirrels. Within each township cooperators placed the gray squirrel in one of four categories of abundance: *Common*—frequently shot or seen; *Scarce*—shot or seen every year but only in low numbers; *Rare*—shot or seen infrequently (every 2 or 3 years); or *Absent*. In addition, cooperators in northern Illinois were requested to note the locations of any melanistic (black) populations of gray squirrels. We also contacted supervisors of urban parks in all the major cities of Illinois to determine the urban distribution of gray squirrels.

Maps showing the distribution of gray squirrels were prepared for each township and were compared with the locations of forested areas delineated in the most recent aerial photo-index maps available for each county (1963–1967, University of Illinois Library) and with a *Presettlement Vegetation Atlas of Illinois* (J. White, Illinois Natural Areas Inventory, unpublished data), a compilation of county maps showing the distribution of forest and prairie in each township as recorded by land surveys made between 1830 and 1860. Townships with little forest cover when first surveyed in the 19th century probably never contained more than an occasional gray squirrel in historic times.

To characterize quantitatively the range of the gray squirrel and the discriminate and significant hab-

[1] Scientific names of plants and animals are listed in the appendix.

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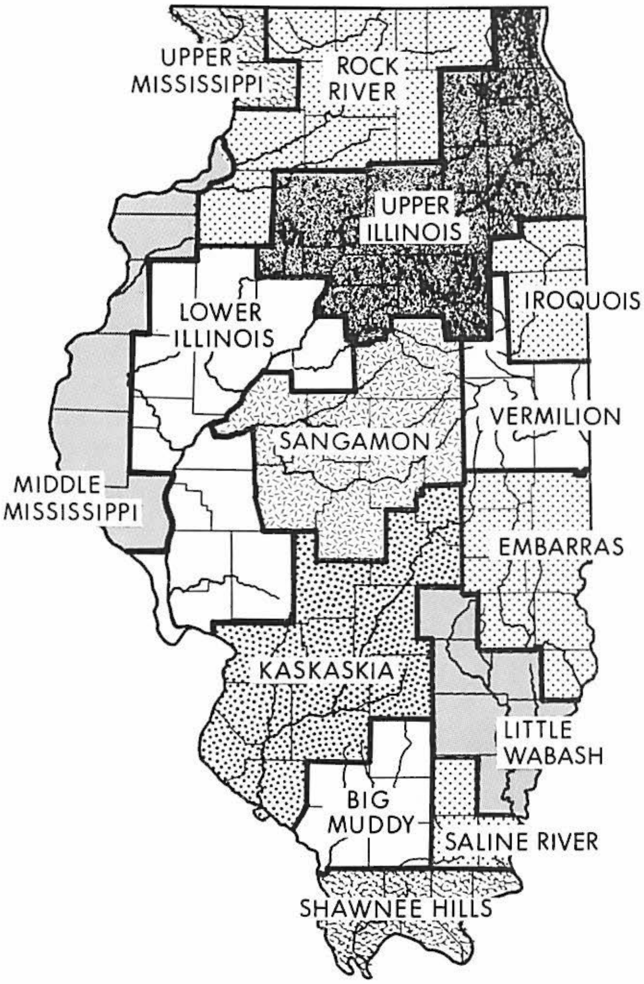


Fig. 1.—Major watersheds used to delineate the present distribution of the gray squirrel in Illinois.

itat factors, we measured forest characteristics in 12 randomly selected townships, 7 in which gray squirrels were present and 5 in which they were absent (Table 1), within eight of the major watersheds in northern and central Illinois. We randomly selected one or two sections (depending on the amount of forest available) in each of the 12 townships (Table 1). Within each selected section we then sampled vegetation in the larger (>1 ha) forest tracts, using recent aerial photos (1963–1967, University of Illinois Library). After randomly selecting a compass bearing for each tract, we extended a line along the bearing from the center of the tract to each edge. If the forest was only a narrow belt along a watercourse, transects were started from the nearest road and the tract was sampled using a zigzag (90° offset) pattern until all major forest types were included. Data were gathered from at least 10 plots in each tract unless a tract was too small or so nearly homogenous that fewer plots provided what we considered a representative sample.

Transects were divided into 8- × 40-m plots. Within each plot the following information was collected for trees with a dbh (diameter at breast height) greater than 12.7 cm: the number of trees of each species, the dbh and type of canopy of each tree (suppressed, codominant, dominant, or dead), and the average height of trees in the plot. Within each 8- × 40-m plot a 4- × 20-m subplot was used to sample all woody stems with diameters between 2.5 and 12.7 cm at the height of 1 m. We counted the number of individuals of each understory species and recorded the average understory height for each plot.

Using data from all 8- × 40-m plots in each tract, we calculated the relative density, frequency, basal area, and Importance Value Index (IVI)—the sum of relative frequency, density, and basal area/3 × 100—for each tree species; the average dbh of all codominant and dominant trees (trees that should produce seeds); the average dbh of all trees (an indication of the age of the forest); the average number of tree species per plot; and the density of all trees per hectare for each forest tract. Data from the 4- × 20-m subplots were used to calculate the average density of each understory species, the average number of species per plot, and the density of all woody stems per hectare for each tract sampled.

Vertical foliage distribution was measured every 5 m along each transect. Above each point the presence or absence of vegetation striking a cylinder 2.5 cm in diameter was recorded for height intervals of 0–1.5 m, 1.5–9 m, >9 m (Karr & Roth 1971; Willson 1974). The number of points with vegetation present in each height interval was used to calculate foliage height diversity with the Shannon-Wiener formula (Willson 1974). The percentage of vegetative cover was determined by summing over the three strata the percentages of points with vegetation present in each stratum (Karr 1968; Karr & Roth 1971; Willson 1974). The percentage of vegetative cover emphasizes total volume of vegetation, whereas foliage height diversity indexes only vertical distribution (Willson 1974). We also determined the number of plant species in each vegetative layer at each point. We felt that these vertical foliage variables, along with the species variables collected, would identify the vegetational characteristics important to gray squirrels (Packard 1956; Taylor 1974).

Along each transect we recorded any recent (<5 years) land treatment that might affect gray squirrels (pasturing, flooding, cutting, or burning) on a scale of 0 (no disturbance) to 4 (severe disturbance). We also tallied the number of tree cavities within each transect and noted whether the cavities could serve squirrels as all-weather refuges and nurseries or only as escape cover.

Using the sample sections as centers, we determined the amount and distribution of all tracts of forest for 9-square-mile areas (23.31 km^2). For each area we then calculated the total number of forest tracts, the average size of these tracts, the total amount of for-

TABLE 1.—Locations of forest stands sampled and numbers of 8- × 40-m transects taken in each township and section.

Watershed	County	Township	Gray Squirrel Abundance	Site	Section Number	Number of Forest Tracts Sampled	Number of 8- × 40-m Transects Taken
Upper Mississippi	Jo Daviess	Guilford	Common	Upland	29	5	57
Rock River	Winnebago	Shirland	Common	Upland	3	1	11
				Upland	27	2	20
	De Kalb	Somonauk	Absent	Upland	34	2	9
				Bottom	34	1	7
				Upland	4	2	17
Upper Illinois	Woodford	Partridge	Common	Upland	35	1	15
				Upland	27	2	25
	Livingston	Union	Absent	Bottom	2	1	9
				Bottom	23	1	10
Lower Illinois	Schuyler	Rushville	Common	Upland	3	1	20
				Upland	8	2	20
Middle Mississippi	Henderson	Bald Bluff	Common	Bottom	11	1	20
Sangamon	Mason	Lynchburg	Common	Upland	20	1	10
				Bottom	28	2	20
				Upland	28	1	10
	Piatt	Goose Creek	Absent	Bottom	36	3	20
				Upland	36	3	48
				Upland	21	1	11
Embarras	Edgar	Prairie	Absent	Upland	19	1	10
				Bottom	19	1	7
				Upland	19A	6	63
Vermilion	Vermilion	Grant	Absent	Bottom	18	1	10
				Upland	3	2	15
		McKendree	Common	Upland	14	1	10
Total						*45*	*474*
All watersheds			Common	Upland		17	198
				Bottom		3	40
						20	*238*
			Absent	Upland		17	173
				Bottom		8	63
						25	*236*

est, and the percentage of the total area in forest.

In our analysis of forest characteristics, we used a stepwise discriminant function program to evaluate possible differences in habitat composition and structure between areas where gray squirrels were absent and areas where they were present.

Finally, we must inject a cautionary word about interpreting our maps of the distribution of gray squirrels in Illinois. The gray squirrel is a hardy, adaptable, and mobile species. Individual squirrels will often move long distances and appear in unexpected places. Where possible, we attempted to limit the occupied range to the appropriate locality (usually a watershed) in each township. In some townships such detail was not possible, and although we may show gray squirrels present in the entire area, they may be present in only a portion of the township. Gray squirrels have also been purposely stocked in unoccupied range by private individuals. For example, a successful stocking has occurred within the past 5 years along the Sangamon drainage between White Heath and Monticello in Piatt County.

HISTORY OF THE GRAY SQUIRREL IN ILLINOIS

Archeological Evidence

Tree squirrels (Sciuridae) have been present in North America at least since the Miocene (29 million years B.P.). Several species of tree squirrels are known from the early Miocene, particularly from the northern Great Basin of the western United States, which was well forested at that time (Black 1963). By this era at least nine genera of sciurids had evolved, but the place of origin for the species found in the New World in the early Pleistocene (1 million years B.P.) deposits is not known. Fossil records of the sciurids are scarce because fossils of forest-dwelling animals are usually rare (Black 1963).

Modern species of squirrels may have evolved independently in the Palearctic and Nearctic regions and migrated back and forth across the Bering land bridge (Black 1972). However, at least during the late Pleistocene, evidence shows that there was no forest cover across the Bering land bridge, the only probable route of invasion from the Palearctic to the Nearctic regions (Hopkins 1959).

During the Pleistocene four major ice advances (Nebraskan, Kansan, Illinoian, and Wisconsinan) affected Illinois. The Illinoian glaciation (100,000 years B.P.) covered nearly all of Illinois except for the southernmost 48 km and small areas in the southwest and northwest. Whether an environment suitable for gray squirrels existed anywhere in Illinois during the period of maximum glaciation is not known because no fossil records of tree squirrels from southern Illinois exist for this period. Certainly by the close of the last advance of glacial ice, the Valders substage of the Wisconsinan glaciation (14,000–11,000 years B.P.), tree squirrels were present in southern Illinois. Bones of gray and fox squirrels were found in a midden at the Modoc Rock Shelter Site located adjacent to the Mississippi River in western Randolph County (Parmalee 1959). Occupancy of the site by Paleo-Indian and archaic peoples spans some 6,000 years (10,000–4,000 years B.P.), and squirrel bones were found in small numbers throughout the midden.

Brown & Cleland (1968: 119), after reviewing pollen records and faunal remains from many sites in the Midwest, believe that the vegetation south of the Valders substage consisted of a mixture of plant communities reflecting many local microclimates and soil conditions. These communities were mixtures of upland spruce-fir, swamp coniferous forest, oak groves, and mixed hardwoods (Brown & Cleland 1968: 119). These last two forest types should have provided suitable habitat for gray squirrels. At Peccary Cave in northern Arkansas, fox squirrel bones were found contemporary with those of the yellow-cheeked vole, a species now restricted to the taiga of northwest Canada. This finding suggests that a mosaic of habitats containing both northern coniferous and deciduous elements was present in the Mississippi Valley in the early postglacial period (Hallberg et al. 1974). Pollen profiles from Illinois bogs show an early postglacial dominance of spruce-fir followed by a rapid increase in deciduous trees among which the oaks were prominent (Geis & Boggess 1968). A pollen profile from north-central Iowa showed spruce-fir dominance at 11,725 years B.P. (climate, cool-moist), deciduous forest dominant at 8,140 years B.P. (warm-dry), and prairie grasses dominant at 6,575 years B.P. (warmer-dry) (Geis & Boggess 1968). If we assume that a similar sequence of vegetational changes occurred in Illinois, there would have been concurrent changes in the distribution and abundance of gray squirrels. However, no fossil records exist for most of the postglacial period. Gray squirrels do not occupy spruce-fir forests (they were replaced by the red squirrel in the New World and the European red squirrel in the Old World), but they are found in most of the northern deciduous forests, even those with large amounts of pine (Jackson 1940). The period between the retreat of glacial ice (11,000 years B.P.) and the spread of prairie grasses into the area (6,000 years B.P.) may have included the maximum distribution and abundance of gray squirrels during the past 12,000 years in what is now Illinois.

With the climatic change favorable to grasses, the deciduous forests began to retreat to refugia in northern and southern Illinois. Gray squirrels may have been forced out of much of the prairie peninsula in northern and central Illinois. The possible relative isolation of populations of gray squirrels, caused by the advancing prairie, may have resulted in limited subspeciation of the gray squirrel in the Midwest (currently, three subspecies are recognized, Barkalow & Shorten 1973).

As the climate changed toward the cooler, more humid conditions typical of historic times, trees began to encroach upon the prairie peninsula. Prairie vegetation was, however, often difficult to dislodge because of microclimates that favored grasses, the presence of a high water table, and frequent fires. Oaks and hickories were often the first to invade, at least on the steeper sites (Geis & Boggess 1968). As these pioneer tree species cooled and shaded the prairie, genera of mesic trees, such as *Acer, Ulmus,* and *Tilia,* invaded the stands. Soil analyses show that forests now occupy soils developed under prairie grasses along most prairie-forest borders in Illinois (Fehrenbacher et al. 1968).

Accumulations of bones, whether from natural entrapment or from middens left by man, shed some light on the composition and distribution of fauna prior to historical records. However, interpretation of the data must be qualified because of known tribal taboos against consumption of certain species, the availability and abundance of each species around the campsites, the relative preservation of the bones after use, and the completeness of bone recovery (Parmalee 1968). The tribes inhabiting Illinois apparently had no taboos against eating squirrels, but their use of squirrels as food seems to have been negligible (Munson et al. 1971).

Bones of gray squirrels have been identified at several archeological sites in Illinois (Table 2). At only one site (Cahokian Site, Madison County) were squirrel remains abundant, ranking second to those of white-tailed deer. At most sites squirrels appeared to represent only an incidental addition to the Indian diet (Table 2).

If we assume that the differing habitat requirements of fox squirrels (open woods, forest edge) and gray squirrels (interior of extensive forest with brushy understory) have changed little over the past 4,000 years, then the number of each squirrel species found

Table 2.—Gray and fox squirrel bones located at archeological sites in Illinois. The percentages of gray squirrel bones are compared with recent gray-squirrel kill percentages from each county.

Watershed	County	Site	Approximate Years Site Was Occupied	Numbers of Squirrels		Gray-Squirrel Percentage	1971–1973		
							Harvest of Squirrels		Gray-Squirrel Percentage
				Fox	Gray		Fox	Gray	
Kaskaskia	Randolph	Modoc[a]	11,000–5000 B.P.	22	17	43.6	306	300	49.5
Embarras	Crawford	Riverton[b]	1600–1169 B.C.	3	76	96.2	114	27	19.1
	Crawford	Swan Island[b]	1600–1169 B.C.	0	40	100.0	114	27	19.1
	Lawrence	Robeson[b]	1600–1169 B.C.	1	7	87.5	49	24	32.9
Lower Illinois	Greene	Apple Creek[c]	600 B.C.–1200 A.D.	2	4	66.7	413	154	27.2
Upper Illinois	Will	Fisher[d]	300–1600 A.D.	6	2	25.0	180	51	22.1
Lower Illinois	Peoria	Kingston[e]	1100–1400 A.D.	16	3	15.8	373	71	16.0
Kaskaskia	Madison	Cahokian[f]	1200–1550 A.D.	222	133	37.5	331	66	16.6
Kaskaskia	Monroe	Meyer Cave[g] (a natural trap)	5000 B.C.–present	0	5	100.0	96	104	52.0

[a] Parmalee (1959). [b] Parmalee (1969). [c] Parmalee et al. (1972). [d] Parmalee (1962*a*). [e] Parmalee (1962*b*). [f] Parmalee (1957). [g] Parmalee (1967).

at each archeological site can reveal something about the mosaic of forest and prairie surrounding the site. The preponderance of fox squirrels at sites in Peoria (Kingston Site) and Will (Fisher Site) counties suggests a habitat with more prairie than forest and with abundant edge between forest and prairie. Gray squirrels dominate in bone samples from Crawford and Lawrence counties, indicating extensive forests adjacent to these sites (Table 2). The more even mix of fox and gray squirrels from sites in Madison, Randolph, and Greene counties suggests a mosaic of dense forest and prairie in nearly equal proportions. It is interesting to compare ratios of gray and fox squirrels from these archeological sites with ratios taken from recent harvest records for the same counties (Table 2). Gray squirrels have declined drastically in abundance in Crawford County and probably in Greene County since prehistoric times but not appreciably in relation to numbers of fox squirrels in the remaining counties (Table 2).

Historical Records

The presettlement forests of Illinois supported immense numbers of gray squirrels as compared with their present abundance. Kennicott (1857: 629) provides a description of gray squirrel abundance during the early days of white settlement:

> "This is the most abundant of our American squirrels. It has a wide geographical range, and is prolific, and in many localities exists in almost incredible abundance. The immense numbers, heretofore mentioned as killed in one year for the bounty offered by Pennsylvania, was chiefly of this species. In Northern Ohio, I have seen them in such numbers as to be truly astonishing. Dr. Hoy relates that he knew a hunter in that state to kill one hundred and sixty in a day, and that, too, when they were not unusually abundant in the locality. In parts of Michigan, Illinois, Southern Wisconsin and Indiana they are no less numerous. Existing in such myriads, their depredations, of course, become, at times, a source of serious damage to the farmer. Fields of corn, and, occasionally, wheat, are much injured or entirely destroyed by them. I am informed that persons have sometimes kept watch in their fields to drive them off, and thus prevent the destruction of their whole crop. This species appears to increase in numbers, in certain districts, for a time after their settlement.
>
> "The migratory [gray] squirrel is at home both in low, heavy timber, and higher and somewhat more open woods, though it loves the heavily timbered, elevated ground best. It never frequents the outskirts of the woods, of which the fox-squirrel is so fond, and does not affect oak openings, nor the prairie groves, unless well timbered."

Patrick Shirreff was a Scot who toured North America in 1833 (Angle 1968: 134–135). Regarding the gray squirrel in Illinois, he wrote:

> ". . . In forests on the banks of the river Illinois, grey coloured squirrels were extremely numerous, and seemed actively engaged in collecting nuts, with which the ground was strewed. Near Pekin I walked a mile or two with a person returning from shooting squirrels, and who bestowed four or five on a woman who asked them for a sick boy."

In the fall of 1834 a great immigration of gray squirrels into southern Illinois began in Kentucky and was noted as far north as White County (Interstate Publishing Company 1883).

We searched some 300 histories of Illinois counties, published between 1870 and 1920, to help determine the distribution of gray squirrels during the early years of settlement, 1820–1860. Because squirrels are small animals, unimportant as food or as a menace to livestock, they are not always mentioned in a county's history. Fig. 2 shows the counties where squirrels were reported to be present. The reported presence of gray squirrels in the north-central counties of Henry, Knox, and McDonough and the central counties of De Witt, Macon, Piatt, and Christian, where they are scarce or absent today, indicates that gray squirrels were distributed in suitable habitats across much of the great prairie during the early days of pioneer settlement.

A search through the *Presettlement Vegetation Atlas of Illinois* (J. White, Illinois Natural Areas Inventory, unpublished data) suggests that there was probably sufficient forest cover to support gray squirrels in virtually every county in Illinois. Two possible exceptions may have been Ford and Livingston counties in east-central Illinois. Forest cover was scarce in these two counties in the 19th century before the osage orange was introduced for livestock fencing.

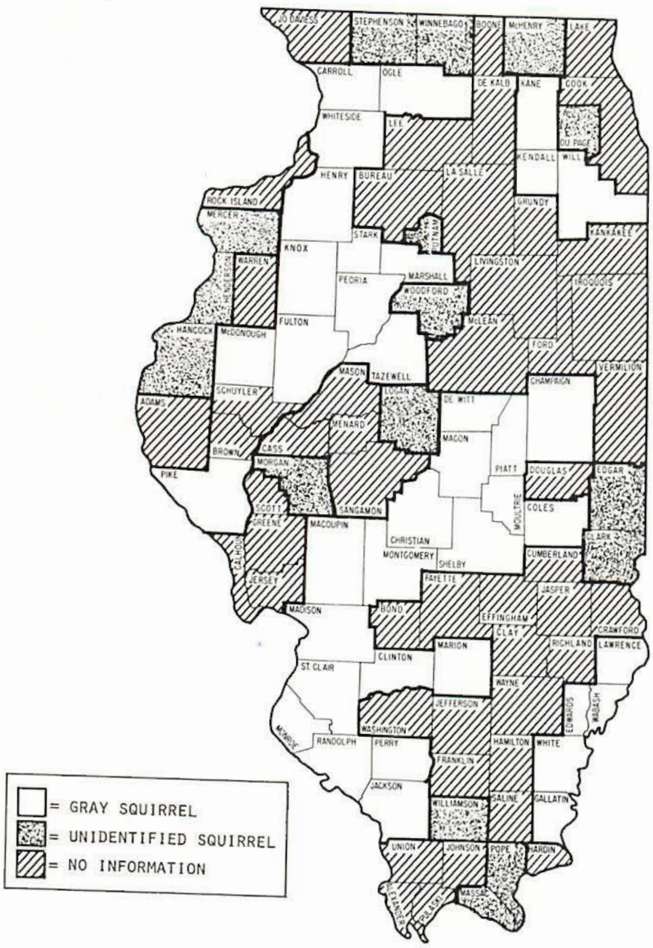


Fig. 2.—Illinois counties where gray squirrels were recorded as present during the early years of pioneer settlement, 1820–1860.

Gray squirrels were even reported to have increased for a time after settlement (Kennicott 1857) although this belief may have been the result of a more abundant human population in closer proximity to gray squirrels. It is true, however, that before the advent of cheap rail and water transportation, the native forests were a vital necessity to the pioneer. Between 1830 and 1855, forest land was valued above prairie, forest fires were controlled, forest plantations were started, and livestock was fenced out of the forests (Telford 1926). After 1855, as lumber from the great pineries of the Lake States became readily available, forests became barriers to more intensive agriculture and began to suffer the neglect and mismanagement that has continued to the present time. The presettlement Illinois forests covered about 15.25 million acres (Anderson 1970). By 1870 only 6 million acres of forest were left in Illinois and much of this acreage had been cut over, burned, and pastured one or more times. Forest acreage reached its lowest ebb in Illinois about 1914–1918 (King & Winters 1952), when little more than 3 million acres remained (Telford 1926). After 1930 forests began to increase in south-central and southern Illinois (King & Winters 1952) but continued to decline in northern Illinois (Essex & Gansner 1965). In 1962 the remaining forest land in Illinois was estimated at 3.7 million acres (Essex & Gansner 1965).

The effects of the destruction and mismanagement of forests on the abundance of gray squirrels was no less catastrophic. By the early 20th century even the casual observer could note their decreasing populations. Ellsworth (1880) reported gray squirrels as "scarce" in Marshall County, and by 1890 they were said to have been "once plentiful" in Henry County (Polson 1968). Bateman et al. (1909) reported them as "scarce" in Ogle County by 1909. At the same time fox squirrels were becoming more abundant as the large tracts of forest were destroyed and as osage orange hedgerows became widespread in the prairie counties (La Salle County, Baldwin 1877; Champaign County, Wood 1910).

By the turn of the century both species of squirrels were becoming scarce in Illinois. In 1889 the Illinois legislature set the first hunting season for squirrels from 1 June through 15 December with no daily or season bag limit. No change in regulation occurred until 1899, when the hunting season was curtailed to 1 September through 15 December, probably in response to a recognized scarcity of squirrels throughout the northeastern states (Jackson 1961). Eminent naturalists feared that both gray and fox squirrels

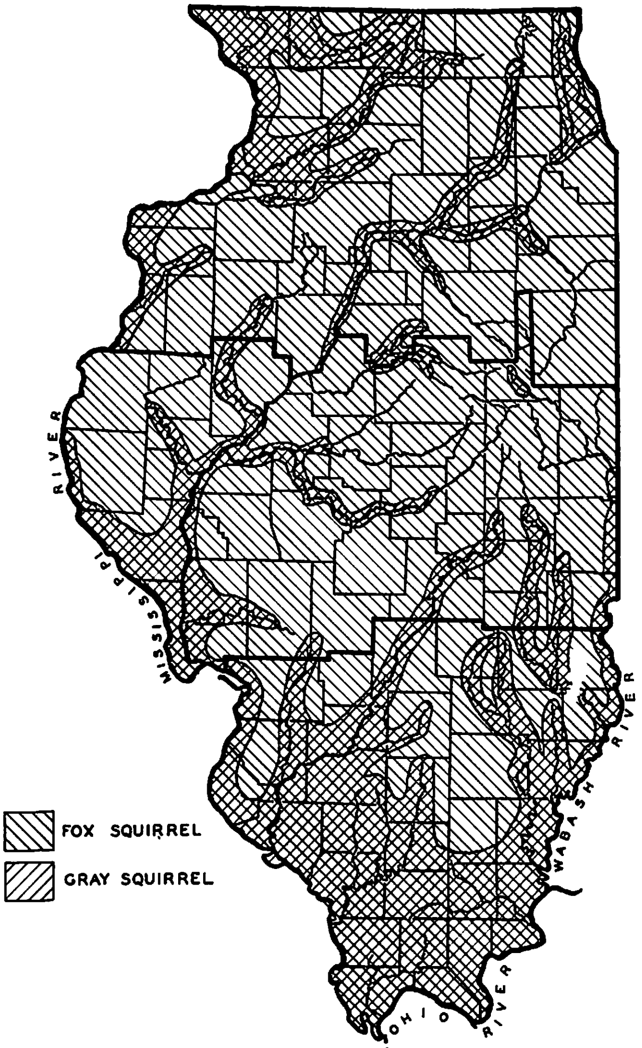


Fig.3.—Distibution of gray and fox squirrels in Illinois in 1942 (Source: Brown & Yeager 1945:454).

might be exterminated and suggested a ban on hunting throughout their range (Jackson 1961: 158). In Illinois a daily bag limit of 15 squirrels was imposed in 1915 and reduced to 10 in 1919. In 1923 three hunting zones were established for further regulation of the squirrel harvest.

In 1941–1942 Brown & Yeager (1945) attempted to map the occupied range of the gray squirrel in Illinois. The map was developed from the reported harvest of gray squirrels in each county, the distribution of forest by county in 1941–1942, and personal contacts with hunters and naturalists (Louis Brown, personal communication, 1972). Fig. 3 shows the somewhat fragmented range of gray squirrels in central and northern Illinois in 1941–1942, when they were found only along the major river valleys. Gray squirrels made up 35.3 percent of the estimated statewide squirrel kill of 1,463,305 in 1942 but constituted only 12–14 percent of the kill from central and northern Illinois (Brown & Yeager 1945: 519). By 1956–1957 gray squirrels constituted only 26 percent of 50,852 squirrels harvested throughout the state (Preno & Labisky 1971: 36). No gray squirrels were killed in two east-central Illinois counties, McLean and Iroquois, in 1956 or 1957. As we will show, Brown & Yeager undoubtedly underestimated the occupied range of the gray squirrel in some watersheds, but they also showed several occupied areas in which the gray squirrel has since been extirpated.

PRESENT DISTRIBUTION AND RELATIVE ABUNDANCE

Upper Mississippi River Region

This two-county region, comprising Carroll and Jo Daviess counties, represents a portion of the Wisconsinan driftless section of the central lowland province and lies in the extreme northwestern corner of Illinois (Fig. 4). The topography of the unglaciated western townships of both counties is one of rolling hills and great relief, particularly along interior stream canyons (Mohlenbrock 1975). Loess-capped bluffs and pallisades overlook broad terrace bottomlands along the Mississippi River. In contrast, the glaciated eastern portions of both counties are mostly flat and overlain with till 1–12 feet thick (Mohlenbrock 1975).

In 1800 the unglaciated portions of both counties were largely forested, with white and black oaks dominating the upland forests, and sugar maple, basswood, and northern red oak occurring on the more mesic lower slopes and ravines. Floodplain forests were dominated by silver maple, ashes, and elms (Mohlenbrock 1975). Jo Daviess County was about 87 percent forested and Carroll County about 24 percent forested before white settlement began after 1800 (Table 3). At present the two counties average only 12 percent forest (Table 3). This average represents a loss of 80.5 percent of their presettlement forests.

Elms, white oak, ashes, shagbark hickory, and black oak were the dominant trees in an upland forest measured in 1975 in Guilford Township, Jo Daviess County (Table 4). Many of the elms were dying, presumably because of Dutch elm disease.

To obtain a model for estimating the proportion of gray squirrels in the Upper Mississippi River Region and other watersheds in Illinois in 1800, we used regression and correlation analyses to examine the relationship between the percentage of gray squirrels in the county squirrel harvest of 1956–1957 (Y) and the amount of forest in each county in 1962 (X), using data from all 102 Illinois counties. The linear correlation of Y and X is $r = +0.82$ ($P < 0.001$), and the linear equation that best fits the regression of Y on X is $Y = 4.48 + 1.48\ X$. Assuming that this relationship between forest cover and gray squirrel abundance is an adequate representation of what existed in 1800 (present forest density does not exceed 60 percent of the land area in any county), we used the

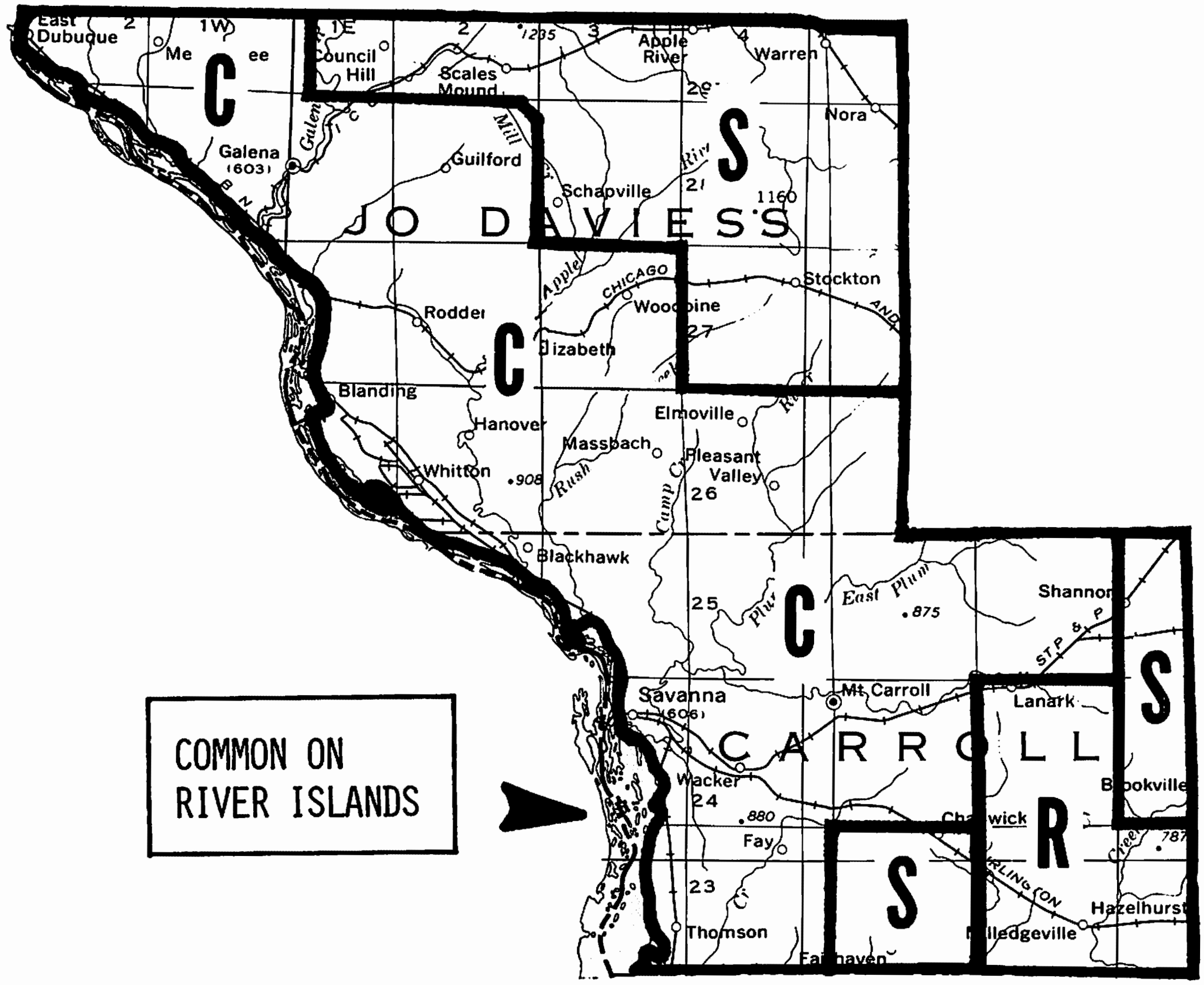


Fig. 4.—Distribution and relative abundance of the gray squirrel in the Upper Mississippi River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

regression equation to calculate the probable proportion of gray squirrels present in each watershed in 1800. The independent variable *X* (forest cover) is the acreage of forest estimated for each county in 1800 (Table 3). On this basis we estimate that 93 percent of the squirrel population in the Upper Mississippi River Region in 1800 was composed of gray squirrels, as compared with only about 35 percent in 1956–1957 (Tables 5 and 6).

Every township in the region still has gray squirrels, but they are considered scarce in the glaciated eastern townships in both counties (Fig. 4). Melanistic (black) populations of gray squirrels occur in the cities of East Dubuque and Hanover in Jo Daviess County and Mt. Carroll in Carroll County (Table 7).

Unfortunately, over half of the remaining forests in these counties are still pastured (Table 8) and suffer from overcutting and frequent wildfires. Fortunately, there has been comparatively little stream channeiization and no strip-mining for coal in either county (Table 8). A comparison between the present occupied range of the gray squirrel and that shown in Fig. 3 for 1942 (Brown & Yeager 1945) indicates a considerable expansion of range in eastern Carroll County since that date. We doubt that this is true, because little change in forest cover in Carroll County has occurred since 1924 (Table 3). We believe it more likely that the 1942 survey underestimated the range of the gray squirrel in Carroll County.

Human densities remained relatively stable in this region from 1950 to 1970 (Table 9); since then, the situation has changed. Several corporations have recently purchased large tracts of land for development as sites for leisure homes. One tract of 6,800 acres in Guilford Township, Jo Daviess County, will be filled with 3,000 homesites where at present there are only a few scattered hill farms. With the extension of multilane highways west from Rockford, Illinois, we can expect more extensive real estate development in this region. As the present forests are reduced in size or cut over, gray squirrels will decline in abundance. It is fortunate that such refuges as Apple River Canyon, Tapley Woods, and Mississippi Palisades State Park and the bottomland forests in the Upper Mississippi National Wildlife Refuge will continue to offer refuge to the gray squirrel if the mature forests now present on these areas are not disturbed. Many private forests now open to squirrel hunting will probably be closed or destroyed as human densities increase. Conservation agencies must move quickly if

TABLE 3.—Forest acreage reported present at intervals since 1800 for each major watershed and each county of Illinois.

Watershed	County	1800[a]		1924[b]		1948[c]		1962[d]		Percentage of Changes 1800–1962
		Acres of Forest	Percent of Total County	Acres of Forest	Percent of Total County	Acres of Forest	Percent of Total County	Acres of Forest	Percent of Total County	
Upper Mississippi	Jo Daviess	344,120	87.6	60,038	15.3	60,000	15.3	59,700	15.2	−82.6
	Carroll	70,675	23.6	24,911	8.3	22,000	7.3	21,000	7.2	−70.3
	Total or mean	*414,795*	*59.9*	*84,949*	*12.3*	*82,000*	*11.8*	*80,700*	*11.7*	*−80.5*
Rock River	Boone	70,080	38.7	5,311	2.9	6,000	3.3	3,100	1.7	−95.6
	De Kalb	30,086	7.4	5,558	1.4	5,000	1.2	5,700	1.4	−81.1
	Henry	66,841	12.6	14,240	2.7	17,000	3.2	15,700	3.0	−76.5
	Lee	29,036	6.2	10,990	2.4	9,000	1.9	10,000	2.1	−65.6
	McHenry	131,322	33.6	6,733	1.7	16,000	4.1	13,900	3.6	−89.4
	Ogle	111,655	23.0	27,757	5.7	29,000	6.0	23,000	4.7	−79.4
	Stephenson	118,250	32.5	12,020	3.3	16,000	4.0	11,600	3.2	−90.2
	Whiteside	85,126	19.3	16,653	3.8	16,000	3.6	14,300	3.2	−83.2
	Winnebago	106,900	32.1	17,877	5.4	22,000	6.6	15,500	4.7	−85.5
	Total or mean	*749,296*	*20.8*	*117,139*	*3.3*	*136,000*	*3.8*	*112,800*	*3.1*	*−84.9*
Upper Illinois	Bureau	90,197	16.2	33,973	6.1	35,000	6.3	25,600	4.6	−71.6
	Cook	70,060	11.5	23,885	3.9	30,000	4.9	28,400	4.7	−59.5
	Du Page	48,839	23.1	9,816	4.6	11,000	5.2	10,500	5.0	−78.5
	Grundy	11,379	4.1	8,837	3.2	10,000	3.6	11,200	4.1	−1.6
	Kane	100,810	30.5	8,686	2.6	10,000	3.0	8,900	2.7	−91.2
	Kendall	22,563	11.0	8,842	4.3	8,000	3.9	4,500	2.2	−80.1
	Livingston	14,710	2.2	6,400	0.9	9,000	1.3	5,300	0.8	−64.0
	Lake	154,507	52.8	19,349	6.6	20,000	6.8	13,900	4.8	−91.0
	La Salle	93,408	12.7	28,905	3.9	26,000	3.5	31,700	4.3	−66.1
	Marshall	52,935	20.9	26,552	10.5	28,000	11.1	23,400	9.3	−55.8
	Putnam	29,603	27.9	19,247	18.1	18,000	16.9	12,800	12.1	−56.8
	Stark	27,161	14.6	6,749	3.6	6,000	3.2	5,000	2.7	−81.6
	Will	53,818	10.0	19,878	3.7	23,000	4.3	20,300	3.8	−62.3
	Woodford	79,014	23.0	36,697	10.7	30,000	8.7	20,600	6.0	−73.9
	Total or mean	*849,004*	*16.0*	*257,816*	*4.8*	*264,000*	*5.0*	*222,100*	*4.2*	*−73.8*
Lower Illinois	Brown	156,000	79.4	15,015	7.6	42,000	21.4	38,200	19.4	−75.5
	Calhoun	125,843	75.9	39,367	23.7	72,000	43.4	60,700	36.6	−51.8
	Cass	96,090	40.6	32,693	13.8	46,000	19.4	32,000	15.5	−66.7
	Fulton	326,906	58.4	70,449	12.6	96,000	17.2	88,600	15.8	−72.9
	Greene	244,380	64.6	33,909	9.8	54,000	15.5	54,800	15.8	−75.6
	Jersey	180,950	75.6	47,070	19.7	66,000	27.6	55,600	23.2	−69.3
	Knox	152,422	32.7	36,265	7.8	44,000	9.4	46,500	10.0	−69.5
	Macoupin	303,481	54.4	60,936	10.9	95,000	17.0	83,100	14.9	−72.6
	McDonough	119,001	31.9	22,460	6.1	40,000	10.7	26,200	7.0	−77.9
	Morgan	179,692	49.7	14,666	4.1	30,000	8.3	26,100	7.2	−85.5
	Peoria	195,923	49.1	50,050	12.5	52,000	13.0	39,200	9.8	−79.9
	Schuyler	183,040	65.9	37,566	13.5	69,000	24.8	58,600	21.1	−67.9
	Scott	102,550	63.9	10,772	6.7	21,000	13.1	19,000	11.9	−81.4
	Tazewell	109,542	26.2	44,967	10.8	38,000	9.1	23,400	5.6	−78.6
	Warren	68,590	19.8	17,299	5.0	25,000	7.2	19,600	5.7	−71.4
	Total or mean	*2,544,410*	*49.4*	*533,484*	*10.4*	*790,000*	*15.5*	*671,700*	*13.2*	*−73.4*
Middle Mississippi	Adams	327,654	59.1	37,871	6.8	93,000	16.8	68,900	12.4	−79.0
	Hancock	224,027	43.9	34,000	6.7	46,000	9.0	49,400	9.7	−78.0
	Henderson	89,390	36.7	23,271	9.5	35,000	14.4	28,600	11.7	−68.0
	Mercer	121,536	34.2	27,123	7.6	28,000	7.9	24,300	6.8	−80.0
	Pike	329,120	62.0	33,510	6.3	97,000	18.3	72,800	13.7	−77.9
	Rock Island	136,216	50.7	35,479	13.2	34,000	12.6	29,500	11.0	−78.3
	Total or mean	*1,227,943*	*49.8*	*191,254*	*7.8*	*333,000*	*13.5*	*273,500*	*11.1*	*−77.7*
Sangamon	Christian	58,810	12.9	NOT AVAILABLE		13,000	2.9	14,500	3.2	−75.3
	De Witt	50,390	19.7			11,000	4.3	9,200	3.6	−81.7
	Logan	29,178	7.3			11,000	2.8	9,400	2.4	−67.8
	Macon	42,886	11.6			12,000	3.3	10,700	2.9	−75.1
	Mason	20,635	6.0			44,000	12.7	35,000	10.1	+69.6
	McLean	65,165	8.7			18,000	2.4	8,700	1.2	−86.6
	Menard	87,120	43.6			15,000	7.5	14,400	7.2	−83.5
	Piatt	16,206	5.8			7,000	2.5	4,900	1.8	−69.8
	Sangamon	110,558	19.6			24,000	4.3	23,200	4.1	−79.0
	Total or Mean	*480,948*	*13.3*			*155,000*	*4.3*	*130,000*	*3.6*	*−72.0*

TABLE 3.—Continued.

Watershed	County	1800[a] Acres of Forest	1800[a] Percent of Total County	1924[b] Acres of Forest	1924[b] Percent of Total County	1948[c] Acres of Forest	1948[c] Percent of Total County	1962[d] Acres of Forest	1962[d] Percent of Total County	Percentage of Changes 1800–1962
Kaskaskia	Bond	107,539	43.9	18,813	7.7	37,000	15.1	35,700	14.6	−66.8
	Clinton	140,538	44.1	56,032	17.6	62,000	19.5	52,100	16.3	−62.9
	Fayette	241,434	52.5	48,323	10.5	84,000	18.3	94,500	20.6	−60.9
	Madison	248,290	53.1	29,485	6.3	57,000	12.2	54,200	11.6	−78.2
	Marion	198,214	53.4	42,313	11.4	62,000	16.7	72,700	19.6	−63.3
	Monroe	177,279	72.9	57,918	23.8	58,000	23.8	52,000	21.4	−70.7
	Montgomery	151,580	33.6	46,498	10.3	46,000	10.2	48,100	10.6	−68.3
	Moultrie	26,874	12.2	2,074	0.9	8,000	3.6	10,100	4.6	−62.4
	Randolph	248,697	65.4	80,229	21.1	85,000	22.4	74,600	19.6	−70.0
	Shelby	155,350	31.4	47,944	9.7	55,000	11.1	62,800	12.7	−59.6
	St. Clair	262,227	61.2	47,945	11.2	55,000	12.8	58,300	13.6	−77.8
	Washington	174,086	48.1	51,212	14.2	63,000	17.4	51,700	14.3	−70.3
	Total or mean	*2,132,108*	*50.8*	*528,786*	*12.6*	*672,000*	*16.0*	*666,800*	*15.9*	*−68.7*
Big Muddy	Franklin	242,425	87.3	40,821	14.7	62,000	22.3	55,000	19.8	−77.3
	Jackson	301,145	78.0	92,100	23.9	123,000	31.9	134,700	34.9	−55.3
	Jefferson	326,110	88.0	37,467	10.2	61,000	16.6	65,600	17.9	−79.9
	Perry	228,510	80.6	60,804	21.4	61,000	21.5	61,100	21.6	−73.3
	Williamson	283,450	100.0	39,933	14.6	60,000	21.9	82,900	30.5	−70.8
	Total or mean	*1,381,640*	*87.0*	*271,125*	*17.1*	*367,000*	*23.1*	*399,300*	*25.1*	*−71.1*
Shawnee Hills	Alexander	121,997	85.1	43,847	30.6	67,000	46.7	67,600	47.1	−44.6
	Hardin	109,056	93.1	35,073	30.0	45,000	38.4	55,300	47.2	−49.3
	Johnson	212,060	96.0	64,778	29.3	79,000	35.8	84,000	38.0	−60.4
	Massac	143,080	90.9	31,604	20.1	44,000	28.0	42,100	26.7	−70.6
	Pope	241,560	99.1	65,259	26.8	100,000	41.0	146,500	60.1	−39.4
	Pulaski	110,310	84.5	23,532	18.0	34,000	26.0	30,600	23.4	−72.3
	Union	216,970	81.9	72,651	27.4	101,000	38.1	97,200	36.7	−55.2
	Total or mean	*1,155,033*	*90.4*	*336,744*	*26.3*	*470,000*	*36.8*	*523,300*	*40.9*	*−54.7*
Saline	Gallatin	194,130	92.5	52,833	25.2	55,000	26.2	54,900	26.2	−71.7
	Hamilton	264,880	95.1	34,830	12.5	53,000	19.0	54,400	19.5	−79.5
	Saline	247,488	100.0	34,523	14.0	43,000	17.5	51,000	20.7	−79.4
	Total or mean	*706,498*	*96.2*	*122,186*	*16.6*	*151,000*	*20.6*	*160,300*	*21.8*	*−77.3*
Little Wabash	Clay	157,796	53.1	33,478	11.3	46,000	15.5	47,100	15.9	−70.2
	Edwards	97,492	67.7	13,867	9.6	20,000	13.9	19,700	13.7	−79.8
	Effingham	127,808	41.4	29,654	9.6	47,000	15.2	54,500	17.7	−57.4
	Richland	152,700	65.5	22,456	9.6	30,000	12.9	37,600	16.1	−75.4
	Wabash	99,604	70.4	10,122	7.2	14,000	9.9	19,200	13.7	−80.7
	Wayne	308,582	67.4	69,874	15.3	74,000	16.2	71,500	15.6	−76.8
	White	188,282	58.7	19,150	6.0	30,000	9.4	36,700	11.4	−80.5
	Total or mean	*1,132,264*	*59.6*	*198,601*	*10.4*	*261,000*	*13.7*	*286,300*	*15.1*	*−74.7*
Embarras	Clark	226,980	70.2	30,617	9.5	58,000	17.9	68,500	21.2	−69.8
	Coles	107,604	33.2	32,605	10.0	23,000	7.1	21,200	6.5	−80.3
	Crawford	208,500	73.7	27,108	9.6	40,000	14.1	47,400	16.8	−77.3
	Cumberland	97,590	44.7	21,923	9.9	30,000	13.6	37,800	17.1	−61.3
	Douglas	26,206	9.7	2,559	0.9	5,000	1.9	4,700	1.7	−82.1
	Edgar	122,131	30.4	38,567	9.6	23,000	5.7	18,800	4.7	−84.6
	Jasper	134,649	42.5	29,847	9.4	36,000	11.4	44,100	13.9	−67.2
	Lawrence	188,710	78.8	24,457	10.2	34,000	14.2	43,500	18.2	−76.9
	Total or mean	*1,112,370*	*46.8*	*207,683*	*8.7*	*249,000*	*10.5*	*286,000*	*12.0*	*−74.3*
Vermilion	Champaign	32,651	5.1	6,400	1.0	7,000	1.1	5,100	0.8	−84.4
	Ford	4,000	1.3	3,068	1.0	1,000	0.3	1,200	0.4	−70.0
	Vermilion	114,548	19.9	5,652	1.0	29,000	5.0	25,000	4.4	−78.2
	Total or mean	*151,199*	*9.9*	*15,120*	*1.0*	*37,000*	*2.4*	*31,800*	*2.1*	*−79.0*
Iroquois	Iroquois	40,197	5.6	6,879	1.0	13,000	1.8	13,600	1.9	−66.2
	Kankakee	29,991	6.9	4,100	0.9	16,000	3.7	13,100	3.0	−56.3
	Total or mean	*70,188*	*6.1*	*10,979*	*1.0*	*29,000*	*2.5*	*26,700*	*2.3*	*−61.9*

[a] Anonymous. 1947–1948. Plan for forestry in Illinois. Mimeographed. 36 p. [b] Telford (1926). [c] King & Winters (1952). [d] Essex & Gansner (1965).

they hope to acquire additional lands in this watershed, because land prices in the area are skyrocketing. Designation of the Apple River in Jo Daviess County as a "wild" or "scenic" river would help to retain the forests now extending along its banks and would provide a corridor of forest cover reaching from the Mississippi eastward to the glaciated uplands in the eastern portion of the county.

Rock River Region

The glaciated Rock River Region (Fig. 5) is an area of rolling topography mantled by a thin layer of Wisconsinan and Illinoian glacial till. Most of the soils developed from moderately thick loess, but soils along portions of the Rock River in Ogle and Lee counties developed from sandy, water-deposited material, forming sand ridges or dunes.

The Rock River Region was about 80 percent prairie in 1800 with Boone County the most forested (38.7 percent) and Lee County the least forested (6.2 percent) before settlement (Table 3). In 1962 only 112,800 acres of forest remained in the region, a decline of 85 percent since 1800 (Table 3).

A survey of an upland forest in Shirland Township, Winnebago County, where gray squirrels are abundant, showed that black oak, bur oak, white oak, elms, shagbark hickory, and black cherry were dominant species (Table 4). The small basal areas (m^2/ha) of these species reflected their generally young age (Table 4), but they are all staple food producers for squirrels. A survey of a bottomland forest in De Kalb County, where gray squirrels are absent, showed bur oak to be the most important species in the tree stratum but not the most numerous (Table 4). Successional species, silver maple, ashes, and elms, were the most abundant, reflecting past disturbances—including flooding, pasturing, and timber cutting—on forest composition and growth (Table 4).

The proportion of grays in the squirrel population in this region has declined from an estimated 35 percent in 1800 (Table 5) to 15–18 percent at present (Table 6). Three counties—Winnebago, McHenry, and Boone—contain the highest proportion of gray squirrels today (Table 6).

We found a significant increase ($P < 0.01$) in the proportion of gray squirrels in the squirrel harvests from the Rock River Region in 1971–1973 compared with the harvests of 1956-1957. We do not believe that this change indicates a recent increase in gray squirrels in the region, but rather a response to the continuing destruction of woodlots. Small woodlots, usually occupied by fox squirrels, are the first to be removed when priorities for land use change. Increases in the proportionate harvest of gray squirrels occurred in Boone, McHenry, Ogle, and Winnebago counties between 1956–1957 and 1971–1973 (Table 6). In these four counties human populations increased an average of 21 percent between 1960 and 1970 (Table 9), and forest cover declined about 24 percent between 1948 and 1962 (Table 3). The loss of small woodlots tended to restrict squirrel hunters to the larger forest tracts inhabited by both gray and fox squirrels, resulting in a proportionate increase in the gray squirrel harvest.

The same situation did not prevail in De Kalb, Lee, and Whiteside counties, where gray squirrels declined drastically in the harvests of 1971–1973 compared with those of 1956–1957 (Table 6). Today, gray squirrels commonly occur only in portions of Stephenson, northern and central Winnebago, eastern McHenry, and central Ogle counties (Fig. 5). They are absent throughout the southeast and southern portions of Lee, Whiteside, and Boone counties and from all of De Kalb County (Fig. 5). The fragmentation of the occupied range is a reflection of the small woodlots scattered throughout the basin. The only extensive forest cover is along the Rock River and its major tributaries. However, the Rock River and its major tributaries are not subject to extreme floods nor do they have extensive bottomlands where water stands for several weeks (Telford 1926). Hence, the nearby forests were cleared early during pioneer settlement, and remaining forests are restricted to narrow strips along the riverbanks or to small islands in the main river. The loss of forests in Boone County is particularly striking. This county had 70,000 acres of forest in 1800 but now has only 3,000 acres (Table 3), most of which is pastured (Table 8).

The small isolated population of gray squirrels in southern Lee County is apparently a remnant of an extensive population formerly occupying the large swamps that once extended along the Green River (Stevens 1914). The Inlet swamp covered 30,000 acres and undoubtedly contained extensive forests. This swamp was ditched and drained about 1901 (Stevens 1914).

A comparison of presently occupied range (Fig. 5) with that shown for 1942 (Fig. 3) indicates that the gray squirrel population has decreased in Whiteside County and in southwest Lee County along the Green River. Gray squirrels are no longer found along the Green or Edwards rivers in Henry County (M. Hartley, Black Hawk College, Moline, personal communication, 1974) although one farmer reported that a hunter had shot a gray squirrel in grazed upland timber in section 10 of Hanna Township in the fall of 1972. He also reported one or more melanistic squirrels (whether gray or fox squirrels is not known) from this same forest, which is located not far (<6.5 km) from occupied range along the lower Rock River and from the extensive forests along the lower Green River.

Gray squirrels are abundant in the city of Rockford, Winnebago County, and are scarce in Rochelle, Ogle County. There are apparently no melanistic populations of gray squirrels in the Rock River Region today, although Kennicott (1857) reported one lot of 50 black squirrels shot "near" the Rock River

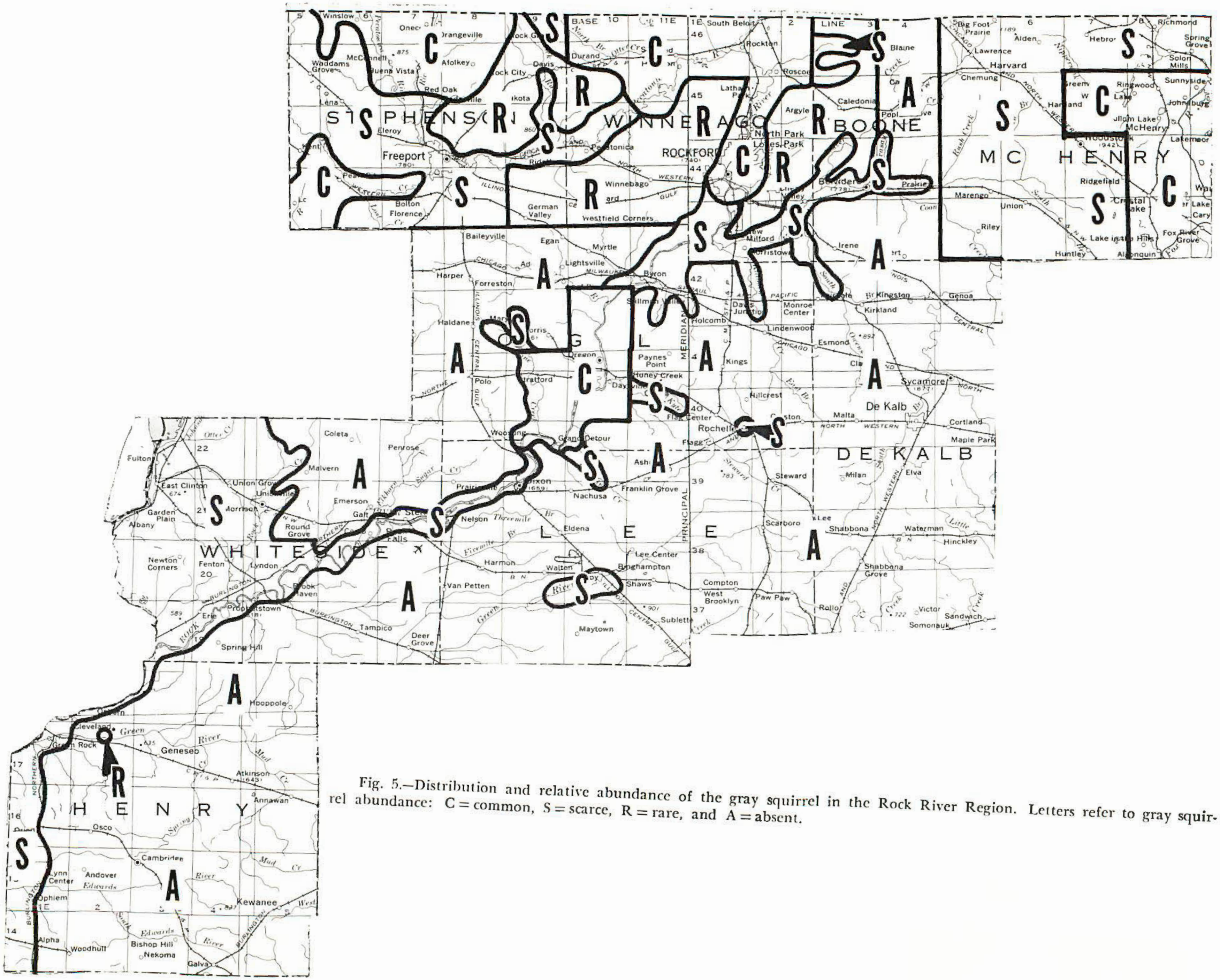


Fig. 5.—Distribution and relative abundance of the gray squirrel in the Rock River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

in the mid-19th century. As late as 1872, black squirrels were reported plentiful in the forests north of Freeport in Stephenson County (Schroger 1949: 206). Deliberate selection by hunters apparently eliminated black squirrels along the Rock River and has reduced the number of "black" gray squirrels throughout their range (Jackson 1961).

More than half the present-day forests in the Rock River basin are pastured and stream channelization has also been extensive (Table 8). Strip-mining for coal is important only in Henry County (Table 8).

Forests are declining in this watershed, particularly in Boone and Winnebago counties (Table 3), and human populations are increasing rapidly (Table 9). Between 1960 and 1970, the human population increased 32.5 percent in McHenry County, 38.6 percent and 25.2 percent in De Kalb and Boone counties, and 17.6 percent in Winnebago County. The close proximity of Rockford and Chicago makes it virtually certain that more people will move into the region either as permanent or as seasonal residents. The future of all forest-dwelling wildlife is bleak in the Rock River Region. Huntable gray squirrel populations will soon become even more difficult to find in the four northern counties as new home construction and land clearance engulf more forests. With the removal of the riparian forests, gray squirrels are even becoming scarce along such major rivers as the Pecatonica. Gray squirrels will remain in state parks and other reserves only so long as the larger tracts of forests are left undisturbed. The best remaining gray squirrel range in Ogle County is anchored in Lowden and White Pines state parks and the 2,200-acre Sinnissippi Farm, a private estate south of Oregon, where forests are managed for sustained yield.

Except in state parks and forest preserves, little can be done to retard the deleterious effects of a burgeoning human population on the natural ecosystem of the Rock River basin. The continued protection and maintenance of closed canopy old-growth hardwood forests are of prime importance on all publicly owned forests in the Rock River basin. These public forests will soon provide the primary haven for those wildlife species, like the gray squirrel, that require extensive forest habitats for survival.

Upper Illinois River Region

The Upper Illinois River Region (Fig. 6) includes the area from Lake Michigan south to the southwest corner of Woodford County. Within this region flow the Illinois River and its principal tributaries, the Fox, the Des Plaines, and the lower reaches of the Kankakee and (North) Vermilion rivers. The entire region was glaciated at least twice. The northeastern section along Lake Michigan consists of hilly moraines, deeply buried beneath glacial drift. Soils were derived from glacial drift, lake-bed sediments, beach deposits, and peat. Close to Lake Michigan are long ridges of shore-deposited sands (Mohlenbrock 1975).

South and west of Lake Michigan, the Illinois River flows through a level, poorly drained plain of relatively young drift. Moraines and other glacial landforms are common throughout this region. Soils, having developed under prairie sods growing on loess, are young and are high in organic matter (Mohlenbrock 1975).

In Woodford County we examined an upland forest where gray squirrels are common. The most important tree species was sugar maple, followed by elms, black oak, white oak, and northern red oak (Table 4). Disturbance in this forest has been limited to pasturing and timber cutting. The forest has been "high-graded" several times for timber products and is generally understocked, with many fire-scarred trees. The high incidence of oak indicates that cutting has been light enough to perpetuate these shade-tolerant species.

In contrast, a bottomland stand in Livingston County, where gray squirrels are absent, has obviously been disturbed to a much greater extent. Successional species predominate in the tree stratum, with osage orange, box elder, cottonwood, ashes, and willows the most important species (Table 4).

An average of 16 percent of the Upper Illinois River Region was forested in 1800, ranging from 53 percent in Lake County to only 2.2 percent in Livingston County (Table 3). By 1962 the forested area had declined to an average of only 4.2 percent of the total basin (Table 3). Kilburn's (1959) map, based on the original land office survey of 1834 for what are now Aurora and Batavia townships in Kane County, documents the loss of forest in the upper basin. In 1834, 7,360 acres (47.9 percent) of this 15,360-acre area were forested (Kilburn 1959). In 1964 only 345 acres (2.2 percent) (based on 7½-minute quadrangular maps—Geneva, Aurora North, Sugar Grove, and Elburn) remained forested.

The destruction of the floodplain forests along the Illinois River has been no less catastrophic. This river has a gentle fall, flows in a wide valley, and has always carried a considerable silt load—a combination conducive to the formation of numerous bottomland lakes, sloughs, and backwaters that were surrounded by forest and tended to limit agricultural development (Mills et al. 1966). However, on 1 January 1900 the Sanitary and Ship Canal was opened at Chicago, connecting the Des Plaines and Illinois rivers with Lake Michigan. The diversion of water from Lake Michigan raised the permanent water levels in the Illinois River 2–4 feet, inundated thousands of acres of bottomlands, and killed most of the timber on the newly flooded bottoms (Mills et al. 1966).

The effects of flooding on bottomland forests and on the gray squirrel have been documented by Yeager (1949) in a study of a bottomland area in Calhoun

County. Virtually all trees flooded to a depth of 20 or more inches were dead 8 years after flooding began. Pin oak, a staple food source for bottomland-dwelling squirrels, was very sensitive to a rise in the water table and died even where flooding was of short duration. Until water levels were raised, the most abundant squirrels in the bottomlands were grays; fox squirrels were confined to the pin oak ridges. The death of large tracts of flooded forest created a mosaic of living and dead timber, and fox squirrels became the more abundant species in the bottomland forests (Yeager 1949: 61).

Fig. 6 depicts the effects of this loss of timber on the distribution of the gray squirrel in the Upper Illinois River Region. From Joliet to just south of La Salle-Peru, the gray squirrel has been virtually eliminated (Fig. 6). Gray squirrels are common only in the upper and lower portions of the basin. In the upper basin, gray squirrels are primarily urban except in northern Lake County and the northwestern corner of Kane County (Fig. 6).

A comparison between the presently occupied range (Fig. 6) and that of 1942 (Fig. 3) indicates a definite reduction in the occupied range. The con-

TABLE 4.—Stand data from selected townships in each major watershed in Illinois. Trees (diameter >12.5 cm at height of 1 m) were counted on 8- × 40-m transects. Only the most important species or groups of species are included in the table.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m^2/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Upper Mississippi	Jo Daviess	Guilford[a] T28N, R2E, Section 29 (Upland)	Elms	98	7.6	17.8	29.8	27.8	25.1
			White oak	37	5.2	12.4	11.2	19.1	14.2
			Ashes	39	2.4	10.8	11.8	8.9	10.5
			Shagbark hickory	27	2.3	8.5	8.3	8.3	8.4
			Black oak	21	2.6	7.7	6.5	9.4	7.9
			Black walnut	17	1.3	7.7	5.3	4.7	5.9
			Hickories (pignut, mockernut, bitternut)	18	0.6	7.7	5.5	2.3	5.1
			Basswood	10	1.6	3.1	3.2	5.7	4.0
			Black cherry	9	0.4	5.1	2.7	1.4	3.0
			Bigtooth aspen	10	0.5	3.9	3.0	1.7	2.8
			Total	*286*	*24.5*	*84.7*	*87.3*	*89.3*	*86.9*
Rock River	Winnebago	Shirland[a] T29N, R11E, Section 27; T28N, R11E, Section 3 (Upland)	Black oak	68	7.2	14.4	19.8	27.6	20.6
			Bur oak	64	5.3	18.0	18.6	20.6	19.1
			White oak	54	6.3	12.6	16.0	24.2	17.6
			Elms	65	2.5	21.6	18.9	9.7	16.7
			Shagbark hickory	28	2.0	11.7	8.3	7.5	9.2
			Black cherry	28	0.7	7.2	8.3	2.5	6.0
			Shadbush	7	0.9	5.4	2.1	3.5	3.7
			Box elder	16	0.5	1.8	4.7	1.8	2.8
			Black walnut	7	0.4	3.6	2.1	1.6	2.4
			Hickories (pignut, mockernut, bitternut)	3	0.2	1.8	0.9	0.8	1.2
			Total	*340*	*26.0*	*98.1*	*99.7*	*99.8*	*99.3*
Rock River	De Kalb	Somonauk[a] T37N, R5E, Sections 4 & 34 (Bottomland)	Bur oak	31	7.7	15.0	10.0	29.5	18.2
			Ashes	54	2.4	10.0	17.1	9.1	12.1
			Elms	52	1.4	12.0	16.5	5.3	11.3
			Silver maple	46	1.8	3.0	14.6	6.8	8.1
			Shagbark hickory	20	2.1	8.0	6.2	8.2	7.5
			White oak	10	3.0	7.0	3.1	11.4	7.2
			Black cherry	22	0.5	7.0	7.2	2.0	5.4
			Northern red oak	11	2.0	5.0	3.4	7.7	5.4
			Hawthorns	25	0.5	6.0	8.1	2.0	5.3
			Black oak	8	1.9	5.0	2.5	7.4	5.0
			Total	*279*	*23.3*	*78.0*	*88.7*	*89.4*	*85.5*

tiguous range along the Illinois and Fox rivers, as shown by Brown & Yeager (1945), no longer exists. Gray squirrels have apparently been extirpated from the Vermilion River (North) since the 1942 survey.

In the lower part of the region, the range of the gray squirrel is centered in western Woodford and Marshall counties. In Woodford County this range includes both upland and bottomland forests. Small

TABLE 4.—Continued.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m^2/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Upper Illinois	Woodford	Partridge[a] T28N, R3W, Section 27; T27N, R3W, Section 35 (Upland)	Sugar maple	48	5.1	14.5	16.4	23.2	18.0
			Elms	40	2.5	12.7	13.8	11.2	12.5
			Black oak	30	2.9	10.2	10.2	13.2	11.2
			White oak	34	2.5	8.4	11.9	11.5	10.6
			Northern red oak	17	2.2	6.6	5.9	9.8	7.5
			Chinquapin oak	14	1.1	2.4	4.9	4.9	4.1
			Hickories (pignut, mockernut, bitternut)	12	0.7	4.2	4.3	3.1	3.9
			Hop hornbeam	13	0.3	5.4	4.3	1.1	3.6
			Bur oak	11	0.6	4.2	3.8	2.7	3.6
			Basswood	9	0.9	3.0	3.2	4.3	3.5
			Total	*228*	*18.8*	*71.6*	*78.7*	*85.0*	*78.5*
Upper Illinois	Livingston	Union[a] T29N, R7E, Sections 23 & 2 (Bottomland)	Osage orange	212	8.1	37.5	47.3	30.2	38.3
			Box elder	164	8.2	27.5	36.6	30.6	31.6
			Cottonwood	21	8.0	10.0	4.8	29.9	14.9
			Ashes	15	1.1	10.0	3.3	3.9	5.7
			Willows	14	0.8	5.0	3.3	2.9	3.7
			Hawthorns	15	0.5	5.0	3.3	1.8	3.4
			Crab apples	5	0.1	2.5	1.1	0.4	1.3
			Black walnut	2	0.1	2.5	0.4	0.3	1.1
			Total	*448*	*26.9*	*100.0*	*100.0*	*100.0*	*100.0*
Lower Illinois	Schuyler	Rushville[a] T2N, R2W, Section 8; T2N, R1W, Section 3 (Upland)	Sugar maple	61	6.6	13.6	21.3	28.0	21.0
			White oak	57	4.5	15.6	19.9	19.2	18.2
			Black oak	37	2.9	12.3	12.8	12.5	12.5
			Hickories (pignut, mockernut, bitternut)	38	2.3	13.0	13.4	9.6	12.0
			Elms	23	1.4	10.4	8.2	5.8	8.1
			Shagbark hickory	23	1.2	7.8	7.9	5.2	7.0
			Northern red oak	14	1.8	7.1	4.9	7.5	6.5
			Hop hornbeam	10	0.2	5.8	3.5	0.8	3.4
			Black cherry	4	0.5	2.6	1.4	2.0	2.0
			Ashes	2	0.7	1.3	0.8	2.9	1.7
			Total	*269*	*22.1*	*89.5*	*94.1*	*93.5*	*92.4*
Middle Mississippi	Henderson	Bald Bluff[a] T12N, R5W, Section 11 (Bottomland)	Silver maple	228	24.3	26.3	55.7	42.8	41.6
			Ashes	66	5.8	17.1	16.0	10.3	14.5
			Pin oak	19	7.6	9.2	4.6	13.4	9.1
			Cottonwood	16	7.0	6.6	3.8	12.4	7.6
			Dead trees	19	2.8	10.5	4.6	5.0	6.7
			Honey locust	13	3.9	7.9	3.1	6.8	5.9
			Elms	14	1.5	7.9	3.4	2.6	4.6
			River birch	16	1.9	5.3	3.8	3.3	4.1
			Sycamore	6	1.4	1.3	1.5	2.5	1.8
			Osage orange	5	0.1	2.6	1.2	0.2	1.3
			Total	*402*	*56.3*	*94.7*	*97.7*	*99.3*	*97.2*

TABLE 4.—Continued.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m^2/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Sangamon	Piatt	Goose Creek[a] T18N, R4E, Section 21; T18N, R5E, Section 36 (Bottomland)	Silver maple	348	35.7	40.0	78.1	70.9	62.9
			Honey locust	35	3.9	15.0	7.9	7.7	10.2
			Sycamore	19	9.5	5.0	4.4	18.8	9.4
			Elms	23	0.7	15.0	5.3	1.4	7.2
			Ashes	12	0.3	15.0	2.6	0.6	6.1
			Osage orange	4	0.2	5.0	0.9	0.4	2.1
			Hawthorns	4	0.1	5.0	0.8	0.1	2.0
			Total	*445*	*50.4*	*100.0*	*100.0*	*99.9*	*99.9*
		Goose Creek[a] T18N, R4E, Section 21; T18N, R5E, Section 36 (Upland)	Elms	151	5.3	19.6	35.7	21.5	25.6
			Hackberry	134	5.3	19.6	31.6	21.4	24.2
			Bur oak	30	3.3	10.9	7.0	13.3	10.4
			Honey locust	16	4.8	7.6	3.7	19.6	10.3
			Hickories (pignut, mockernut, bitternut)	31	0.9	13.0	7.4	3.9	8.1
			Black walnut	16	1.4	6.5	3.7	5.8	5.3
			Basswood	6	1.8	2.2	1.5	7.4	3.7
			Total	*384*	*22.8*	*79.4*	*90.6*	*92.9*	*87.6*
Sangamon	Mason	Lynchburg[a] T18N, R10W, Sections 28 & 20 (Bottomland)	Silver maple	163	7.1	14.3	35.6	22.6	24.2
			Cottonwood	66	12.8	14.3	14.4	41.1	23.3
			Pin oak	50	3.6	9.5	11.0	11.6	10.7
			Elms	41	1.1	14.3	8.9	3.5	8.9
			Box elder	31	1.5	7.1	6.8	4.7	6.2
			Ashes	19	0.6	9.5	4.1	1.9	5.2
			Pecan	19	1.0	7.1	4.1	3.3	4.8
			Total	*389*	*27.7*	*76.1*	*84.9*	*88.7*	*83.2*
	Mason	Lynchburg[a] Section 20 (Upland)	Black oak	97	20.4	55.5	52.5	87.4	65.2
			Blackjack oak	88	2.9	44.5	47.5	12.6	34.8
			Total	*185*	*23.3*	*100.0*	*100.0*	*100.0*	*100.0*
Kaskaskia	St. Clair	Englemann[b] T1S, R6W, Sections 23, 24, 25, & 26 (Bottomland)	Silver maple	78	6.2	13.3	19.3	23.1	18.5
			Hackberry	93	2.7	14.7	23.0	10.0	15.9
			Elms	59	2.9	15.1	14.6	11.0	13.6
			Ashes	37	2.7	7.2	7.5	8.0	7.6
			Box elder	26	0.9	7.2	6.4	3.6	5.7
			Overcup oak	15	2.2	4.3	3.8	8.1	5.4
			Big shellbark hickory	18	1.4	6.1	4.3	5.1	5.2
			Pin oak	15	2.0	4.3	3.6	7.4	5.1
			Pecan	12	1.3	4.7	2.9	4.6	4.1
			Bur oak	6	0.7	2.9	1.4	2.6	2.3
			Total	*359*	*23.0*	*79.8*	*86.8*	*83.5*	*83.4*
Kaskaskia	Shelby	Windsor[c] T11N, R4E, Section 30 (Upland)	White oak	345	11.3	11.9	53.1	52.6	39.2
			Black oak	90	3.2	10.7	13.9	14.7	13.1
			Northern red oak	64	2.6	10.7	9.9	12.0	10.9
			Hickories (pignut, mockernut, bitternut)	31	0.6	11.9	4.8	3.0	6.6
			Shagbark hickory	31	1.2	8.3	4.8	5.6	6.2
			Ashes	31	0.8	7.1	4.8	4.0	5.3
			Elms	11	0.2	8.3	1.7	1.1	3.7
			Shingle oak	10	0.4	6.0	1.5	2.1	3.2
			Black walnut	10	0.3	6.0	1.5	1.5	3.0
			Sugar maple	11	0.4	3.6	1.7	2.0	2.4
			Total	*634*	*21.0*	*84.5*	*97.7*	*98.6*	*93.6*

remnant populations of gray squirrels, holdovers from extensive populations that existed as late as 1900 along the Illinois and Kankakee rivers (Hahn 1907), persist south of Joliet and along the lower Kankakee River.

In La Salle County, gray squirrels are abundant only in Starved Rock State Park (Fig. 6) and the city

TABLE 4.—Continued.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m^2/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Big Muddy	Jackson	Elk[b]	Pin oak	16	5.8	10.4	6.1	26.3	14.3
		T7S, R1W,	Silver maple	39	2.7	8.9	14.4	12.4	11.9
		Sections 14, 15, 22, & 23	Big shellbark hickory	29	3.6	6.1	10.7	16.1	11.0
		(Bottomland)	Elms	33	1.1	12.2	12.3	4.9	9.8
			Ashes	25	1.4	10.4	9.2	6.4	8.7
			Swamp white oak	21	1.3	8.5	7.7	5.7	7.3
			Post oak	21	1.2	4.3	8.6	5.3	6.1
			Shagbark hickory	15	1.0	7.2	5.5	4.4	5.7
			Mockernut hickory	16	1.0	5.3	6.1	4.7	5.4
			Black oak	7	0.4	2.9	2.5	1.8	2.4
			Total	*222*	*19.5*	*76.2*	*83.1*	*88.0*	*82.6*
Shawnee Hills	Union[b]	(No Township)	Silver maple	61	5.3	9.6	12.7	17.8	13.3
		T12S, R2W,	Sweet gum	58	3.9	7.6	12.2	13.1	10.9
		Sections 30 & 31	Elms	51	3.1	11.9	10.8	10.2	10.9
		(Bottomland)	Pin oak	42	3.7	6.4	8.8	12.4	9.2
			Box elder	56	1.8	8.4	11.6	6.2	8.7
			Ashes	39	1.8	9.9	8.1	6.2	8.0
			Sugarberry	27	1.2	5.8	5.7	4.1	5.2
			Pecan	19	1.1	5.2	4.0	3.8	4.3
			Hackberry	12	0.6	4.1	2.5	1.9	2.8
			Cottonwood	10	1.2	2.3	2.1	4.1	2.8
			Total	*375*	*23.7*	*71.2*	*78.5*	*79.8*	*76.1*
Shawnee Hills	Johnson	Cache[b]	Sweet gum	71	3.7	11.6	17.1	12.2	13.6
		Vienna	Ashes	46	2.0	8.3	11.1	6.8	8.7
		T13S, R2E,	Elms	29	2.3	8.8	7.1	7.7	7.9
		Sections 30 & 31 (Bottomland)	Swamp chestnut oak	22	2.7	6.1	5.4	8.9	6.8
			Box elder	27	1.1	3.9	6.5	3.6	4.7
			Red maple	22	1.2	4.4	5.4	4.1	4.7
			Ironwood (blue beech)	20	0.3	7.7	4.9	1.1	4.6
			Shumard's oak	7	1.9	2.2	1.6	7.3	3.7
			Tulip tree	19	1.1	2.8	4.6	3.5	3.6
			Pin oak	7	1.9	2.2	1.6	6.4	3.4
			Total	*270*	*18.2*	*58.0*	*65.3*	*61.6*	*61.7*
Shawnee Hills	Pope[c]	(No Township)	Northern red oak	38	7.9	11.3	12.5	33.4	19.1
		T13S, R6E,	Sugar maple	90	3.2	12.0	29.9	13.8	18.6
		Section 5 (Upland)	Hickories (pignut, mockernut, bitternut)	46	3.0	11.3	15.4	12.8	13.2
			American beech	31	2.6	9.3	10.1	11.2	10.2
			Shagbark hickory	17	1.2	8.6	5.7	5.3	6.5
			White oak	14	1.1	9.6	4.6	4.6	6.3
			Elms	22	0.7	7.6	7.2	2.8	5.9
			Tulip tree	11	1.3	4.8	3.8	5.7	4.8
			Ashes	8	0.8	4.8	2.6	3.2	3.5
			Black oak	5	0.6	3.8	1.7	2.7	2.7
			Total	*282*	*22.4*	*83.1*	*93.5*	*95.1*	*90.8*

TABLE 4.—Continued.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m²/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Saline	Saline	Raleigh[b]	Ashes	61	2.3	12.0	14.0	9.9	12.1
		T8S, R6E, Sections 29,	Northern red oak	49	3.3	9.5	11.4	14.1	11.7
		30, 32 & 33	Sweet gum	48	3.2	8.9	11.1	13.4	11.1
		(Bottomland)	Black oak	36	3.9	6.3	8.3	16.6	10.4
			Elms	48	0.9	13.3	11.1	3.7	9.1
			Pin oak	32	3.0	5.7	7.4	12.8	8.6
			Shagbark hickory	20	0.7	7.0	4.6	3.0	4.8
			River birch	20	0.8	2.5	4.6	3.4	3.5
			Silver maple	13	0.6	3.8	3.1	2.6	3.1
			Cherrybark oak	5	1.2	1.9	1.2	5.1	2.7
			Total	*332*	*19.9*	*70.9*	*76.8*	*84.6*	*77.1*
Little Wabash	Wabash[b]	(No Township)	Elms	83	2.5	18.7	24.3	6.6	16.5
		T2S, R13W,	Hackberry	64	2.0	16.0	18.7	5.2	13.3
		Section 11	Silver maple	37	4.8	8.0	10.9	12.6	10.5
		(Bottomland)	Sweet gum	17	2.8	6.7	4.9	7.5	6.4
			Box elder	24	0.7	8.0	7.0	2.0	5.7
			Bur oak	6	4.4	3.3	1.8	11.6	5.6
			Pecan	8	3.3	4.0	2.5	8.7	5.1
			Northern red oak	5	3.6	2.0	1.4	8.6	4.0
			Sugarberry	19	0.6	4.7	5.6	1.5	3.9
			Shagbark hickory	12	2.0	2.7	3.5	5.4	3.8
			Total	*275*	*26.7*	*74.1*	*80.6*	*69.7*	*74.8*
Embarras	Edgar	Prairie[a]	Osage orange	78	3.6	14.1	21.5	17.0	17.6
		T16N, R10W,	Black walnut	38	2.6	11.8	10.4	12.2	11.4
		Section 19;	Honey locust	48	2.3	10.2	13.4	10.7	11.4
		T16N, R11W, Section 19	Shagbark hickory	43	2.6	9.4	11.9	12.0	11.1
		(Upland)	Shingle oak	22	2.4	8.2	6.1	11.1	8.4
			Elms	23	0.7	7.4	6.5	3.3	5.7
			Black cherry	14	0.8	7.8	4.0	3.6	5.1
			Black oak	12	1.8	2.0	3.5	8.5	4.7
			Hickories (pignut, mockernut, bitternut)	17	. 0.7	4.7	4.8	3.3	4.3
			Hackberry	9	1.0	3.5	2.4	4.8	3.6
			Total	*304*	*18.5*	*79.1*	*84.5*	*86.5*	*83.3*
Embarras	Coles	Pleasant Grove[d]	Silver maple	420	19.8	26.1	62.4	50.7	46.4
		T11N, R9E,	Cottonwood	132	15.2	23.8	19.6	38.8	27.4
		Section 23	Box elder	51	1.4	22.7	7.6	4.3	11.5
		(Bottomland)	Willows	52	1.5	9.0	7.6	3.7	6.8
			Red elm	7	0.1	6.8	1.0	0.3	2.7
			Total	*662*	*38.0*	*88.4*	*98.2*	*97.8*	*94.8*
Vermilion	Vermilion	Grant[a]	Osage orange	221	7.2	19.2	44.1	28.9	30.8
		T22N, R12W, Section 3;	Shagbark hickory	63	4.8	10.1	12.5	19.4	14.0
		T23N, R11W,	Box elder	64	2.1	7.1	12.7	8.4	9.4
		Section 18	Hawthorns	49	0.9	13.1	9.7	3.6	8.8
		(Upland)	Black oak	21	3.6	7.1	4.2	14.7	8.7
			Bur oak	13	1.7	7.1	2.5	6.8	5.5
			Willows	16	0.9	2.0	3.2	4.0	3.1
			White oak	4	1.3	3.0	0.8	5.3	3.0
			Black cherry	7	0.2	6.1	1.5	0.6	2.7
			Black walnut	10	0.4	4.0	2.0	1.6	2.5
			Total	*468*	*23.1*	*78.8*	*93.2*	*93.3*	*88.5*

of Streator, southeast La Salle County (Streator Superintendent of Parks, personal communication, 1976), where Mohr (1941) reported them present in 1940.

Gray squirrels made up an estimated 28.2 percent of the squirrel population in the Upper Illinois River Region in 1800 (Table 5). In recent years gray squirrels still have constituted between 12 and 20 percent of the squirrel harvest (Table 6). Woodford, Marshall, and Lake counties contribute most of the gray squirrels to the harvest in the basin. As noted for the Rock River Region, the significant ($P < 0.01$) increase in the proportion of gray squirrels in the squirrel harvest between 1956–1957 and 1971–1973 (Table 6) is probably due to the loss of woodlots that formerly supported fox squirrels. The remaining forests, restricted to the roughest topography, are relatively large and contain proportionately more gray squirrels.

The largest concentration of melanistic gray squirrels left in Illinois is found in the Upper Illinois River Region along the shoreline of Lake Michigan from Evanston north to Zion (Table 7). Black gray squirrels have managed to survive in Illinois only where they are protected from hunting, as in urban parks or other reservations. Human settlements along Lake Michigan north of Chicago most likely progressed so rapidly (human densities increased 46 times between 1835 and 1850 (Telford 1926)) that hunting was curtailed sufficiently early to preserve remnants of the formerly extensive distribution of black squirrels in that area (Kennicott 1857).

An average of 40.7 percent of the remaining forests in this region are pastured, most heavily in Grundy, Kendall, Stark, and Woodford counties (Table 8).

Extensive areas in Will, Grundy, Bureau, La Salle, and Stark counties have been strip-mined for coal (Table 8). In the entire upper basin only 121 of

Table 4.—Continued.

Watershed	County	Township	Species	Stems per Ha	Basal Area (m^2/ha)	Relative Frequency (Percent)	Relative Density (Percent)	Relative Dominance (Percent)	Importance Value Index (Percent)
Vermilion	Vermilion	McKendree[c] T18N, R11W, Section 14 (Upland)	Black oak	69	5.5	14.3	23.7	23.7	20.6
			Hickories (pignut, mockernut, bitternut)	47	1.8	12.2	16.1	7.8	12.1
			White oak	19	4.0	10.2	6.4	17.4	11.4
			Sugar maple	34	2.2	8.2	11.8	9.7	9.9
			Shagbark hickory	31	0.9	6.1	10.7	4.0	7.0
			American beech	16	1.9	6.1	5.4	8.4	6.6
			Northern red oak	12	1.3	6.1	4.3	5.5	5.3
			Tulip tree	12	1.2	6.1	4.3	5.1	5.2
			Ashes	9	0.9	6.1	3.2	4.0	4.4
			Sassafras	6	1.0	4.1	2.1	4.4	3.5
			Total	*255*	*20.7*	*79.5*	*88.0*	*90.0*	*86.0*
Iroquois	Iroquois	Concord[a] T27N, R11W, Section 30 (Upland)	Black oak	287	15.0	51.5	19.2	51.9	40.9
			White oak	79	5.1	14.3	17.3	17.8	16.5
			Northern red oak	48	3.3	8.7	13.5	11.4	11.2
			Black cherry	43	1.4	7.7	13.4	4.7	8.6
			Ashes	40	1.6	7.1	9.6	5.4	7.4
			Bitternut hickory	14	1.2	2.6	7.7	4.2	4.8
			Total	*511*	*27.6*	*91.9*	*80.7*	*95.4*	*89.4*
Iroquois	Iroquois	Douglas[a] T27N, R14W, Section 26 (Bottomland)	Ashes	156	10.8	29.1	25.0	29.4	27.8
			Elms	144	6.0	26.7	25.0	16.3	22.7
			Silver maple	113	8.4	20.9	15.0	22.9	19.6
			Basswood	69	2.9	12.8	5.0	8.0	8.6
			Hackberry	6	4.1	1.2	5.0	11.2	5.8
			Cottonwood	6	2.9	1.2	5.0	7.8	4.7
			Hawthorns	19	0.3	3.5	10.0	0.7	4.7
			Total	*513*	*35.4*	*95.4*	*90.0*	*96.3*	*93.9*

[a] Trees > 12.7 cm dbh. Trees tallied using 8- × 40-meter transects. (See Methods and Table 1 for sampling intensity.)
[b] Trees > 10.2 cm dbh. Data provided by R. & J. Graber, Illinois Natural History Survey. Trees tallied using 1/10-acre circular plots taken each 2 acres.
[c] Trees > 12.7 cm dbh. Plots 0.1 ha, taken each 60 meters.
[d] Trees > 10.2 cm dbh. Data from Crites & Ebinger (1969). Trees tallied using 25-m^2 plots in a complete census.

nearly 20,000 strip-mined acres have forests old enough to support squirrels (Table 8), and nearly all of those few acres are in Will County. Stream channelization has also been fairly extensive in the Upper Illinois River Region, particularly in Livingston, Will, Cook, La Salle, Kane, and Bureau counties (Table 8).

The Upper Illinois River Region currently contains over 7 million people, more than 50 percent of the human population of Illinois. Most of these people live in Cook County (Table 9), but human densities are now increasing more rapidly in the surrounding counties of Du Page, Kendall, Lake, and

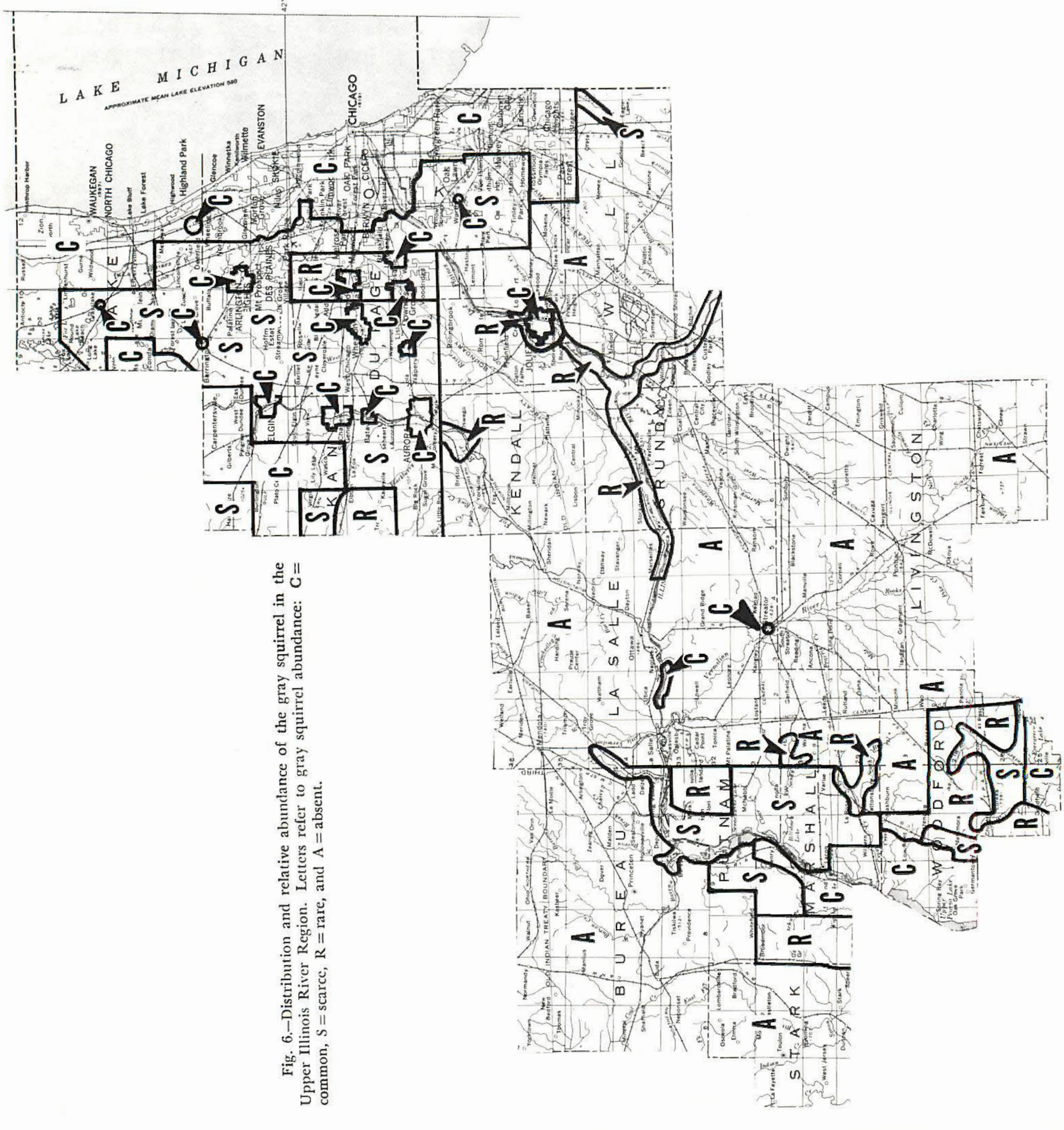


Fig. 6.—Distribution and relative abundance of the gray squirrel in the Upper Illinois River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

TABLE 5.—Estimated proportion of gray squirrels in the squirrel population of each watershed in 1800 compared with the percentage of gray squirrels in the squirrel harvests of 1956–1957. Estimates are based on the linear regression equation $Y = 4.48 + 1.48\ X$, where $X =$ the estimated percentage of each watershed forested in 1800.

Watershed	Estimated Percent of Gray Squirrels in 1800 Squirrel Population	Average Percent of Gray Squirrels in 1956–1957 Squirrel Harvest	Change Between Sampling Periods (Percent)
Upper Mississippi	93.1	34.8	−62.6
Rock River	35.3	15.0	−57.5
Upper Illinois	28.2	12.0	−57.4
Lower Illinois	77.6	16.6	−78.6
Middle Mississippi	78.2	13.2	−83.1
Sangamon	24.2	3.6	−85.1
Kaskaskia	79.7	22.5	−71.8
Big Muddy	100.0	49.8	−50.2
Shawnee Hills	100.0	67.1	−32.9
Saline	100.0	56.6	−43.4
Little Wabash	92.5	28.6	−69.1
Embarras	73.7	20.9	−71.6
Vermilion	19.1	6.7	−64.9
Iroquois	13.5	0.9	−93.3

Will (Table 9). Gray squirrels will probably remain abundant in the urban parks and forest reserves of this region unless there is a drastic loss of forest cover. However, their future outside these forest reserves is uncertain.

Gray squirrels are most numerous on the state-owned conservation areas adjacent to the Illinois River in the southern portion of this region. These areas, located in Woodford and Marshall counties, should continue to provide quality hunting for gray squirrels.

The upland forests in the Upper Illinois River Region are among the poorest in Illinois in quality of timber. Because these woodlands contain little salable timber, there is little incentive for landowners to practice sustained timber management. Forests will persist in areas too rough for successful farming, but such areas are becoming very attractive for water impoundments and housing developments. The close proximity of Peoria to the occupied gray squirrel ranges in Woodford and Marshall counties probably means that these ranges will eventually be lost as more people move into these counties.

Lower Illinois River Region

The Lower Illinois River Region stretches from northern Peoria County to the junction of the Illinois River with the Mississippi. It includes tributaries of the La Moine, Mackinaw, and Spoon rivers and Kickapoo, Sugar, and Macoupin creeks (Fig. 7).

This region lies in a glacial valley forming a part of the former Mississippi seabed (Illinois State Planning Commission 1940). The streams and rivers flow through Illinoian drift, but surface deposit consists of a layer of Wisconsinan loess 5–20 feet thick. The topography is gently rolling and the Illinois River is paralleled by fairly high bluffs. Where the Mississippi and Illinois rivers converge, the terrain becomes rougher. In Calhoun County only a narrow ridge separates the valleys of the two rivers (Illinois State Planning Commission 1940). The portions of Calhoun County that were never glaciated exhibit the typical dissected upland topography noted in Jo Daviess and Carroll counties.

The upland forests in Schuyler County that we sampled showed a mixture of species, with species dominance dependent on site. Sugar maple, white oak, black oak, and hickories were the most important species (Table 4). As in Woodford County, however, these forests are generally understocked and poor in quality but contain species that provide adequate food and den sites for squirrels.

The Lower Illinois River Region averaged about 50 percent forested in 1800 and still contains more than 671,000 acres of forest (Table 3). Forests are scarce in the northern portion of the region in Tazewell, McDonough, Warren, and Knox counties, but counties in the lower portion of the basin remain extensively forested (Calhoun, 36.6 percent; Jersey, 23.2 percent) (Table 3).

In 1800 gray squirrels made up an estimated 77.6 percent of the squirrel population in the Lower Illinois River Region (Table 5). By 1956–1957 this proportion was reduced by 78.6 percent to an average of 16.6 percent of the squirrel harvest (Table 6). This decline is nearly identical to the 73.4 percent loss of forest land in the basin from 1800 to 1962 (Table 3).

Gray squirrels are now abundant in the counties of the lower portion of the basin. East and west of the Illinois River in the upper basin of the lower river they are scarce or absent (Fig. 7). Gray squirrels are scarce north of Bernadotte in Fulton County. In the 1880's Strode (1887) reported that both gray and fox squirrels were abundant along the Spoon River near Bernadotte. Gray squirrels made up 48.8 percent of a sample of 41 squirrels shot in 1973 on Sugar Creek in Schuyler County, where they are still common. Gray squirrels are generally scarce along most of the La Moine River (Fig. 7). They are common on the west side of the Illinois River in Peoria County but are scarce on the east side except in East Peoria (Tazewell County) (Fig. 7). Gray squirrels are absent from most of Knox and Warren counties, northern McDonough and eastern Scott counties, and are rare in most of Morgan County. They are common in the cities of Peoria (Peoria County), East Peoria (Tazewell County), and Jacksonville (Morgan County).

Gray squirrels comprise about 20 percent of the squirrel harvest from the Lower Illinois River Region (Table 6). They are most abundant in harvests from Calhoun, Jersey, Macoupin, Brown, Greene, and Schuyler counties (Table 6). They were significantly ($P < 0.01$) more abundant in the squirrel harvests of

TABLE 6.—Gray and fox squirrels reported shot by hunters in 1956–1957 and 1971–1973 in each major watershed in Illinois.

Watershed and County	Mail Questionnaire[a] 1956–1957				Mail Questionnaire[b] 1971–1973			
	Number Fox	Number Gray	Total	Percent Gray	Number Fox	Number Gray	Total	Percent Gray
Upper Mississippi								
Jo Daviess	310	204	514	40.0	195	131	326	40.2
Carroll	253	97	350	28.0	124	40	164	24.4
Total or mean	*563*	*301*	*864*	*34.8*	*319*	*171*	*490*	*34.9*
Rock River								
Boone	128	25	153	16.3	38	10	48	20.8
De Kalb	89	12	101	11.9	68	2	70	2.9
Henry	536	47	583	8.8	250	32	282	11.3
Lee	305	47	352	13.4	189	5	194	2.6
McHenry	403	113	516	21.9	86	130	216	60.2
Ogle	272	32	304	10.5	126	23	149	15.4
Stephenson	412	69	481	14.3	206	36	242	14.9
Whiteside	295	37	332	11.1	303	18	321	5.6
Winnebago	167	77	244	31.6	112	57	169	33.7
Total or mean	*2,607*	*459*	*3,066*	*15.0*	*1,378*	*313*	*1,691*	*18.5*[c]
Upper Illinois								
Bureau	425	42	467	9.0	433	79	512	15.4
Cook	276	71	347	20.5	61	9	70	12.9
Du Page	159	24	183	13.1	42	19	61	31.1
Grundy	243	22	265	8.3	160	25	185	13.5
Kane	200	32	232	13.8	151	21	172	12.2
Kendall	212	13	225	5.8	28	0	28	0.0
Livingston	159	5	164	3.0	127	2	129	1.6
Lake	302	88	390	12.6	82	197	279	70.6
La Salle	483	50	533	9.4	513	33	546	6.1
Marshall	420	70	490	14.3	340	119	459	25.9
Putnam	200	23	223	11.3	102	16	118	13.6
Stark	290	5	295	1.7	66	1	67	1.5
Will	224	8	232	3.4	180	51	231	22.1
Woodford	427	93	520	17.9	192	59	251	30.7
Total or mean	*4,020*	*546*	*4,566*	*12.0*	*2,477*	*631*	*3,108*	*20.3*[c]
Lower Illinois								
Brown	292	70	362	19.3	119	65	184	35.3
Calhoun	332	236	568	41.5	386	403	789	51.1
Cass	166	92	258	35.7	360	57	417	13.7
Fulton	1,000	186	1,186	15.7	572	47	619	7.6
Greene	699	141	840	16.8	413	154	567	27.2
Jersey	434	251	685	36.6	262	205	467	43.9
Knox	751	113	864	13.1	215	50	265	18.9
Macoupin	1,074	106	1,180	9.0	781	254	1,035	24.5
McDonough	579	23	602	3.8	184	18	202	8.9
Morgan	394	10	404	2.5	285	24	309	7.8
Peoria	1,141	224	1,365	16.4	373	71	444	16.0
Schuyler	295	109	404	17.0	149	47	196	24.0
Scott	271	46	317	14.5	216	12	228	5.3
Tazewell	818	56	874	6.4	378	30	408	7.4
Warren	342	44	386	11.4	24	1	25	4.0
Total or mean	*8,588*	*1,707*	*10,295*	*16.6*	*4,717*	*1,438*	*6,155*	*23.4*[c]
Middle Mississippi								
Adams	711	88	799	11.0	729	79	808	9.8
Hancock	584	9	593	1.5	227	9	236	3.8
Henderson	174	2	176	1.1	142	24	166	14.5
Mercer	263	50	313	16.0	224	89	313	28.4
Pike	757	198	955	20.7	439	257	696	36.9
Rock Island	609	124	733	16.9	349	165	514	32.1
Total or mean	*3,098*	*471*	*3,569*	*13.2*	*2,110*	*623*	*2,733*	*22.8*[c]
Sangamon								
Christian	483	47	530	8.9	310	15	325	4.6
De Witt	195	11	206	5.3	106	0	106	0.0
Logan	250	3	253	1.2	143	6	149	4.0
Macon	394	15	409	3.7	71	4	75	5.3
Mason	489	18	507	3.6	273	25	298	8.4
McLean	230	0	230	0.0	247	1	248	0.4
Menard	144	10	154	6.5	69	4	73	5.5
Piatt	362	2	364	0.6	110	3	113	2.7
Sangamon	535	9	544	1.7	222	16	238	6.7
Total or mean	*3,082*	*115*	*3,197*	*3.6*	*1,551*	*74*	*1,625*	*4.5*

TABLE 6.—Continued.

Watershed and County	Mail Questionnaire[a] 1956–1957				Mail Questionnaire[b] 1971–1973			
	Number Fox	Number Gray	Total	Percent Gray	Number Fox	Number Gray	Total	Percent Gray
Kaskaskia								
Bond	198	120	318	37.7	178	53	231	22.9
Clinton	190	118	308	38.3	148	254	402	63.2
Fayette	400	489	889	55.0	165	126	293	43.3
Madison	1,027	112	1,139	9.8	331	66	397	16.6
Marion	334	327	661	49.5	119	123	242	50.8
Monroe	429	308	737	41.8	96	104	200	52.0
Montgomery	773	218	991	22.0	161	100	261	38.3
Moultrie	215	48	263	18.3	60	21	81	25.9
Randolph	562	400	962	41.6	306	340	646	52.6
Shelby	565	236	801	29.5	95	88	183	48.1
St. Clair	599	101	700	14.4	159	106	265	40.0
Washington	510	322	832	38.7	60	100	160	37.5
Total or mean	*5,802*	*2,799*	*8,601*	*22.5*	*1,878*	*1,481*	*3,361*	*44.1*[c]
Big Muddy								
Franklin	287	309	596	51.8	257	328	585	56.1
Jackson	404	437	841	52.0	33	56	89	37.1
Jefferson	127	199	326	61.0	51	47	98	48.0
Perry	683	316	999	31.6	106	94	200	47.0
Williamson	352	574	926	62.0	86	154	240	64.2
Total or mean	*1,853*	*1,835*	*3,688*	*49.8*	*533*	*679*	*1,212*	*56.0*[c]
Shawnee Hills								
Alexander	325	244	569	42.9	48	105	153	68.6
Hardin	91	372	463	80.3	15	61	76	80.3
Johnson	192	450	642	70.1	94	221	315	70.2
Massac	101	395	496	79.6	53	87	140	62.1
Pope	87	359	446	81.5	34	109	143	76.2
Pulaski	208	135	343	39.4	36	73	109	67.0
Union	226	552	778	71.0	50	104	154	67.4
Total or mean	*1,230*	*2,507*	*3,737*	*67.1*	*330*	*760*	*1,090*	*69.7*
Saline								
Gallatin	215	233	448	52.0	67	46	113	40.7
Hamilton	156	348	504	69.0	148	173	321	53.9
Saline	226	199	425	46.8	62	46	108	42.6
Total or mean	*597*	*780*	*1,377*	*56.6*	*277*	*265*	*542*	*48.9*[c]
Little Wabash								
Clay	403	129	532	24.2	311	266	577	46.1
Edwards	92	20	112	17.9	36	36	72	50.0
Effingham	372	176	548	32.1	72	36	108	33.3
Richland	477	286	763	37.5	105	110	215	51.2
Wabash	176	18	194	9.3	20	10	30	33.3
Wayne	357	174	531	32.8	168	98	266	36.8
White	426	118	544	21.7	12	11	23	47.8
Total or mean	*2,303*	*921*	*3,224*	*28.6*	*724*	*567*	*1,291*	*43.9*[c]
Embarras								
Clark	540	194	734	26.4	268	63	331	19.0
Coles	475	152	627	24.2	182	40	222	18.0
Crawford	341	140	481	29.1	114	27	141	19.1
Cumberland	112	71	183	38.8	98	53	151	35.1
Douglas	244	6	250	2.4	100	2	102	2.0
Edgar	389	12	401	3.0	226	43	269	16.0
Jasper	283	88	371	23.7	85	33	118	28.0
Lawrence	357	63	420	15.0	49	24	73	32.9
Total or mean	*2,741*	*726*	*3,467*	*20.9*	*1,122*	*285*	*1,407*	*20.3*
Vermilion								
Champaign	112	9	121	7.4	56	5	61	8.1
Ford	105	10	115	8.7	45	0	45	0.0
Vermilion	635	42	677	6.2	271	20	291	6.9
Total or mean	*852*	*61*	*913*	*6.7*	*372*	*25*	*397*	*6.3*
Iroquois								
Iroquois	280	0	280	0.0	214	2	216	0.9
Kankakee	157	4	161	2.5	138	20	158	12.7
Total or mean	*437*	*4*	*441*	*0.9*	*352*	*22*	*374*	*5.9*

[a] Total sample = 50,852 squirrels (W. L. Preno, Illinois Department of Conservation, personal communication, 1973).
[b] Total sample = 30,886 squirrels (W. L. Preno, Illinois Department of Conservation, personal communication, 1971–1973).
[c] Significantly different ($P < 0.01$) from the total percentage for gray squirrels in the watershed squirrel harvests of 1956–1957.

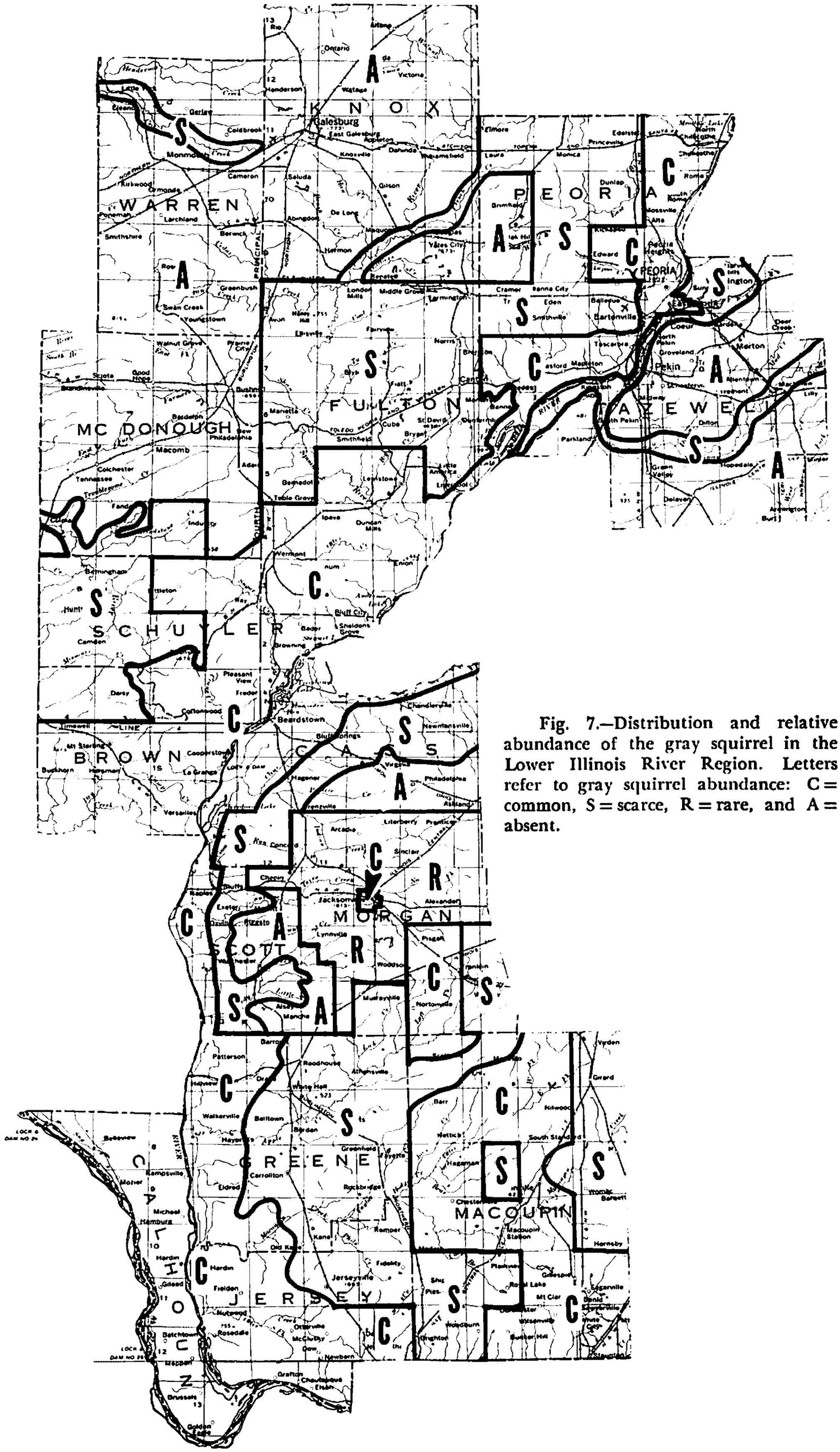


Fig. 7.—Distribution and relative abundance of the gray squirrel in the Lower Illinois River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

TABLE 7.—Locations of melanistic populations of gray squirrels in Illinois.

Watershed	County	Location
Upper Mississippi	Jo Daviess	City of East Dubuque City of Hanover
	Carroll	City of Mt. Carroll (scarce)
Upper Illinois	Cook	Village of Winnetka
	Lake	City of Highland Park
	Cook	Village of Glencoe
	Cook	Village of Northbrook
	Lake	USVA Hospital, City of North Chicago
	Lake	City of Zion
	Lake	City of Lake Forest
	Cook	Village of Wilmette (scarce)
	Cook	City of Evanston (scarce)
	Lake	Fort Sheridan
Middle Mississippi	Rock Island	City of Rock Island
	Rock Island	City of Moline
	Rock Island	U.S. Army, Rock Island Arsenal
	Rock Island	Black Hawk State Park
	Adams	City of Quincy (very rare)
All other watersheds	None	None

.1971–1973 in this region than in the harvests of 1956–1957 (Table 6). Proportionate harvests of gray squirrels increased in Brown, Calhoun, Greene, Jersey, Macoupin, Schuyler, and Knox counties in 1971–1973 (Table 6). Forest cover decreased in most of these counties between 1948 and 1962 (Table 3). We reiterate that the increases in the proportionate harvests of gray squirrels are the result of woodlot removal, forcing hunters into forests occupied by both species.

Comparing the present distribution of gray squirrels with the distribution in 1942 (Fig. 3) indicates that their abundance has not changed appreciably in the basin since 1942. Although gray squirrels may appear to be more widespread in Macoupin, Greene, Peoria, and Fulton counties today (Fig. 3 and 7), this apparent prevalence may only reflect an insufficient survey of occupied range in 1942.

Gray squirrels were considered common in McDonough County at the turn of the century, and an occasional black squirrel (presumably gray) was seen (Bateman et al. 1907). Today they have apparently been extirpated from all but the southernmost townships (Fig. 7).

At present about 44 percent of the forests in the entire basin are pastured; over half the forests in Calhoun, Cass, Fulton, Knox, McDonough, Schuyler, and Scott counties are used as pasture (Table 8).

It is fortunate that many streams in the basin remain unchannelized (Table 8). The main problem continues to be the building of levees and the clearing of floodplain forests along the Illinois River. Once levees are in place, the conversion of forest lands to croplands is usually rapid (Mills et al. 1966). Initially (prior to 1900), 400,000 acres of bottomland were subject to river flooding between La Salle and Grafton (Mills et al. 1966). At the height of drainage activity (1920's), there were 38 drainage districts and three private drainage areas aggregating 200,000 acres, or half the available flooded bottomlands (Mills et al. 1966). Since then, some drainage districts have failed, and nearly 8,000 acres (4.0 percent) have been returned to forests, sloughs, and marshes (Mills et al. 1966).

More than 66,000 acres of the lower Illinois basin have been strip-mined for coal, nearly 41,000 acres in Fulton County (Table 8). At least some of this strip-mined land was prairie, not forest, but as only 261 of these acres have succeeded to maturing forests since they were strip-mined, forest wildlife in the basin has suffered substantial losses of habitat.

Human densities increased about 5 percent in this region between 1960 and 1970, with only Tazewell and McDonough counties showing substantial growth (Table 9). The human population decreased in several counties in the lower basin during the 1960's (Table 9).

Gray squirrels appear to be reasonably secure in the Lower Illinois River Region if the remaining forests are not drastically altered by overcutting or completely destroyed. Land purchase by Illinois in the Lake Meredosia area in Morgan and Cass counties would provide a substantial refuge for wildlife in the lower Illinois basin. This purchase has been recommended by the Illinois Division of Waterways (1969).

The upland forests of the basin also contain gray squirrels. Thus, the continued loss of bottomland forest will not in itself eliminate gray squirrels from the region, at least not from the extensive forests of Calhoun and Jersey counties. In the upper counties, however, an expanding human population around the cities of Peoria and Macomb threatens to reduce forests adjacent to these areas. North of Liverpool in Fulton County, gray squirrels are abundant only along the Illinois River (Fig. 7), and any substantial alteration of bottomland forests in that area will reduce gray squirrel abundance.

Middle Mississippi River Region

The six-county area we chose to call the Middle Mississippi River Region (Fig. 8) was glaciated during the Pleistocene. Deep, well-drained loess soils cover most of the uplands. The bottomland soils are sandy where they were frequently inundated but contain more clay along the bluffs (Telford 1926). Three distinct topographic areas occur in the region: (1) a flat to undulating upland plain dissected by numerous small streams; (2) a bluff region of rugged hills broken by many valleys tending east and west; and (3) the floodplain of the Mississippi River, which varies from

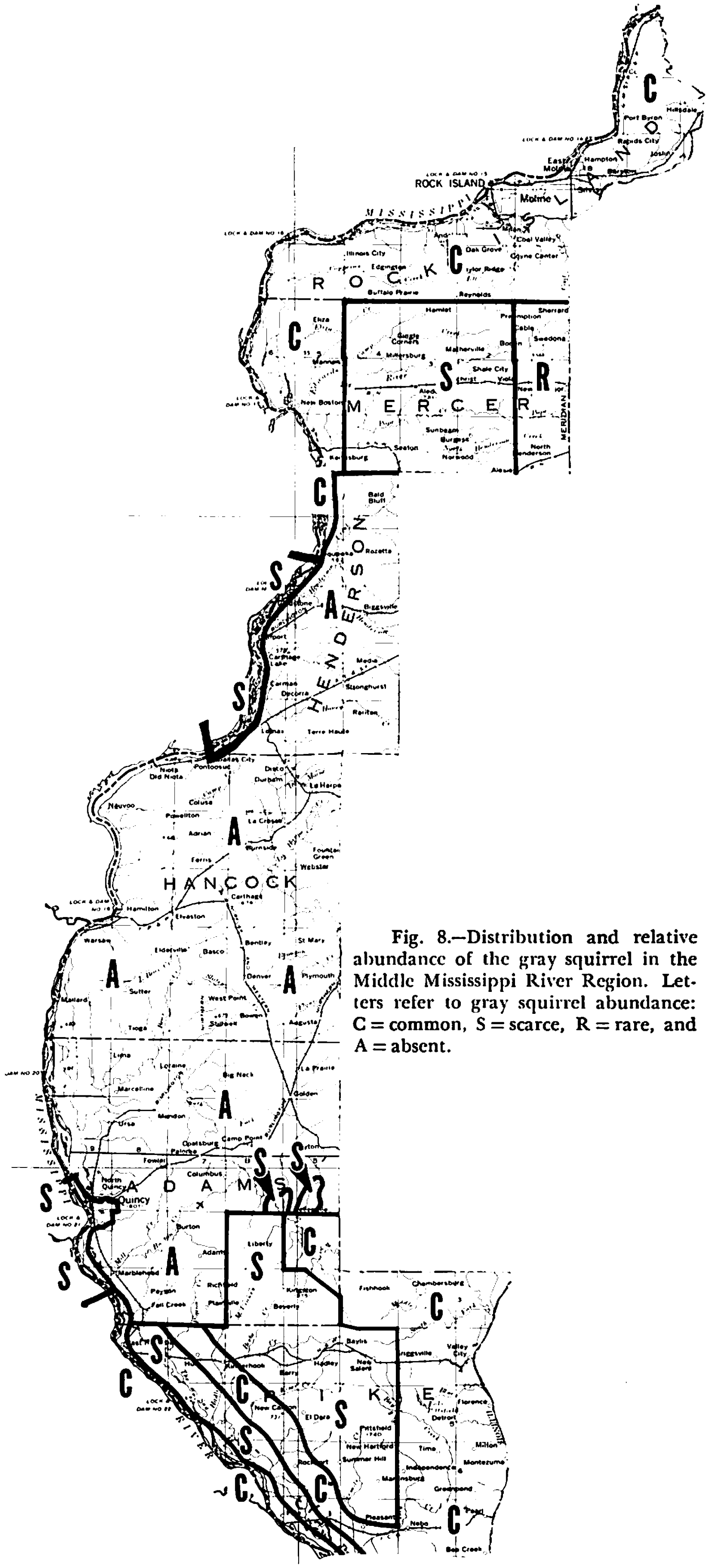


Fig. 8.—Distribution and relative abundance of the gray squirrel in the Middle Mississippi River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

large tracts of farmlands to swamps and abrupt sand terraces (Telford 1926).

The region was about 50 percent forested in 1800 but is only about 11 percent forested today (Table 3). Most of the bottomland forests have been removed and those that remain bear little resemblance to those of presettlement times (Telford 1926). A bottomland forest adjacent to the Mississippi River in Henderson County was dominated by silver maple, ashes, pin oak, and cottonwood (Table 4). This stand seems similar to one also adjacent to the Mississippi River in Union County that Telford (1926: 6) measured in the 1920's. The upland forests, similar to those measured in Schuyler County (Table 4), have been generally overcut and frequently burned, and are usually pastured.

Gray squirrels comprised an estimated 78.2 percent of the squirrel population in this region in 1800 (Table 5) but make up only about 20 percent of the squirrel harvest there today (Table 6). Gray squirrels are abundant in Rock Island County, western Mercer County, the northwestern corner of Henderson County, southeastern Adams County along McKee Creek, and much of Pike County. They are absent from all of Hancock County and most of Adams and Henderson counties (Fig. 8). We feel that the gray squirrels recorded by hunters in 1956–1957 and 1971–1973 in Hancock County (Table 6) represent hunter error in calling fox squirrels gray squirrels, because we can find no verified reports of their presence in the county. They are found in Quincy, Adams County, and are common in the Quad Cities area (Rock Island County), particularly in Moline and Rock Island.

The absence of gray squirrels along the Mississippi River in Hancock and Adams counties can be explained by the extensive clearing of the bottomland forests that has occurred since settlement (Telford 1926). The absence of gray squirrels from the upland forests in the basin, particularly in Adams County, is not so easily explained. In 1962 Adams County contained nearly 70,000 acres of forest (Table 3), more forest than was found in Rock Island County in 1962, where gray squirrels are still abundant. About 64 percent of the forests in Adams County are pastured (Table 8), but so are about 66 percent of the forests in Mercer County. Yet gray squirrels are abundant along McKee Creek in southeastern Adams County. Gray squirrels constituted 86.9 percent of 481 squirrels shot by hunters in 1972–1973 at Siloam Springs State Park located on McKee Creek on the Adams-Brown county line. McKee Creek drains into the lower Illinois River, and we believe the gray squirrels on McKee Creek belong to the extensively occupied range in the lower Illinois basin (Brown County, Fig. 7). It seems unlikely that the gray squirrels along McKee Creek ranged west across Adams County to the Mississippi River. Prairie vegetation dominated the townships north and west of McKee Creek when the area was first surveyed in the 1830's (J. White, Illinois Natural Areas Inventory, personal communication, 1975).

Brown & Yeager (1945) showed gray squirrels present all through western Henderson and Adams counties (Fig. 3) but did not report them as present in southeast Adams County along McKee Creek, where they are abundant today (Fig. 3 and 8). Mohr (1941) also reported gray squirrels to be abundant south of Oquawka in Henderson County, where they are now scarce (Fig. 8).

In the six-county region, melanistic gray squirrels are found regularly only in the cities of Moline and Rock Island, in the area of the Rock Island Arsenal, and in Black Hawk State Park, Rock Island County (Table 7).

Within the basin, gray squirrels are most secure in the upland forests of Pike County. Gray squirrel range in Rock Island and Mercer counties is less secure because of the increasing human population in the Quad Cities area. Any permanent rise of the Mississippi River will necessitate new levees, resulting in losses of bottomland forests. If water levels rise, bottomland forests not protected by levees, as in Big River State Forest, Henderson County, would be doomed. Because most of the forests in the Middle Mississippi River Region are not secure, we expect the gray squirrel to continue to decline in abundance in this region.

Sangamon River Region

The Sangamon River (Fig. 9) begins in and flows to its juncture with the Illinois River across what was once known as the "Grand Prairie." This region, nearly all covered with prairie grasses in 1800, consists of a level, poorly drained plain of relatively young glacial drift (Jones & Bell 1974). Moraines and other glacial landforms are common. Soils are young and high in organic matter, having developed under prairie grasses from loess or from glacial drift. Soils of the lower basin (Mason County) are derived from sand deposited by the outwash from the Wisconsinan glacier. In the upper part of the region, the upland forests have been heavily disturbed and are generally dominated by elms, hackberry, bur oak, and honey locust (Table 4). Bottomland forests of the region have also been extensively cut and are often nearly a monotype of silver maple (Table 4). The percentage of oak in the upland forests has declined since settlement (Mohlenbrock 1975) because of the selective cutting of oaks and extensive pasturing.

Forests in Mason County adjacent to the Illinois River, where gray squirrels are still common, are dominated by silver maple although it is less important in the bottomlands of Mason County than it is in most of the forests of the region (Table 4). Cottonwood, pin oak, elms, box elder, ashes, and pecan are also important components of the tree stratum in

TABLE 8.—Land-use practices potentially destructive to gray squirrel habitat and the number of strip-mined acres covered with maturing forest in 1971.

Watershed and County	Percent of County Forest Area Pastured[a]	Miles of Streams Channelized[b]	Acres Strip-mined for Coal[c]	Strip-mined Acres Covered with Maturing Forest[c]
Upper Mississippi				
Jo Daviess	65.1	5.6	None	. . .
Carroll	46.9	18.8	None	. . .
Total	*112.0*	*24.4*	*0.0*	. . .
Mean	*56.0*	*12.2*		
Rock River				
Boone	75.8	25.3	None	. . .
De Kalb	26.3	194.0	None	. . .
Henry	71.7	280.6	2,676.0	81.0
Lee	30.0	119.1	None	. . .
McHenry	30.3.	257.6	None	. . .
Ogle	49.8	37.2	None	. . .
Stephenson	65.5	No data	None	. . .
Whiteside	54.7	277.0	None	. . .
Winnebago	74.2	15.6	None	. . .
Total	*478.3*	*1,206.4*	*2,676.0*	*81.0*
Mean	*53.1*	*150.8*		
Upper Illinois				
Bureau	47.5	149.9	3,135.0	16.0
Cook	9.8	184.3	None	. . .
Du Page	None[d]	28.4	None	. . .
Grundy	62.7	27.3	7,134.0	5.0
Kane	16.2	152.0	None	. . .
Kendall	66.7	36.9	None	. . .
Livingston	17.3	246.7	46.0	0.0
Lake	20.1	45.1	None	. . .
La Salle	51.6	155.7	1,213.0	0.0
Marshall	43.0	11.1	1.0	0.0
Putnam	50.0	10.0	None	. . .
Stark	60.1	29.0	1,992.0	0.0
Will	24.9	190.2	6,067.0	100.0
Woodford	60.4	35.4	None	. . .
Total	*530.3*	*1,302.0*	*19,588.0*	*121.0*
Mean	*40.8*	*93.0*		
Lower Illinois				
Brown	41.4	18.0	19.0	0.0
Calhoun	51.5	18.5	None	. . .
Cass	68.4	71.0	None	. . .
Fulton	57.8	116.9	40,524.0	229.0
Greene	32.1	102.8	56.0	0.0
Jersey	26.8	16.9	1.0	0.0
Knox	73.0	7.5	17,350.0	32.0
Macoupin	35.0	26.1	None	. . .
McDonough	57.3	1.0	None	. . .
Morgan	5.8	24.5	4.0	0.0
Peoria	24.4	18.1	6,187.0	0.0
Schuyler	57.9	45.6	2,064.0	0.0
Scott	75.9	43.5	1.0	0.0
Tazewell	37.2	60.5	None	. . .
Warren	17.4	13.1	None	. . .
Total	*661.9*	*584.0*	*66,206.0*	*261.0*
Mean	*44.1*	*38.9*		
Middle Mississippi				
Adams	64.1	74.0	228.0	18.0
Hancock	53.3	38.2	101.0	0.0
Henderson	45.9	77.1	None	. . .
Mercer	65.8	54.3	25.0	0.0

TABLE 8.—Continued.

Watershed and County	Percent of County Forest Area Pastured[a]	Miles of Streams Channelized[b]	Acres Strip-mined for Coal[c]	Strip-mined Acres Covered with Maturing Forest[c]
Pike	46.7	137.9	1.0	0.0
Rock Island	54.2	83.1	None	. . .
Total	*330.0*	*464.6*	*355.0*	*18.0*
Mean	*55.0*	*77.4*		
Sangamon				
Christian	18.2	87.0	None	. . .
De Witt	50.0	25.0	None	. . .
Logan	2.3	138.5	None	. . .
Macon	33.9	76.0	None	. . .
Mason	42.0	210.5	None	. . .
McLean	26.7	133.1	None	. . .
Menard	33.4	34.5	6.0	0.0
Piatt	14.3	124.6	None	. . .
Sangamon	50.1	2.0	None	. . .
Total	*270.9*	*831.2*	*6.0*	*0.0*
Mean	*30.1*	*92.4*		
Kaskaskia				
Bond	47.6	12.2	None	. . .
Clinton	16.5	25.1	None	. . .
Fayette	50.0	34.5	None	. . .
Madison	16.1	48.9	7.0	0.0
Marion	26.0	1.0	None	. . .
Monroe	5.8	78.7	None	. . .
Montgomery	55.6	160.3	None	. . .
Moultrie	47.1	44.8	None	. . .
Randolph	26.8	14.2	5,425.0	146.0
Shelby	25.0	33.0	None	. . .
St. Clair	9.2	63.1	12,482.0	342.0
Washington	13.9	No data	None	. . .
Total	*339.6*	*515.8*	*17,914.0*	*488.0*
Mean	*28.3*	*43.0*		
Big Muddy				
Franklin	No data	9.3	None	. . .
Jackson	40.6	59.8	4,899.0	40.0
Jefferson	6.8	5.0	387.0	0.0
Perry	11.6	No data	20,317.0	970.0
Williamson	11.5	33.5	12,701.0	823.0
Total	*70.5*	*107.6*	*38,304.0*	*1,833.0*
Mean	*17.6*	*21.5*		
Shawnee Hills				
Alexander	None	42.8	None	. . .
Hardin	7.5	None	None	. . .
Johnson	42.3	25.8	50.0	0.0
Massac	12.1	71.7	None	. . .
Pope	10.8	26.5	26.0	0.0
Pulaski	9.6	118.5	None	. . .
Union	10.6	61.7	None	. . .
Total	*92.9*	*347.0*	*76.0*	*0.0*
Mean	*13.3*	*49.6*		
Saline				
Gallatin	14.3	166.3	1,483.0	0.0
Hamilton	5.8	119.8	None	. . .
Saline	10.8	182.0	9,504.0	0.0
Total	*30.9*	*468.1*	*10,987.0*	*0.0*
Mean	*10.3*	*156.0*		
Little Wabash				
Clay	18.5	11.0	None	. . .
Edwards	18.5	22.5	None	. . .

TABLE 8.—Continued.

Watershed and County	Percent of County Forest Area Pastured[a]	Miles of Streams Channelized[b]	Acres Strip-mined for Coal[c]	Strip-mined Acres Covered with Maturing Forest[c]
Effingham	25.0	6.3	None	. . .
Richland	34.2	7.0	None	. . .
Wabash	21.1	31.5	10.0	0.0
Wayne	18.3	66.0	None	. . .
White	31.5	59.0	None	. . .
Total	*167.1*	*203.3*	*10.0*	*0.0*
Mean	*23.9*	*29.0*		
Embarras				
Clark	57.8	21.6	3.0	0.0
Coles	33.8	70.3	None	. . .
Crawford	9.7	33.0	4.0	0.0
Cumberland	37.2	16.1	None	. . .
Douglas	42.6	112.7	None	. . .
Edgar	45.3	148.0	51.0	0.0
Jasper	52.9	16.0	None	. . .
Lawrence	51.5	90.5	None	. . .
Total	*330.8*	*508.2*	*58.0*	*0.0*
Mean	*41.4*	*63.5*		
Vermilion				
Champaign	28.2	390.3	None	. . .
Ford	53.5	351.8	None	. . .
Vermilion	50.0	114.6	5,297.0	31.0
Total	*131.7*	*856.7*	*5,297.0*	*31.0*
Mean	*43.9*	*285.6*		
Iroquois				
Iroquois	29.8	470.3	None	. . .
Kankakee	7.9	340.7	2,160.0	0.0
Total	*37.7*	*811.0*	*2,160.0*	*0.0*
Mean	*18.9*	*405.5*		

[a] Illinois Conservation Needs Committee (1970). [b] Lopinot (1972). [c] Haynes & Klimstra (1975). [d] Obvious error.

these bottomlands and provide squirrels with an extensive food base (Table 4). The upland forests in Mason County grow on sandy soils and generally have fewer species. One upland stand in Mason County contained only black and blackjack oaks (Table 4).

The Sangamon basin averaged only 13.3 percent forest in 1800. The earliest survey of the region shows that only in Menard County were extensive forests found away from the river. The region averages only 3.6 percent forest today, but Mason County actually contains more forest now than it had in 1800 (Table 3). The sandy soils of Mason County are generally droughty and unsuited to grain culture and have been extensively planted to pines to stabilize the sand dunes. These pine stands are not occupied by gray squirrels.

Except in various urban parks, gray squirrels are common only in the Sangamon-Illinois river bottomlands, in adjacent uplands in Mason County, and in the forests southeast of Pana in Christian County (Fig. 9). Gray squirrels are common in Springfield (Sangamon County) and Taylorville (Christian County). Mixed populations of gray and fox squirrels occur in Lincoln (Logan County), Bloomington (McLean County), and Decatur (Macon County), but fox squirrels are the more abundant.

A comparison of the present distribution with that of 1942 (Fig. 3) indicates that the gray squirrel has recently been extirpated from most of the Sangamon River bottomlands between Decatur and the Mason County line. As noted earlier, extensive cutting has left only small, nearly monotypic tracts of silver maple along most of the upper river.

Both Mohr (1941) and Brown & Yeager (1945) reported gray squirrels present in McLean County adjacent to Tazewell County (Fig. 3). Today, gray squirrels are present but scarce along portions of Funks Branch and Rock Creek in western McLean County and have been extirpated from the rest of the county. The surveys of 1941 and 1945 both reported the presence of gray squirrels in eastern Mason County, where there are none today.

As late as 1928–1929 nearly equal numbers of gray and fox squirrels occurred along the Sangamon south of White Heath, Piatt County (Goff 1952), but they were apparently extirpated shortly thereafter (D. R. Vance, Illinois Natural History Survey, personal communication, 1974). A successful reintroduction of gray squirrels was made in the early 1970's in Monticello and also southeast of White Heath in the bottomlands along the Sangamon River. The reintroduction was a private project using stock obtained in Champaign-Urbana (D. R. Vance, personal communication, 1975). It seems likely that gray squirrels will soon invade Allerton Park, a 1,500-acre forested sanctuary located just south of Monticello. In 1918 an unsuccessful reintroduction was attempted 2 miles south of Athens in Menard County (Watson Hall, personal communication to Carl Mohr, Illinois Natural History Survey, 1944).

Gray squirrels constituted an estimated 24.2 percent of the presettlement squirrel population in the Sangamon River Region (Table 5) but constitute only about 4 percent of the squirrels harvested today (Table 6). We suspect that some of the gray squirrels reported shot in Champaign, De Witt, and Piatt counties are improperly identified although gray squirrels dispersing from the urban parks would be available to squirrel hunters in these counties.

The streams and rivers of the Sangamon basin have been extensively channelized (Table 8). The riparian forests associated with these streams are removed before maturity because drainage ditches are cleaned periodically of all tree cover. Only the forests in De Witt, Sangamon, and Mason counties are extensively pastured (Table 8).

Human densities are increasing in the basin, particularly in McLean and Sangamon counties (Table 9), and additional intrusions by humans into the remaining forests will further reduce the distribution

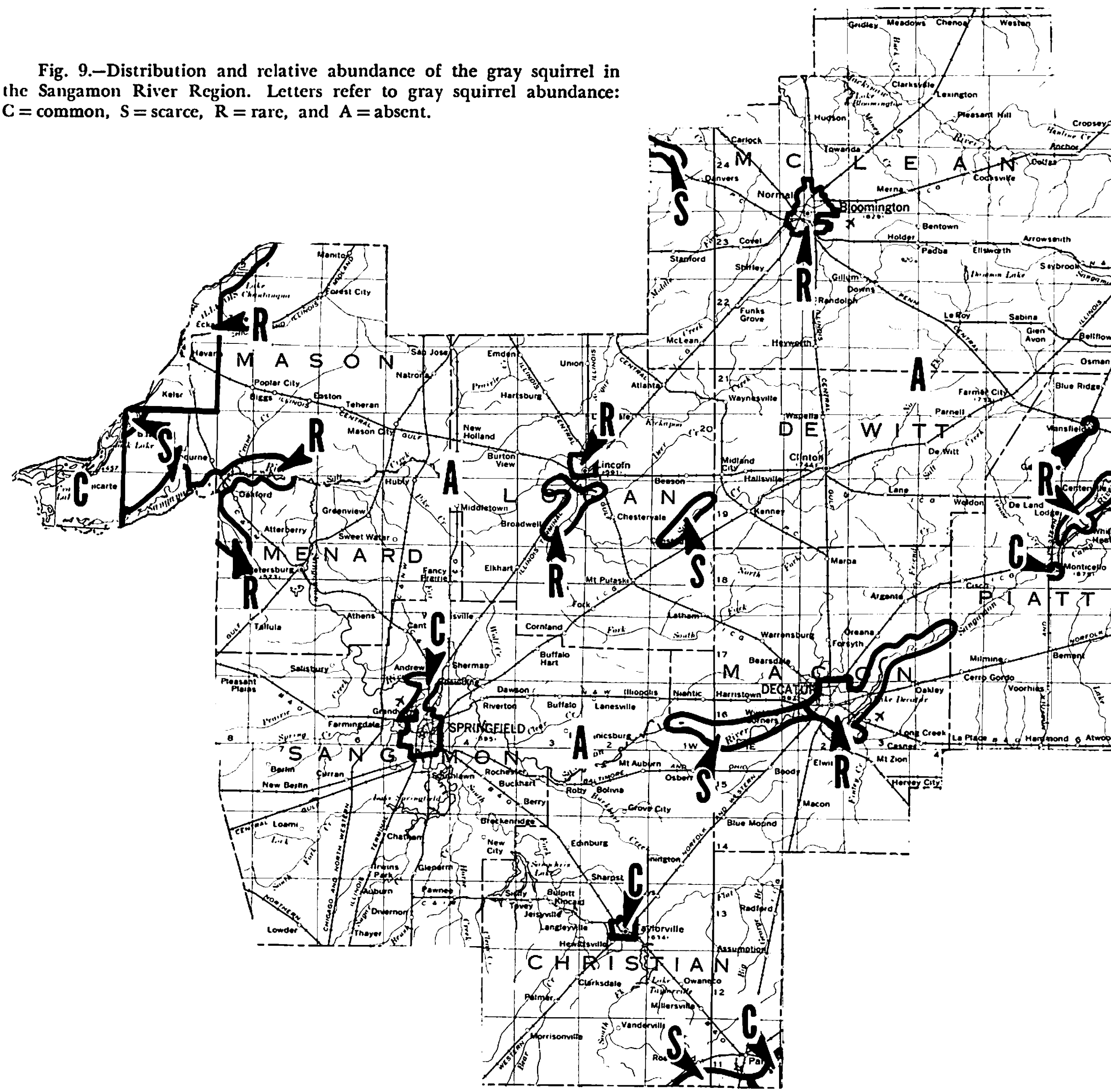


Fig. 9.—Distribution and relative abundance of the gray squirrel in the Sangamon River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

of the gray squirrel. We expect that the gray squirrel populations now listed as scarce or rare north and south of Decatur in Macon County, south and east of Lincoln in Logan County, and north of Petersburg in Menard County will be eliminated unless they find sanctuary in public parks and reserves. Populations of gray squirrels in urban areas in the basin should continue to flourish and even expand somewhat as trees planted in housing developments mature and begin to produce food and den sites. The best gray squirrel range in Mason County is the 8,000-acre Sanganois Conservation Area, a near wilderness of sloughs, forests, and swamps. The purchase of more forests, marshes, and sloughs surrounding this public area, as recommended by the Illinois Division of Waterways (1969), would give additional protection to the resident population of gray squirrels.

Kaskaskia River Region

The Kaskaskia River (Fig. 10) begins in a level dissected plain and flows southwestward through rolling hills. The river is a low-gradient stream with a fairly wide floodplain. Soils are predominantly loess developed under a nearly equal mixture of prairie and forest.

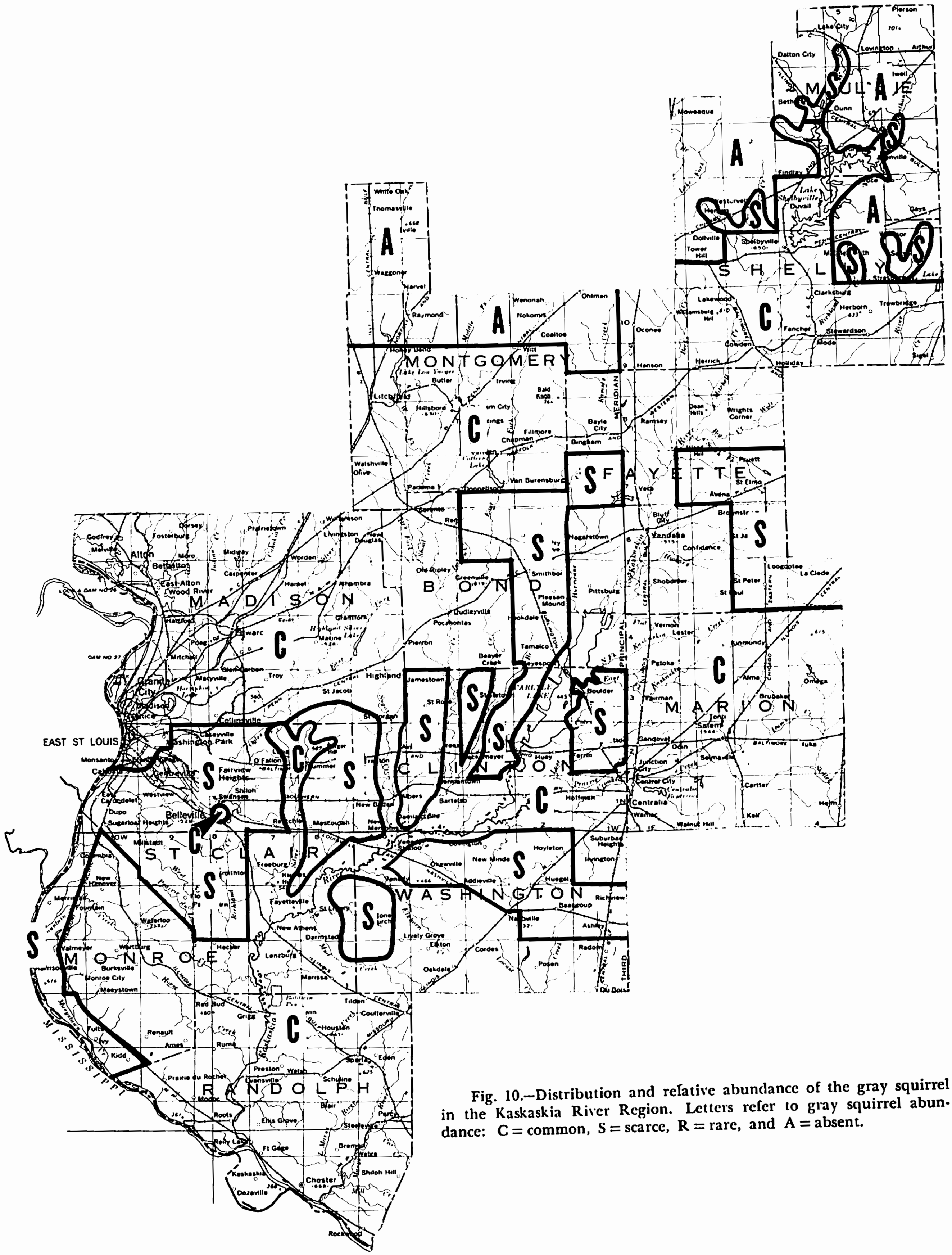


Fig. 10.—Distribution and relative abundance of the gray squirrel in the Kaskaskia River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

TABLE 9.—Human densities in each major watershed in Illinois, 1950–1970.

Watershed and County	1950[a]	1960[b]	1970[c]	Percentage of Change, 1960–1970
Upper Mississippi				
Jo Daviess	21,459	21,821	21,766	– 0.003
Carroll	18,976	19,507	19,276	– 0.012
Total or mean	*40,435*	*41,328*	*41,042*	*– 0.007*
Rock River				
Boone	17,070	20,326	25,440	+25.2
De Kalb	40,781	51,714	71,654	+38.6
Henry	46,492	49,317	53,217	+ 7.9
Lee	36,451	38,749	37,947	– 2.1
McHenry	50,656	84,210	111,555	+32.5
Ogle	33,429	38,106	42,867	+12.5
Stephenson	41,595	46,207	48,861	+ 5.7
Whiteside	49,336	59,887	62,877	+ 5.0
Winnebago	152,385	209,765	246,623	+17.6
Total or mean	*468,195*	*598,281*	*701,041*	*+17.2*
Upper Illinois				
Bureau	37,711	37,594	38,541	+ 2.5
Cook	4,508,792	5,129,725	5,492,369	+ 7.1
Du Page	154,599	313,459	491,882	+56.9
Grundy	19,217	22,350	26,535	+18.7
Kane	150,388	208,246	251,005	+20.5
Kendall	12,115	17,540	26,374	+50.4
Livingston	37,809	40,341	40,690	+ 0.008
Lake	179,097	293,656	382,638	+30.3
La Salle	100,610	110,800	111,409	+ 0.005
Marshall	13,025	13,334	13,302	– 0.002
Putnam	4,746	4,570	5,007	+ 9.6
Stark	8,721	8,152	7,510	– 7.9
Will	134,336	191,617	249,498	+30.2
Woodford	21,335	24,579	28,012	+13.9
Total or mean	*5,382,501*	*6,415,963*	*7,164,772*	*+11.7*
Lower Illinois				
Brown	7,132	6,210	5,586	–10.0
Calhoun	6,898	5,933	5,675	– 4.3
Cass	15,097	14,539	14,219	– 2.2
Fulton	43,716	41,954	41,890	. . .
Greene	18,852	17,460	17,014	– 2.6
Jersey	15,264	17,023	18,492	+ 8.6
Knox	54,366	61,280	61,280	. . .
Macoupin	44,210	43,524	44,557	+ 2.4
McDonough	28,199	28,928	36,653	+26.7
Morgan	35,568	36,571	36,174	– 1.1
Peoria	174,347	189,044	195,318	+ 3.3
Schuyler	9,613	8,746	8,135	– 6.9
Scott	7,243	6,377	6,096	– 4.4
Tazewell	76,165	99,789	118,649	+18.9
Warren	21,981	21,587	21,595	. . .
Total or mean	*558,651*	*598,965*	*631,333*	*+ 5.1*
Middle Mississippi				
Adams	64,690	68,467	70,861	+ 3.5
Hancock	25,790	24,574	23,645	– 3.8
Henderson	8,416	8,237	8,451	+ 2.6
Mercer	17,374	17,149	17,298	. . .
Pike	22,155	20,552	19,185	– 6.7
Rock Island	133,558	150,991	166,734	+10.4
Total or mean	*271,983*	*289,970*	*306,174*	*+ 5.6*
Sangamon				
Christian	38,816	37,207	35,948	– 3.4
De Witt	16,894	17,253	16,975	– 1.6
Logan	30,671	33,656	33,538	– 0.03

TABLE 9.—Continued.

Watershed and County	1950[a]	1960[b]	1970[c]	Percentage of Change, 1960–1970
Macon	98,853	118,257	125,010	+ 5.7
Mason	15,326	15,193	16,161	+ 6.4
McLean	76,577	83,877	104,389	+24.5
Menard	9,639	9,248	9,685	+ 4.7
Piatt	13,970	14,960	15,509	+ 3.7
Sangamon	131,484	146,539	161,335	+10.1
Total or mean	*432,230*	*476,190*	*518,550*	*+ 8.9*
Kaskaskia				
Bond	14,157	14,060	14,042	– 0.001
Clinton	22,594	24,029	28,315	+17.8
Fayette	24,582	21,946	20,752	– 5.4
Madison	182,207	224,689	250,934	+11.7
Marion	41,700	39,349	38,986	– 0.009
Monroe	13,282	15,507	18,831	+21.4
Montgomery	32,460	31,244	30,260	– 3.1
Moultrie	13,171	13,635	13,263	– 2.7
Randolph	31,673	29,988	31,379	+ 4.6
Shelby	24,434	23,404	22,589	– 3.5
St. Clair	205,995	262,509	285,176	+ 8.6
Washington	14,460	13,569	13,780	+ 1.6
Total or mean	*620,715*	*713,929*	*768,307*	*+ 7.6*
Big Muddy				
Franklin	48,685	39,281	38,329	–21.3
Jackson	38,124	42,151	55,008	+30.5
Jefferson	35,892	32,135	31,446	– 2.1
Perry	21,684	19,184	19,757	+ 2.9
Williamson	48,621	46,117	49,021	+ 6.3
Total or mean	*193,006*	*178,868*	*193,561*	*+ 8.2*
Shawnee Hills				
Alexander	20,316	16,061	12,015	–25.2
Hardin	7,530	5,879	4,914	–16.4
Johnson	8,729	6,928	7,550	+ 9.0
Massac	13,594	14,341	13,889	– 3.2
Pope	5,779	4,061	3,857	– 5.0
Pulaski	13,639	10,490	8,741	–16.7
Union	20,500	17,645	16,071	– 8.9
Total or mean	*90,087*	*75,405*	*67,037*	*–11.1*
Saline				
Gallatin	9,818	7,638	7,418	– 2.9
Hamilton	12,256	10,010	8,665	–13.4
Saline	33,420	26,227	25,721	– 1.9
Total or mean	*55,494*	*43,875*	*41,804*	*– 4.7*
Little Wabash				
Clay	17,445	15,815	14,735	– 6.8
Edwards	9,056	7,940	7,090	–10.7
Effingham	21,675	23,107	24,608	+ 6.5
Richland	16,889	16,299	16,829	+ 3.3
Wabash	14,651	14,047	12,841	– 8.6
Wayne	20,933	19,008	17,004	–10.5
White	20,935	19,373	17,312	–10.6
Total or mean	*121,584*	*115,589*	*110,419*	*– 4.5*
Embarras				
Clark	17,362	16,546	16,216	– 2.0
Coles	40,328	42,860	47,815	+11.6
Crawford	21,137	20,751	19,824	– 4.5
Cumberland	10,496	9,936	9,772	– 1.7
Douglas	16,706	19,243	18,997	– 1.3
Edgar	23,407	22,550	21,591	– 4.3
Jasper	12,266	11,346	10,741	– 5.3
Lawrence	20,539	18,540	17,522	– 5.5
Total or mean	*162,241*	*161,772*	*162,478*	*+ 0.04*

TABLE 9.—Continued.

Watershed and County	1950[a]	1960[b]	1970[c]	Percentage of Change, 1960–1970
Vermilion				
Champaign	106,100	132,436	163,281	+23.3
Ford	15,901	16,606	16,382	– 1.3
Vermilion	87,779	96,176	97,047	+ 0.09
Total or mean	*209,780*	*245,218*	*276,710*	*+12.8*
Iroquois				
Iroquois	32,348	33,562	33,532	– 0.09
Kankakee	73,524	92,063	97,250	+ 5.6
Total or mean	*105,872*	*125,625*	*130,782*	*+ 4.1*

[a] New York World Telegram & The Sun (1954).
[b] New York World Telegram & The Sun (1961).
[c] Newspaper Enterprise Association, Inc. (1975).

A bottomland forest measured in St. Clair County showed that silver maple, hackberry, elms, ashes, box elder, overcup oak, big shellbark hickory, pin oak, pecan, and bur oak dominated the tree stratum (Table 4). In general, forests along the Kaskaskia and other southern Illinois rivers contain more species of oak and hickory than do their counterparts along rivers in central and northern Illinois (Telford 1926).

The virgin bottomland forests persisted along the Kaskaskia River longer than did those in most other regions of Illinois. As late as 1924 Telford (1926) reported that one-fourth of all the old-growth bottomland forests in the entire state grew along the Kaskaskia. A few of these old stands still exist south of Carlyle Lake (J. White, Illinois Natural Areas Inventory, personal communication, 1975).

About 50 percent of the region was forested in 1800; by 1962 only about 16 percent was forested (Table 3). Gray squirrels were abundant in the Kaskaskia basin in 1800, constituting an estimated 79.7 percent of the squirrel population (Table 5). They are still common throughout the basin except where the forests have been extensively altered or removed (Fig. 10). Today gray squirrels are totally absent only in areas that were predominantly prairie before settlement, northern Montgomery, Shelby, and Moultrie counties (J. White, unpublished *Presettlement Vegetation Atlas of Illinois*) (Fig. 10).

Gray squirrels comprise nearly half or more of the squirrel harvests from Clinton, Fayette, Marion, Monroe, and Randolph counties (Table 6). In 1972–1974 they made up 46.8 percent of 295 squirrels harvested on the Stephen A. Forbes State Park in Marion County. Gray squirrels are abundant in Granite City (Madison County) and East St. Louis and Belleville (St. Clair County).

In 1942 it was thought that gray squirrels were confined to the immediate vicinity of the Kaskaskia River (Fig. 3). However, we believe that Brown & Yeager (1945) underestimated the distribution of gray squirrels in the basin (Fig. 10). Since 1942 the removal of forests has reduced gray squirrel populations in the uplands away from the Kaskaskia River in St. Clair and Monroe counties (Fig. 10).

The greatest threat to the gray squirrel in the basin has been reservoir construction. The construction of Carlyle (26,000 acres) and Shelbyville (11,100 acres) reservoirs destroyed thousands of acres of bottomland forests occupied by gray squirrels. In addition, the record high floodwaters experienced in the basin between 1973 and 1974 killed thousands of acres of upland forests surrounding both reservoirs (Bell & Johnson 1974). Leisure homes and recreational facilities and pursuits on both public and private lands around the reservoirs have also intruded upon the forests. As the remaining forests are opened up and reduced in size, fox squirrels can be expected to increase in abundance. In March 1976 and 1977, gray squirrels made up 42.3 percent of 52 squirrels live-trapped in two pole-sized upland stands of oak-hickory adjacent to Lake Shelbyville.

Only 24.6 percent of the existing forests in the region are pastured, mostly in the northern counties (Table 8). Channelization has occurred on an average of 47 miles of stream per county, with Montgomery and Monroe counties the most affected (Table 8). Strip-mining for coal is important only in St. Clair and Randolph counties, where nearly 18,000 acres have been mined. Only 488 of these strip-mined acres now support maturing forests (Table 8).

Human populations are increasing in the basin, particularly in Madison County near St. Louis and in Monroe and Clinton counties (Table 9).

Huntable populations of gray squirrels appear assured in the region for the foreseeable future although gray squirrels will undoubtedly continue to decline in the upper basin as human activities remove or modify the remaining forests.

Big Muddy River Region

The Big Muddy basin located in southwest Illinois encompasses five counties (Fig. 11). The topography is characterized by gently undulating hills in the north and west; low relief, wide valleys, and well-developed upland in the east; and more rugged, well-defined valleys in the south (Big Muddy River Basin Coordinating Committee 1971). Local relief seldom exceeds 100 feet.

A bottomland forest located along the Little Muddy River in Jackson County showed pin oak, silver maple, big shellbark hickory, elms, ashes, swamp white oak, and post oak as the most important species (Table 4). The large number of mature oaks and hickories contributes to the widespread abundance of the gray squirrel throughout the Big Muddy basin (Fig. 11). The upland forests are predominately mixtures of oak and hickory with smaller numbers of sugar maple, basswood, ashes, tulip tree, and American beech on the better sites (Telford 1926).

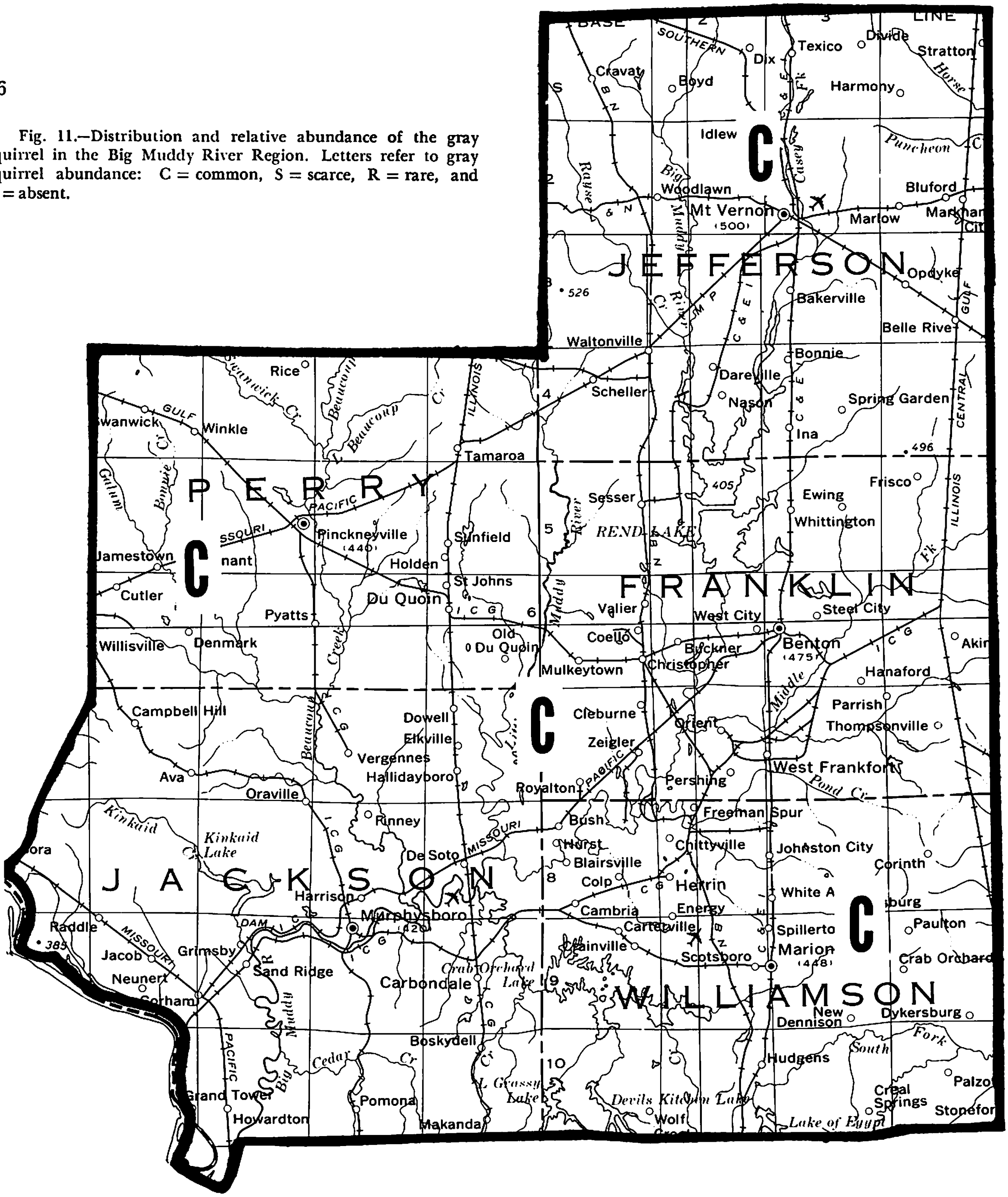


Fig. 11.—Distribution and relative abundance of the gray squirrel in the Big Muddy River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

At the time of settlement the basin was 87 percent forested. Although a slight increase (2.0 percent) in forest land occurred between 1948 and 1962, there has been an overall decline of 71.1 percent since 1800, leaving 25 percent of the region in forest by 1962 (Table 3).

Gray squirrels make up about 50 percent of the squirrel population and may be increasing throughout the basin (Table 6). They are most abundant in Jackson and Williamson counties.

Human densities have virtually stabilized in the Big Muddy River basin since 1950 (Table 9) but are beginning to increase around Murphysboro and Carbondale. Rend Lake (18,900 acres) and Lake Kincaid (3,800 acres) have flooded and destroyed several thousand acres of the gray squirrels' bottomland habitat.

Although pasturing of forests and stream channelization are not problems for gray squirrels in this region, strip-mining for coal has disturbed many acres (Table 8). More than 38,000 acres had been strip-mined by 1971, with Perry, Jackson, and Williamson counties extensively affected (Table 8). Only about 1,800 acres have succeeded to a maturing forest capable of supporting gray squirrels. The increasing demand for coal will probably result in many more acres of strip-mined land, and it may be many years, if ever, before gray squirrels reoccupy the strip-mined areas.

There are several extensive forests in public ownership in the Big Muddy River Region that, properly managed, should insure the continued presence of gray squirrels. The 43,000-acre Crab Orchard National Wildlife Refuge, the federally owned forests in Jackson and Williamson counties, and the forests surrounding Rend Lake in Franklin and Jefferson counties should all continue to support abundant populations of gray squirrels.

Shawnee Hills Region

The Shawnee Hills Region comprises the seven southernmost counties in Illinois (Fig. 12). It is a complexly dissected upland that extends across the southern tip of Illinois from Fountain Bluff on the Mississippi River to the Shawneetown Hills near the mouth of the Wabash River. These uplands escaped Pleistocene glaciation. The Greater Shawnee Hills form a band along the northern edge of the basin and consist of massive Pennsylvanian-aged sandstones that dip northward toward the Illinois River basin (Mohlenbrock 1975). The north slope of the Greater Shawnee Hills is relatively gentle, but the south slope consists of many scarps, cliffs, and overhanging bluffs. This section averages only 10 miles in width and grades into the Lesser Shawnee Hills section to the south. The Lesser Shawnee Hills are underlain by Mississippian-aged limestones and sandstones. Their elevation averages about 200 feet lower than that of the Greater Shawnee Hills. The soils of the Shawnee Hills Region are derived mainly from loess. South of the Shawnee Hills lies the coastal plain, a region of swampy forested bottomlands and low clay and gravel hills (Mohlenbrock 1975).

A bottomland stand in Union County contained silver maple, sweet gum, elms, and pin oak as the dominant tree species (Table 4). A second bottomland stand in Johnson County was dominated by sweet gum, ashes, elms, swamp chestnut oak, box elder, and red maple (Table 4). In an upland forest on a mesic site in Pope County, northern red oak, sugar maple, hickories, American beech, and white oak were dominant in the tree stratum (Table 4).

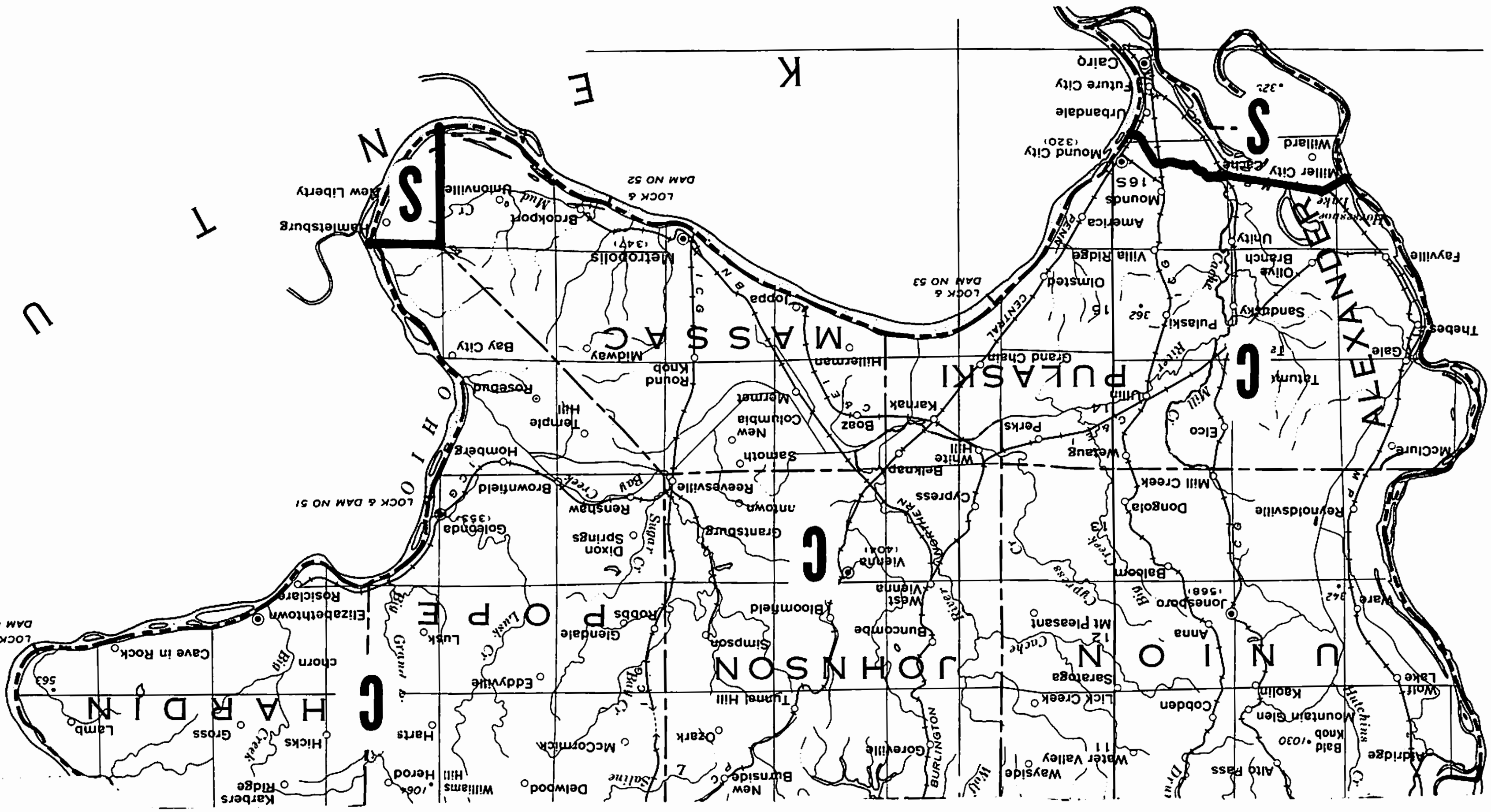
Upland forests of the region have not fared well in this century. Miller & Fuller (1921:96–98) documented the abuses endured by these forests in Alexander County. Their description applies equally well to most of the forests of the entire state. In 1920 they found none of the forests in primitive condition. Most lands originally mapped as forest were so completely cut over that no merchantable timber remained. Tulip trees were cut first, between 1880 and 1890, followed by the larger oaks. Finally, the small oaks were cut for railroad ties. The forests were then grazed and burned so often that the species valuable for timber products were killed, and the stands converted to a black oak-hickory type (Miller & Fuller 1921:96–99).

In the 1930's the United States government began buying the abandoned hill farms in the region, and today the Shawnee National Forest contains 230,000 acres of forest, most of which support gray squirrels. Under protection, the upland forests have slowly recovered, and production of quality hardwood has increased, especially white oak, black walnut, and tulip tree (U.S. Department of Agriculture Forest Service 1969). However, this increase in forest land has not been uniform in the region. Although the upland forests have increased (Table 3), the bottomland forests have declined. For example, there were 15,802 acres of mature lowland forest in 1942 in a 30-square-mile tract of bottomland encompassing portions of Cache and Vienna townships, Johnson County, and Karnak, Logan, and Benton townships, Massac County. By 1966 this forest had been reduced to 5,312 acres, and only 3,584 acres were left in 1971, a 77.3 percent decline in only 29 years (J. and R. Graber, Illinois Natural History Survey, unpublished data). These mature bottomlands have the best soils in the region and, when properly drained, are highly productive for row crops.

The Shawnee Hills and associated bottomlands were almost entirely forested in 1800 (Table 3) and even today remain about 40 percent forested. Forests in Pope, Hardin, and Johnson counties (mostly upland forests) have increased since 1948, but in Massac, Union, and Pulaski counties, where extensive tracts of bottomland forests occur, forest acreage has declined slightly (Table 3).

Gray squirrels are abundant throughout the Shawnee Hills with the exception of two floodplains, extensively cleared for agricultural use, adjacent to the Ohio and Mississippi rivers (Fig. 12). Fox squirrels were probably comparatively rare in the Shawnee Hills

Fig. 12.—Distribution and relative abundance of the gray squirrel in the Shawnee Hills Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.



in the early 19th century (Table 5), and even today gray squirrels constitute about two-thirds of the squirrel harvest (Table 6). In a few of the protected bottomland forests, such as Horseshoe Lake Conservation Area in Alexander County, the squirrel population is made up almost entirely of gray squirrels. On Horseshoe Lake Island gray squirrels may reach their highest density in Illinois (J. and R. Graber, personal communication, 1973–1974).

Human populations declined in every county of the Shawnee Hills Region except Johnson between 1960 and 1970 (Table 9), but this trend is not likely to continue. More and more leisure homes are being built throughout the region. Private forests are being cleared for pastures, often on slopes that should remain tree covered. Funds from the U.S. Department of Agriculture are used for pasture improvement, but only in Johnson County is pasturing of private forests a serious problem (Table 8). In the counties of this region, 57.8 miles (average) of streams have been channelized.

Survival of the gray squirrel in the Shawnee Hills Region seems assured because of the large area of both upland and bottomland forests now in public ownership. Of the nearly 300,000 acres of publicly owned forests, almost all support gray squirrels.

Saline River Region

Most of this three-county basin (Fig. 13) has been glaciated and is characterized by low relief and broad alluvial valleys along the larger streams. The southern edge of the region was not glaciated and forms a portion of the Shawnee Hills, a dissected upland of rugged relief. The rivers are low in gradient, and the wide floodplains that supported large tracts of bottomland timber were formerly subject to extensive flooding. Soils are derived from loess and glacial outwash.

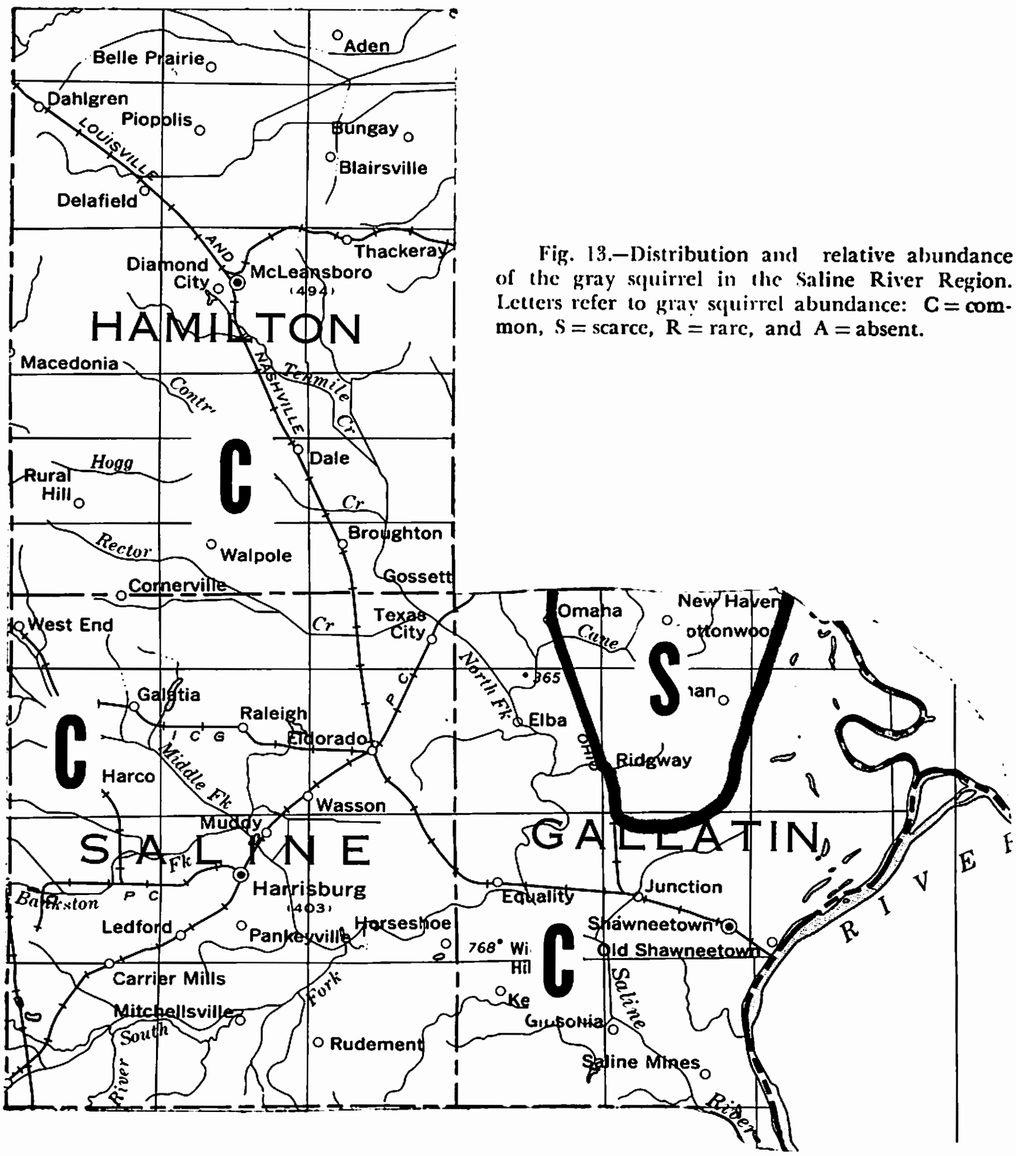


Fig. 13.—Distribution and relative abundance of the gray squirrel in the Saline River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

The upland forests are predominately oaks and hickories. A forest sampled along the first terrace of the Middle Fork of the Saline River was dominated by ashes, northern red oak, sweet gum, black oak, elms, and pin oak (Table 4).

Gray squirrels are generally common throughout the basin except where there has been extensive clearing of forests (Fig. 13). The basin was nearly 100 percent forested in 1800—the most heavily forested region in Illinois (Table 3). By 1962 only about 21.8 percent of the area was still in forest, mostly on bottomlands adjacent to the Saline River and its tributaries (Table 3). The proportion of gray squirrels in the harvest declined from an estimated 100 percent in 1800 to 56.6 percent in 1956–1957 (Table 5). Today, gray squirrels make up about 50 percent of the squirrel kill from this region (Table 6), with Hamilton County contributing the highest proportion of gray squirrels to the harvest (Table 6).

Although the human population of the region has declined in recent years (Table 9), drainage has been intensive (Table 8). Channelization is now under way or planned for most of the Saline River and its principal tributaries. Dredging of the river would permit barge traffic to move coal from the extensive deposits in Saline and Gallatin counties to markets downriver. Once the principal rivers are channelized, the extensive bottomland forests adjacent to the rivers are doomed to be cleared, drained, and farmed. It is unfortunate that so little of the present forest land in the Saline basin is in public ownership. The almost certain decline of the gray squirrel in the basin in future years will depend largely on how much bottomland forest is cleared. The significant decrease ($P < 0.01$) in the proportion of gray squirrels in the harvests in 1971–1973, compared with that in 1956–1957 (Table 6), indicates that gray squirrels may already be declining in the basin.

Little Wabash River Region

The Little Wabash River Region encompasses a seven-county area in southeastern Illinois (Fig. 14). The river begins near Mattoon in Coles County and flows southeast about 120 miles to its junction with the Wabash River in White County. The uplands and bottomlands are both flat, with steep, rolling land between them. Local relief varies as much as 100 feet in the lower portion of the basin (Barker et al. 1967*a*). Upland soils are generally derived from a thin loess over till or outwash. Bottomland soils are of recent alluvium over lacustrine deposits (Barker et al. 1967*a*).

A floodplain forest surveyed in Wabash County was dominated by elms, hackberry, silver maple, sweet gum, box elder, bur oak, and pecan (Table 4). The upland forests were dominated by oaks and hickories—post oak and blackjack oak on the poorest soils and black, white, shingle, and northern red oaks, basswood, hickories, ashes, and sugar maple on the better upland sites (Mohlenbrock 1975).

The basin was about 60 percent forested in 1800, but by 1962 only about 15 percent of the land area was still forested (Table 3). On a percentage basis, forest acreage is nearly equal in each county throughout the basin (Table 3).

Gray squirrels were the most abundant squirrel in the basin in 1800 (Table 5), but by 1956–1957 they constituted only about 30 percent of the squirrel harvest (Table 6). Today, gray squirrels are scarce in portions of the basin, particularly in the upland forests away from the major streams (Fig. 14). Upland forests have been extensively cleared for agricultural purposes. Gray squirrels are most common in the central and southern portions of the region.

The proportionate harvest of gray squirrels increased in every county in the basin in 1971–1973 as compared with that of 1956–1957 (Table 6). This significant increase ($P < 0.01$) in the proportionate gray squirrel harvest may reflect the 1.4 percent increase in forest land that occurred in the basin between 1948 and 1962 (Table 3). More recent estimates of forest cover are not available.

The pasturing of forests is not a serious problem in the Little Wabash basin, at least compared with more northern watersheds in Illinois (Table 8). Stream and river channelization is not a major difficulty at this time, and coal deposits are not of commercial importance (Table 8).

Human populations have generally declined over most of the basin, with only Effingham and Richland counties showing increases between 1960 and 1970 (Table 9). Population projections do not indicate large increases in human population for the region (Barker et al. 1967*a*). Even though most of the forests are privately owned, huntable gray squirrel populations should persist for the foreseeable future.

Also present in the Little Wabash Region are the famed "white" gray squirrels of Olney, Illinois. These squirrels are descendants of one or more white squirrels originally captured near Sumner (Lawrence County) (Thomas 1971). J. C. Banks of Olney bought a pair of these captive squirrels and released them in the town in 1902. The number of albino gray squirrels now in Olney is estimated at 1,000 (Thomas 1971).

Embarras River Region

The Embarras River originates in the upland prairies of southern Champaign County and flows through the level prairies of northern Douglas County (Fig. 15). The river then flows as a sluggish meandering stream across the level uplands and is fed by numerous low-gradient tributaries. Near the Coles-Douglas county line the river drops abruptly to form a steep-walled V-shaped valley 50–70 feet deep that

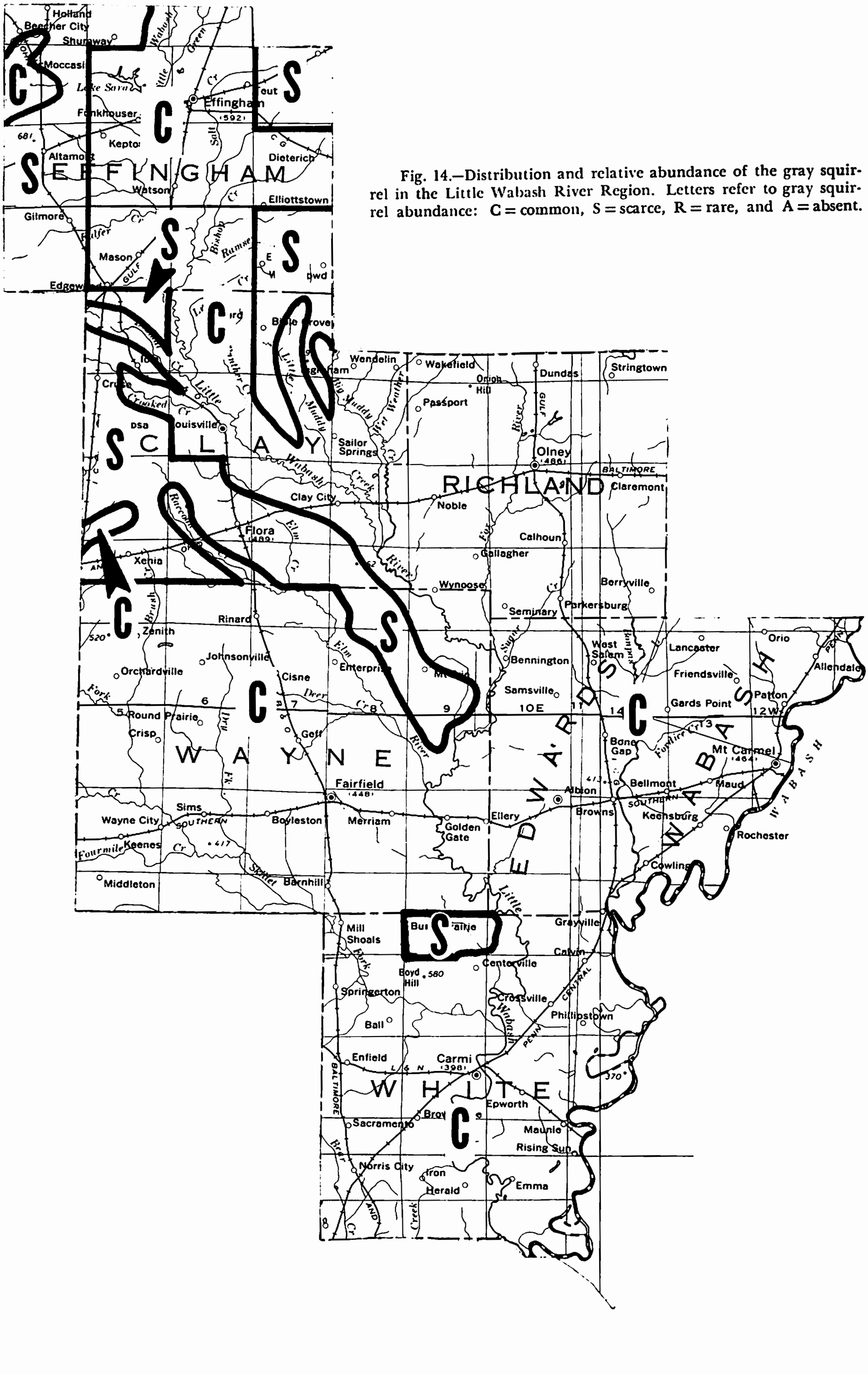


Fig. 14.—Distribution and relative abundance of the gray squirrel in the Little Wabash River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

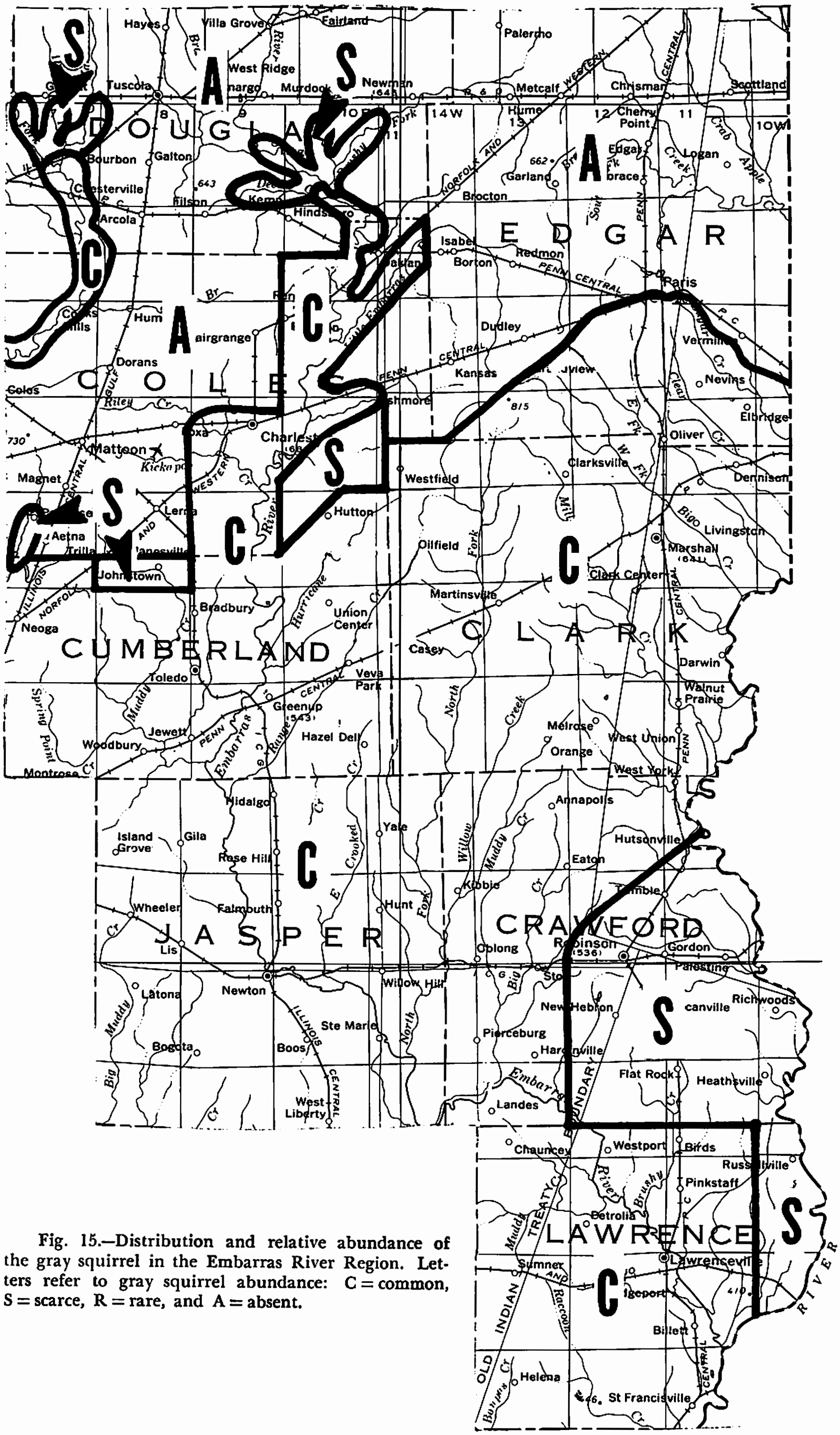


Fig. 15.—Distribution and relative abundance of the gray squirrel in the Embarras River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

extends southward for approximately 50 miles (Telford 1926).

In preglacial times the Embarras River flowed through the Pennsylvanian Lowland and had a valley that ranged from 1 to 5 miles in width. This drainage system was altered by glaciation, and the Embarras River now crosses three distinct physiographic divisions. The river originates on the Bloomington Ridged Plain, composed of glacial till; crosses the Shelbyville moraine into the Springfield Plain; and finally, in southern Crawford County, crosses the Mount Vernon hill country (Mohlenbrock 1975). The topography varies from hilly terrain in the upper reaches to flat to gently rolling terrain along the lower river. The valley is less than a mile wide in northern Cumberland County but is 3–4 miles wide in the lower reaches. Soils are derived from loess, glacial till, and outwash.

In 1800 the Embarras River basin supported one of the largest stands of hardwood forest in the eastern United States (Winters 1969). Lawrence, Clark, and Crawford counties were about 75 percent forest although, as a whole, the basin was over half prairie in 1800 (Table 3). Today only about 12 percent of the basin is forested, and Clark, Crawford, and Lawrence counties are still among the most forested counties in the region (Table 3).

In a second-growth upland forest surveyed in Edgar County, where gray squirrels are absent, osage orange, black walnut, honey locust, shagbark hickory, shingle oak, and elms were the dominant tree species (Table 4). A bottomland forest along the Embarras in Coles County contained silver maple, cottonwood, box elder, willows, and elms as the most important tree species (Crites & Ebinger 1969) (Table 4).

An estimated 74 percent of the squirrel population in this region was composed of gray squirrels in 1800 (Table 5), compared with about 20 percent grays in recent squirrel harvests (Table 6). The remains of squirrels found at archeological sites indicate that gray squirrels constituted nearly 100 percent of the squirrel populations in prehistoric Crawford and Lawrence counties (Table 2).

Gray squirrels are proportionately more abundant today in Jasper, Cumberland, and Lawrence counties (Table 6) than in the remaining counties. They are absent in the upper Embarras River basin north of the Douglas County Conservation Area but are generally distributed and abundant from there south to the mouth of the Embarras River. There are none in the uplands of Coles County and in central and northern Edgar County. These upland areas were mostly prairie in the 19th century and probably never have harbored many gray squirrels during historic times. Gray squirrel habitat has also been reduced along the Wabash River in Crawford and Lawrence counties (Fig. 15) because of widespread removal of the bottomland forests for agricultural purposes.

The Embarras River is still relatively undisturbed throughout much of its course although stream channelization has been extensive in the upper Embarras basin, particularly in Douglas and Edgar counties (Table 8). The removal of riparian forests during channelization eliminated gray squirrels from most of the upper river in those counties. Nearly half of the remaining forests are pastured, further reducing the quality of forest habitat available to gray squirrels (Table 8).

Human densities have remained relatively stable in the basin since 1950 (Table 9). Only Coles County increased in population between 1960 and 1970.

In the upper basin gray squirrels will continue to decline as forests are removed or degraded by man's activities. In the lower basin occupied gray squirrel range is more extensive, and many forests will continue to harbor gray squirrels for the foreseeable future.

Vermilion River Region

The Vermilion River Region comprises three counties in east-central Illinois (Fig. 16). The Vermilion basin is essentially a sequence of low moraines and level plains, left by the retreat of glacial ice, through which the principal streams have cut downward to their present levels. Steep slopes are confined to the valley walls of the larger streams. Near Danville local relief changes as much as 100 feet along the river. Soils developed on loess over till, outwash, or lake-bed deposits. The bottomlands are alluvial, silt loams (Barker et al. 1967*b*).

In an upland forest, where gray squirrels are common, in McKendree Township, Vermilion County, our survey showed that black oak, various hickories, white oak, sugar maple, and American beech were the dominant trees (Table 4). In a forest in which gray squirrels are absent in Grant Township, Vermilion County, osage orange, shagbark hickory, box elder, hawthorns, and black oak were dominant in the tree stratum (Table 4). Bottomland forests throughout the basin are dominated by silver maple, ashes, elms, cottonwood, and some willows.

Gray squirrels are common in the cities of Champaign-Urbana, St. Joseph, Rantoul, and in Lake of the Woods Park in Champaign County (Fig. 16). They are also present in both Brownfield Woods and Trelease Woods, 24.2-ha old-growth forests located just northeast of Urbana. They are locally rare to scarce along the Salt Fork of the Vermilion River between Urbana and St. Joseph in Champaign County (Fig. 16). Their presence along the Salt Fork and south of Lake of the Woods Park on the Sangamon River may represent a recent expansion of range, as Wood (1910) reported no gray squirrels present in the rural areas of Champaign County in the early 20th century.

In Vermilion County gray squirrels are scarce in Danville but are locally abundant downstream from

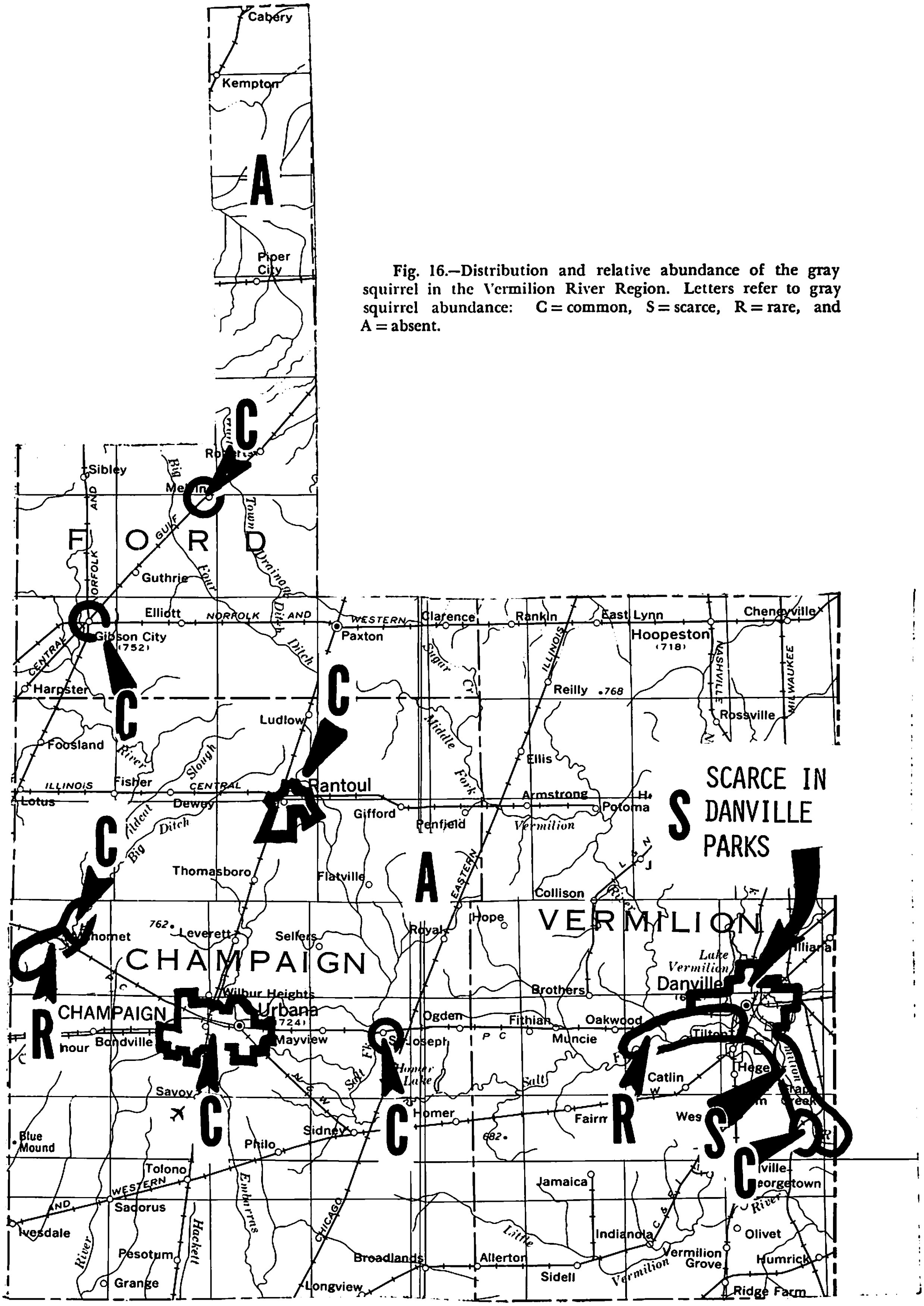


Fig. 16.—Distribution and relative abundance of the gray squirrel in the Vermilion River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

Danville along the Vermilion River. Gray squirrels make up about 10 percent of the squirrel population below Danville (Nixon & Havera, unpublished data) but may be more abundant in localized areas. On a 12.1-ha upland forest of mixed hardwoods at Forest Glen County Preserve, 7 miles southeast of Danville, 38 of 62 livetrap captures (61.3 percent) were gray squirrels. On a similar 12.1-ha tract only 400 m away, 7 of 46 captures (15.2 percent) were gray squirrels.

The 1942 survey of gray squirrel distribution (Brown & Yeager 1945) showed gray squirrels present along the upper reaches of the Middle Fork River in Ford County and along the lower Vermilion River adjacent to Indiana in Vermilion County (Fig. 3). Since 1942 gray squirrels have been extirpated from areas along the upper Middle Fork and are found only in the cities of Melvin and Gibson City in Ford County. Stream channelization began early in this region, a practice that removed what was often the only forested habitat in this prairie-dominated area. The extensive stream channelization in both Champaign and Ford counties (Table 8) may have been a factor in reducing the range of the gray squirrel in those counties.

In recent years gray squirrels have constituted only about 6 percent of the squirrel harvest from the Vermilion basin (Table 6). We suspect that reports of gray squirrels killed in Ford and Champaign counties represent hunter error or illegal hunting on reserves, because gray squirrels are virtually nonexistent in areas legally open to hunting in these counties (Fig. 16). According to landowners along the Little Vermilion River in southwest Vermilion County, gray squirrels were present in Elwood Township until about 1960, when extensive timber cutting decimated the riparian forests in the township. Mohr's (1941) sighting of a gray squirrel in this drainage in the 1940's confirms the landowners' observations. He (Mohr, personal communication, 1975) also sighted a gray squirrel in 1940 near Oakwood (Vermilion County) in a formerly strip-mined area. They are not present in this area today. The recent purchase of portions of the lower Vermilion River valley by public agencies should protect the area from land clearing, grazing, and indiscriminate timber cutting and thus help to maintain gray squirrel populations along the Vermilion River south of Danville.

Human populations are increasing rapidly in Champaign County (Table 9) but fortunately have remained relatively stable in Vermilion County, where most of the gray squirrel habitat in the Vermilion River Region exists today.

Iroquois River Region

The Iroquois River Region, a two-county area (Fig. 17), is drained by the Iroquois River and a portion of the Kankakee River, both of which arise in western Indiana. Both rivers have relatively low gradients and flow through a mantle of unconsolidated glacial deposits (Barker et al. 1967*c*). Sand dunes are common in southeastern Kankakee and northeastern Iroquois counties. The topography is nearly flat in old glacial lake beds but is rolling and locally steep along the sides of the numerous moraines that occur throughout the basin (Barker et al. 1967*c*). Forests are confined to the floodplains and their associated bluffs along the major rivers and streams.

Only 6.1 percent of the basin was forested in 1800 (Table 3). Today, only 26,700 acres of forest remain—about 2.3 percent of the land area (Table 3). The tree stratum of a bottomland forest in Iroquois County was dominated by ashes, elms, silver maple, basswood, and hackberry (Table 4). The dominant trees in an upland forest in Iroquois County were black oak, white oak, northern red oak, black cherry, and ashes (Table 4).

Gray squirrels are now considered present but rare north and south of Watseka along Sugar Creek, along the Iroquois River just south of the Kankakee County line, along the Kankakee River east and west of Momence, and northwest of Bourbonnais along the Kankakee River to the Will County line (Fig. 17). Gray squirrels are occasionally seen by park personnel at Kankakee River State Park southeast of the Kankakee-Will county line (R. Fredericks, personal communication, 1974). However, during 1971–1973 no grays were among the 300 squirrels reported shot by hunters in this park. Gray squirrels are occasionally shot by hunters in Kankakee County but only rarely in Iroquois County (Table 6). In 1942 gray squirrels were thought to have been extirpated from these two counties (Brown & Yeager 1945) (Fig. 3), but it seems likely that the 1942 survey missed the four small, isolated populations mentioned here.

Streams in these two counties have been extensively modified by channelization (Table 8), and riparian forests have been removed or converted to forests of osage orange, box elder, hawthorn, ashes, and elms. Forests have been totally removed along many of the smaller streams and have been replaced by grasses and forbs. Between 1960 and 1970 human densities remained stable in Iroquois County but increased about 6 percent in Kankakee County (Table 9).

Gray squirrels will probably continue to be rare in the Iroquois basin. The continued removal of forests or overcutting of the forests where grays presently occur will very likely extirpate them. Only the 2,000-acre Kankakee River State Park protects any appreciable amount of forest in the basin, and although gray squirrels are present in the park, they have not recently increased to any degree and persist at a very low density (R. Fredericks, personal communication, 1974).

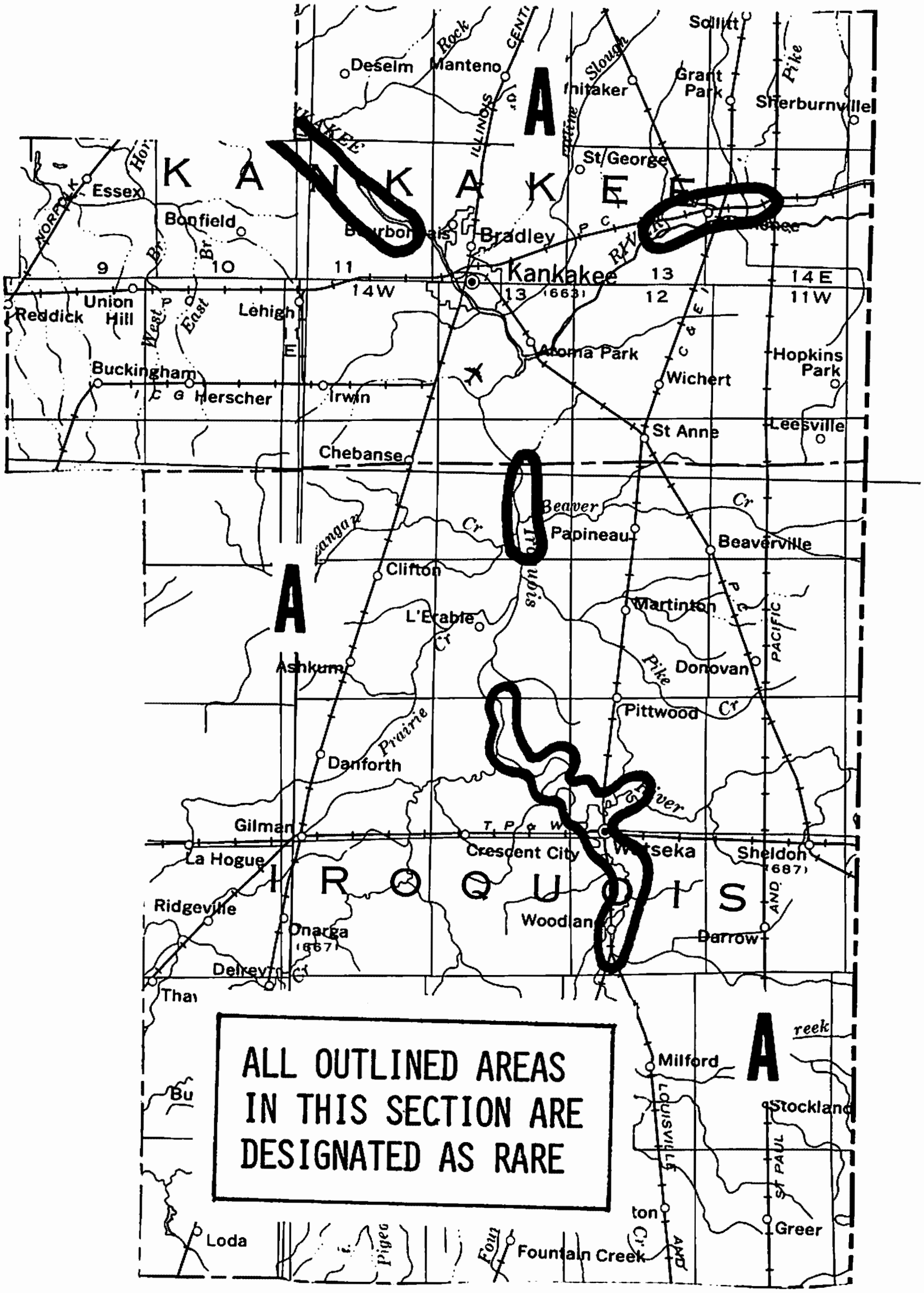


Fig. 17.—Distribution and relative abundance of the gray squirrel in the Iroquois River Region. Letters refer to gray squirrel abundance: C = common, S = scarce, R = rare, and A = absent.

CHARACTERISTICS OF GRAY SQUIRREL HABITAT

We found a highly significant relationship between the percentages of gray squirrels killed in each county *(Y)* in 1956–1957 and the percentage of each county forested *(X)* in 1962 ($r = +0.82$, $R^2 = 0.67$, df = 100) ($P < 0.001$). This analysis suggests that about two-thirds of the difference in the numbers of gray squirrels harvested in various counties is associated with the proportion of forested land in the counties where they are hunted. On the basis of this relationship, we conclude that a county must be 30 percent forested to attain a squirrel harvest composed 50 percent of gray squirrels.

We tried square root and logarithmic transformations of both independent and dependent variables but were unable to increase materially the value of the correlation coefficient.

The proportion of gray squirrels in the 1956–1957 squirrel harvest in each county *(Y)* was also tested for association with the percentage of forest land that was grazed by livestock in each county (Illinois Conservation Needs Commission 1970) and with the amount of hardwood sawtimber (dbh of 4.72 cm or more) remaining in each county (Essex & Gansner 1965:40). The correlation between the proportionate harvest of gray squirrels and the percentage of grazed forest land was negative but relatively low ($r = -0.42$, $P > 0.05$, df $= 100$). A significant positive correlation ($r = +0.61$, $P < 0.01$, df $= 73$) was found between the common logarithm of the proportion of gray squirrels in the harvest and the amount of hardwood sawtimber in each county.

On the basis of these limited analyses, we find that forests occupied by gray squirrels tend to be extensive and ungrazed and to contain a predominance of trees of the sawtimber size. Bakken (1952) also found a highly significant correlation between the gray:fox ratio in the squirrel harvest and the percentage of woodland for counties in central and southern Wisconsin.

Discriminant function analyses (Rao 1970) were used to determine whether significant differences exist between characteristics of forests where gray squirrels are present and where they are absent. The sampling intensity is shown in Table 1, and the 54 independent variables used in our analyses are given in Table 10. Discriminant function analysis is a linear combination of variables that emphasize the differences among groups. We used a stepwise discriminant function program with the F-levels to enter and exit set at $P \leqq 0.05$ and $P \geqq 0.10$, respectively.

The first discriminant function analysis treated all 54 variables and selected 7 variables as being important in separating the gray-squirrels-present from the gray-squirrels-absent groups of forests (Table 11). In a classification performance using this first discriminant function, all 24 forests where gray squirrels are absent and all 20 forests where gray squirrels are present were correctly grouped (Fig. 18)

The importance of each variable to the discriminant function can be examined by two different methods. The first method used was the magnitude of the standardized (scaled) discriminant function coefficients (Tatsuoka 1971). Examination of these values in Table 11 reveals that the amount of forests in the 23.31 km^2 (9 square miles), including the sample section, was by far the most important factor associated with the presence or absence of gray squirrels. The number of forested tracts in the 23.31 km^2, including the sample section, and the Importance Value Index (IVI) for sugar maple were the next two most important variables separating the gray-squirrels-absent and gray-squirrels-present groups (Table 11).

The second method used for examining the importance of variables to the discriminant function was the absolute value of the correlation of a given variable with the discriminant function. Shugart & Patten (1972) feel that this method, which supplies the maximum separation among groups, indicates how well the variable separates the groups.

Examination of the correlation between each of the seven variables that entered the discriminant func-

TABLE 10.—Variables used to compare forests with and without gray squirrels. Trees (diameter > 12.5 cm at height of 1 m) were tallied on 8- × 40-m transects. Shrubs, vines, and small trees (diameter 2.5–12.5 cm at height of 1 m) were tallied on 4- × 20-m transects. Foliage height diversity, percentage of vegetative cover, and number of plant species were calculated at height intervals of 0–1.5 m, 1.5–9.0 m, and > 9.0 m at every 5 m along each 8- × 40-m transect.

	Variable
1.	Density of total trees per hectare
2.	Density of total shrubs, vines, and small trees per hectare
3.	Average number of tree species per transect
4.	Average number of shrub, vine, and small-tree species per transect
5.	Average dbh of dominant and codominant trees
6.	Average dbh of trees (diameter > 12.5 cm at height of 1 m)
7.	Average height of trees (diameter > 12.5 cm at height of 1 m)
8.	Average height of shrubs, vines, and small trees
9.	Density of tree cavities per hectare
10.	Foliage height diversity
11.	Percentage of total vegetation (sum of percentage of cover in each of three layers of vegetation)
12.	Mean number of plant species below 1.5 m from ground
13.	Mean number of plant species between 1.5 m and 9 m from ground
14.	Mean number of plant species above 9 m from ground
15.	Number of timber stands in 23.31 km^2, including sample section
16.	Average size of timber stands in 23.31 km^2, including sample section
17.	Total amount of forest in 23.31 km^2, including sample section
18.	IVI[a] for shagbark hickory
19.	IVI for hickory (mockernut, bitternut, pignut)
20.	IVI for black oak
21.	IVI for blackjack oak
22.	IVI for northern red oak
23.	IVI for shingle oak
24.	IVI for pin oak
25.	IVI for white oak
26.	IVI for chinquapin oak
27.	IVI for post oak
28.	IVI for bur oak
29.	IVI for black walnut
30.	IVI for butternut
31.	IVI for pecan
32.	IVI for sugar maple
33.	IVI for silver maple
34.	IVI for box elder
35.	IVI for cottonwood
36.	IVI for bigtooth aspen
37.	IVI for honey locust
38.	IVI for black locust
39.	IVI for elms
40.	IVI for basswood
41.	IVI for hackberry
42.	IVI for hawthorns
43.	IVI for osage orange
44.	IVI for ashes
45.	IVI for black cherry
46.	IVI for crab apple
47.	IVI for willows
48.	IVI for tulip tree
49.	IVI for sassafras
50.	IVI for sycamore
51.	IVI for river birch
52.	IVI for Ohio buckeye
53.	IVI for persimmon
54.	IVI for American beech

[a] Importance Value Index = (sum of relative frequency, relative density, and relative basal area) × 100%.

TABLE 11.—The F-levels to enter the discriminant function, the standardized discriminant function coefficients, the correlation with the discriminant function, and the mean values of the variables selected in the discriminant function analysis for forests where gray squirrels are present or absent. The discriminant function was highly significant (X^2 = 95.5, 7 df; $P < 0.005$).

Variable	F-level to Enter Discriminant Function	Standardized Discriminant Function Coefficients	Correlation with the Discriminant Function	Mean Values Where Gray Squirrels Are Present	Mean Values Where Gray Squirrels Are Absent
Amount of forest in 23.31 km², including and surrounding the sample section	97.53	0.708	−0.87[a]	776.3 ha	167.4 ha
Number of individual forest tracts in 23.31 km², including and surrounding the sample section	4.34	0.462	−0.42	58.2	34.8
IVI[b] for sugar maple	7.35	0.349	−0.43	6.39%	0.49%
IVI for box elder	5.44	0.191	+0.21	1.36%	4.74%
IVI for basswood	3.70	−0.129	−0.10	1.84%	1.22%
IVI for black oak	6.06	0.128	−0.43	14.72%	3.53%
Average number of plant species occurring below 1.5 m from ground	6.59	0.081	−0.45	1.24	1.13

[a] $P < 0.01$, 6 df. [b] Importance Value Index.

tion at the 95 percent level and the discriminant function revealed that only the amount of forest in the 23.31 km² (9 square miles), including the sample section, was significantly correlated ($r = 0.87$, $P < 0.01$, 6 df) with the discriminant function (Table 11). Although all seven variables were selected at the 5 percent significance level, the amount of forest apparently accounted for most of the variance associated with the presence or absence of gray squirrels.

Four other variables had nonsignificant absolute correlation values with the discriminant function. These variables were the average number of species occurring below 1.5 m from the ground ($r = 0.45$), the number of forests in the 23.31 km² including the sampled woods ($r = 0.42$), and the IVI for sugar maple and for black oak ($r = 0.43$) (Table 11).

A second discriminant function analysis considered only the IVI for the 37 principal tree species encountered on the study plots (see Table 10 for principal tree species). This analysis selected IVI values for nine species as significant variables (Table 12). In a classification performance, this discriminant function correctly classified 22 of the 24 sampled forests where gray squirrels are absent and 19 of 20 forests where they are present (Fig. 18). However, none of the correlation coefficients between the nine IVI values and the discriminant functions was significant ($P > 0.05$, 8 df) (Table 12).

Finally, we considered only the physical characteristics of the forest environment (a compilation of tree and shrub measurements from direct counts of tree and shrub species), using discriminant function analysis to evaluate the first 14 variables listed in Table 10. The discriminant function selected five variables as most important in separating forests occupied by gray squirrels from forests where gray squirrels are absent (Table 13). A classification performance of this discriminant function correctly classified 21 of

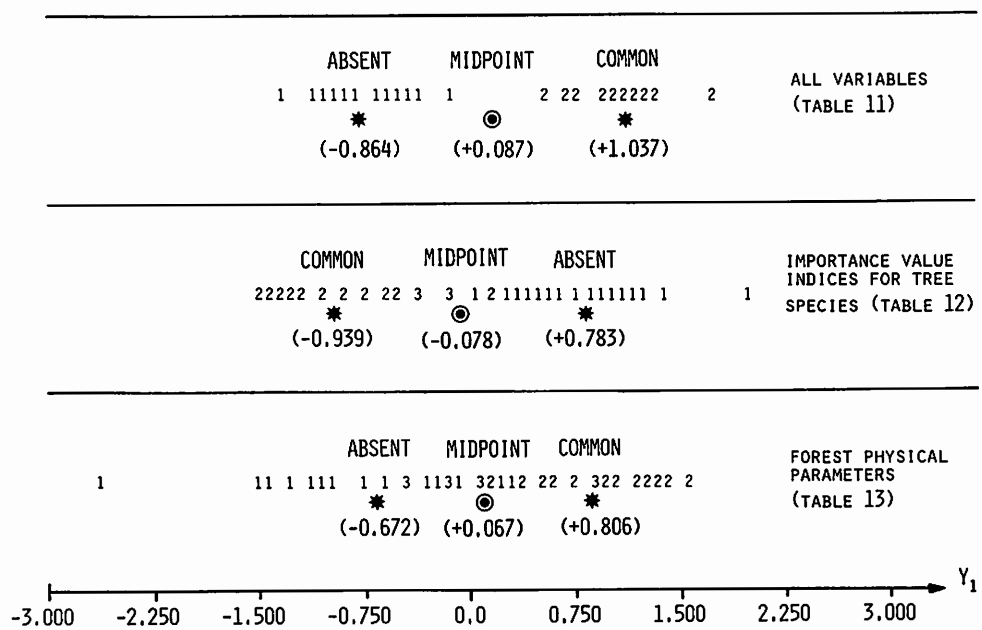


Fig. 18.—Plots of the discriminant function scores, group means (*), and midpoint scores (⊙) generated from the variables listed in Tables 11, 12, and 13. The numbers 1 and 2 denote, respectively, the location of the discriminant score for each sample forest in group 1 (gray squirrels absent) and group 2 (gray squirrels present). The number 3 denotes overlapping discriminant scores for some sample forests in group 1 and group 2.

TABLE 12.—The F-levels to enter the discriminant function, the standardized discriminant function coefficients, the correlation with the discriminant function, and the mean values of the Importance Value Index of the tree species selected in the discriminant function analysis from tree species tallied in forests where gray squirrels are present or absent. The discriminant function was highly significant ($X^2 = 52.30$, 9 df; $P < 0.005$).

Variable	F-level to Enter Discriminant Function	Standardized Discriminant Function Coefficients	Correlation with the Discriminant Function	Mean Values Where Gray Squirrels Are Present (Percent)	Mean Values Where Gray Squirrels Are Absent (Percent)
IVI[a] for elms	3.03	−0.337	+0.47	14.36	6.99
IVI for shagbark hickory	8.79	0.332	−0.11	5.26	6.94
IVI for hawthorns	16.06	0.314	−0.61	0.00	5.18
IVI for hackberry	5.41	0.301	−0.41	0.75	5.37
IVI for black oak	3.60	−0.251	+0.48	14.72	3.53
IVI for osage orange	5.29	0.241	−0.51	0.36	15.21
IVI for black cherry	5.05	0.228	−0.13	2.48	3.66
IVI for sugar maple	3.57	−0.216	+0.48	6.39	0.49
IVI for white oak	9.35	−0.200	+0.59	10.85	1.95

[a] Importance Value Index.

24 forests in the gray-squirrels-absent group and 17 of 20 forests in the gray-squirrels-present group (Fig. 18). Only the percentage of total vegetative cover (total volume of vegetation taken as the sum of the percentage of vegetative cover for the layers of vegetation from 0 to 1.5 m, 1.5 to 9 m, and >9 m) was significantly ($P < 0.05$) different between the two groups of forests, but the difference between the two groups in the number of tree cavities per hectare approached significance ($0.10 < P < 0.20$) (Table 13).

To summarize from our analysis, landscapes in central and northern Illinois that are occupied by gray squirrels have at least 20 percent of the land area covered by forest. Our sample townships ($N = 11$) where gray squirrels are present averaged 34.0 percent forested (range = 19.4–51.9 percent). The mean percentage of forest cover averaged only 3.9 (range = 0.03–18.5 percent) for townships ($N = 10$) where gray squirrels are absent.

Where gray squirrels are present, sugar maple, white oak, elms, and black oak occur in the tree strata. Sugar maple and black and white oaks are found on well-drained soils, but only the elms, which are more tolerant of water, are found in both upland and bottomland forests in Illinois. Sugar maples in Illinois are usually found on forested slopes and in upland ravines that offer a well-drained soil and a cool, moist microclimate (Braun 1950). Sugar maple is usually considered a climax species, at least on sites favoring its growth (Godman 1957). Black and white oaks are found in a wide range of sites in Illinois, but on average sites (for tree growth) these two species are usually dominant (Braun 1950). White oak is a climax species on many sites (Minckler 1957), whereas black oak may be a subclimax species due to its relatively short life-span (Brinkman 1957). The elms are not considered climax species on upland sites, where they are usually succeeded by sugar maple and American beech. American elm, however, can be considered a climax species on bottomland sites over most of its range (Guilkey 1957). Thus, all four of these species important to gray squirrels may be considered climax or near-climax species in Illinois forests.

In contrast, those species characteristic of forests where gray squirrels are absent are successional trees, usually intolerant of shade and requiring a major disturbance of the forest to become established (Table 12). Hawthorn, box elder, osage orange, black cherry, and hackberry are species that cannot withstand shade and die when overtaken by more shade-tolerant spe-

TABLE 13.—The F-levels to enter the discriminant function, the standardized discriminant function coefficients, the correlation with the discriminant function, and the mean values of the variables selected in the discriminant function analysis from the physical parameters measured in forests where gray squirrels are present or absent. The discriminant function was significant ($X^2 = 31.92$, 5 df; $P < 0.005$).

Variable	F-level to Enter Discriminant Function	Standardized Discriminant Function Coefficients	Correlation with the Discriminant Function	Mean Values Where Gray Squirrels Are Present	Mean Values Where Gray Squirrels Are Absent
Percentage of total vegetative cover	28.50	0.726	0.85[a]	221.4	181.2
Tree cavities per hectare	3.02	0.414	0.63	23.3	11.5
Average number of tree species per plot	2.75	−0.269	−0.13	1.03	1.14
Density of total trees (> 12.5 cm at height of 1 m) per hectare	3.44	−0.227	−0.40	319.1	400.8
Density of total shrubs, vines, small trees (<12.5 cm at height of 1 m) per hectare	2.71	−0.301	0.02	1,637.1	1,612.3

[a] $P < 0.05$, 4 df.

cies. The higher frequency of shagbark hickory in forests where gray squirrels are absent (Table 12) is usually the result of extensive pasturing. Hickories are relatively unpalatable to livestock and tend to resprout readily when damaged. Many shagbark hickories present today grow in long-abandoned pastures (B. Roach, U.S. Forest Service, personal communication, 1974) and often remain uncut because loggers find them unsuitable for timber products.

Forests inhabited by gray squirrels have a well-developed forest understory both above and below 1.5 m from ground level. The mean percentage of woody vegetative cover below 1.5 m was 34.2 in forests ($N = 24$) where gray squirrels are absent and 52.9 in forests ($N = 20$) where they are present. For the middle layers of woody vegetation (1.5–9 m high), the percentage values were nearly equal (83.9 where gray squirrels are absent, 90.4 where they are present). For the tree canopy, the percentage of vegetative cover was also higher for forests occupied by gray squirrels (78.1) than for forests without gray squirrels (63.1).

Taylor (1974: 282) found that the percentage of understory was significantly higher in forests where only gray squirrels lived than it was in forests where they coexisted with fox squirrels. Most descriptions of forests occupied by gray squirrels mention a dense understory and a tree canopy sufficiently developed so that gray squirrels can travel from tree to tree (Madson 1964: 10; Goodrum 1961: 9). Our data confirm that gray squirrels in Illinois thrive best in forests with closed canopies and well-developed understory structures.

Woodlands that support gray squirrels contain more tree cavities suitable for nurseries or for escaping predators and inclement weather than do forests where gray squirrels are absent. The mean number of tree cavities per hectare was twice as high in forests occupied by gray squirrels as it was in forests where they are absent (Table 13). Forests occupied by gray squirrels never averaged less than six cavities per hectare, whereas several forests unoccupied by gray squirrels had no tree cavities. Gray squirrels seem to have greater need of tree cavities for nesting and protection than have fox squirrels (Bakken 1952; Madson 1964). Packard (1956) found that gray squirrels in Kansas were restricted to forests containing tree cavities. The continued existence of fox squirrels in hedgerows and young forests (<40 years) in Illinois indicates that fox squirrels can live in forests with few tree cavities (Nixon, unpublished data).

DISCUSSION

The flora and fauna present in Illinois when the first white settlers moved north and westward across the Ohio River have undergone drastic changes during the past 175 years. The transformation of Illinois from a forest and prairie wilderness to a modern technological society has destroyed most of the plant and animal communities that had existed at least 10,000–12,000 years since the recession of the Wisconsinan glacier. The prairies were drained and plowed for production of corn, soybeans, and other crops. The forests, which once totaled 15 million acres, have been reduced by nearly 75 percent to an estimated 3.7 million acres (Essex & Gansner 1965).

Although it is useless to regret what has been lost, we cannot help marveling at descriptions of the magnificence of the virgin forests. The largest hardwoods on this continent, as described by Ridgway (1872: 661), grew in the Wabash valley:

> "Of the ninety to a hundred species of trees of the lower Wabash Valley, about seventy exceed the height of forty feet; forty-six (perhaps fifty) exceed seventy feet in height, and about thirty are known to reach or exceed the height of one hundred feet. Of the latter class, as many as nine are known certainly to reach, or even exceed, the altitude of one hundred and fifty feet, while four of them (sycamore, tulip-poplar, pecan and sweet gum), attain, or go beyond, an elevation of one hundred and seventy-five feet! The maximum elevation of the tallest sycamore and tulip trees is probably not less than two hundred feet.
>
> "Going into these primitive woods, we find symmetrical, solid trunks of six feet and upwards in diameter, and fifty feet, or more, long to be not uncommon, in half a dozen or more species; while now and then we happen on one of those old sycamores, for which the rich alluvial bottoms of the western rivers are so famous, with a trunk thirty or even forty, possibly fifty or sixty, feet in circumference, while perhaps a hundred feet overhead stretch out its great white arms, each as large as the biggest trunks themselves of most eastern forests, and whose massive head is one of those which lifts itself so high above the surrounding tree-tops. The tall, shaft-like trunks of pecans, sweet gums or ashes, occasionally break on the sight through the dense undergrowth, or stand clear and upright in unobstructed view in the rich wet woods, and rise straight as an arrow for eighty or ninety, perhaps over a hundred, feet before the first branches are thrown out."

In such forests gray squirrels reached densities that can only be guessed at today. Shelford's (1963) estimate of 1,000–2,000 squirrels per square mile certainly appears conservative, because squirrel densities today approach this level, at least on small woodlands in Illinois (Nixon & Havera, unpublished data). Gray squirrel densities seem to fluctuate in response to the amount of storable tree seed (Nixon et al. 1975;

Barkalow et al. 1970). Zawacki & Hausfater (1969) estimated that presettlement, mixed upland hardwood stands produced between 38,000 and 148,000 bushels of storable tree seed (hickories, walnuts, and acorns) per square mile. In contrast, the average yield in a mixed upland second-growth forest in southeast Ohio was only about 1,700 bushels of sound seed per square mile (10 years' data extrapolated from Nixon et al. 1975). Even if the estimate of storable tree seed produced in virgin forests was in error by a factor of 10, we would expect presettlement densities of gray squirrels to far exceed present densities.

Seton (1953: 24) estimated that there were at least 1 billion gray squirrels in their entire range in 1800. By 1900, naturalists urged that gray-squirrel hunting be banned in the northeastern United States for fear that gray squirrels would be extirpated from the region (Jackson 1961). As the virgin forests were removed or drastically modified, fox squirrels began to expand their range north and eastward from their prehistoric range, which had centered in the Mississippi Valley (Michigan, Allen 1943: 3; Indiana, Allen 1954: 9; Ohio, Baumgartner 1940: 28).

Favored habitats for gray squirrels have been described as heavy stands of timber with abundant ground cover and brush (Parmalee 1969: 139), dense timber with mature nut-bearing trees (Packard 1956: 17), and big forests of mature hardwoods and abundant understories of smaller trees and shrubs (Madson 1964: 10). In the Mississippi and Ohio river drainages both fox and gray squirrels are found primarily in habitats dominated by oaks. The numerical dominance of one or the other squirrel species apparently varies with the density of stand, tract size, and past land-use practices (Bakken 1952). In the southeastern states, however, there is an ecological separation of the two species; fox squirrels inhabit the upland pines and mixed pine-hardwoods, whereas gray squirrels live in the bottomland hardwoods (Bakken 1952; Goodrum 1961).

We conclude that at least 20 percent of the land area must be forested for gray squirrels to remain abundant. Such forests should approach maturity and contain climax species as the dominant trees, notably black oak and white oak on upper slopes and ridges or a combination of black and white oaks with basswood and sugar maple on more mesic lower slopes and ravines. Understories should be well developed, and the values for total vegetative cover in all strata should be above 200 percent (see METHODS for the derivation of vegetative cover). There should be at least six tree cavities per hectare (2.4 per acre)—no forests where gray squirrels were present had fewer. Extensive timber cutting, heavy and continuous pasturing, and repeated burning should be avoided in forests occupied by gray squirrels. These activities, which reduce tree and understory densities and the number of tree cavities and increase the number of successional tree species, generally provide fox squirrels with a competitive advantage over gray squirrels. Today, fox squirrels are present in virtually all the forests in Illinois.

Except in a few small forest reserves, it is doubtful that the optimum habitat requirements for gray squirrels will persist in central and northern Illinois forests in future years. However, if forests are allowed to mature and if that land area unsuited to agriculture (about 4 million acres in 1948, King & Winters 1952) is allowed to succeed to forest, gray squirrel numbers could stabilize and even increase in many areas. For example, there were few gray squirrels on the Kellogg Bird Sanctuary in Michigan where Allen (1943) conducted his fox squirrel studies in the 1930's. Today, gray squirrels outnumber fox squirrels on this sanctuary because the forests have matured and developed a dense understory during the intervening years (Johnson 1973).

THE FUTURE

The human population of Illinois will probably increase to nearly 14.5 million by the year 1990 (U.S. Department of Commerce 1974). We expect gray squirrels to continue to decline in the upper Mississippi, Rock River, upper Illinois, Sangamon, Vermilion, and Iroquois drainage basins because of land changes imposed by the demands of an ever-increasing human society. Gray squirrels are most vulnerable to extinction in the watersheds where they are already scarce (see Fig. 4–6, 9, 16, 17). The expected continuation of forest destruction will no doubt extirpate the gray squirrel from many of these areas.

Gray squirrels will continue to decline in the upper reaches of the Kaskaskia, Little Wabash, and Embarras basins if stream channelization and conversion of forests to cropland continue at present levels. Gray squirrels should be relatively secure in the lower portions of these basins as well as in the Big Muddy basin, the Shawnee Hills Region, and portions of the Saline River basin. However, as water impoundments are created, additional acres are strip-mined for coal, and towns and cities expand, gray squirrels will become locally scarce or absent even in these extensively forested basins.

There is a need for greater public ownership of forests in central and northern Illinois. North of the line extending between Kankakee and the Quad Cities, only about 12,800 acres of hardwood forest over 100 years old remain today (Essex & Gansner 1965 as modified by Graber & Graber 1976: 6). Of these 12,800 acres, only 1,300 are bottomland forest, a type that formerly occupied all the major floodplains in the state (Graber & Graber 1976: 6). The Illinois Division of Waterways (1969) has recommended public purchase of additional bottomlands along the Illinois River from Bureau County south to Morgan County for recreational use. Most of this range is occupied by gray squirrels.

The forests now in public ownership in central and northern Illinois should be managed (or left alone) to perpetuate a closed-canopy mature forest with a well-developed understory. Selective timber cutting should be designed to ensure that a plentiful supply of storable tree seed (mostly acorns and hickory nuts) remains after logging. Because tree seeds are important to many species of wildlife, we cannot justify the cutting of hickories and oaks on public lands in northern Illinois. Such forests, if left undisturbed, will become increasingly valuable to wildlife as private forests are removed. The U.S. Forest Service in the Shawnee National Forest has recognized the value of retaining old-growth hardwoods (85 or more years) for their aesthetic value, for wildlife and water management, and as laboratories for the study of undisturbed forest ecosystems. The Forest Service has proposed reserving 10 percent of each compartment of 400 acres or more in the Shawnee National Forest as old-growth uncut forest (Winter 1976). We believe that a much larger percentage of the forests remaining in northern Illinois should be similarly set aside.

A reintroduction of gray squirrels may become feasible in a few mature forests where they have been extirpated. We recommend that these potential release sites be sampled, using procedures similar to ours to determine the suitability of tree and shrub species, the percentage of vegetative cover, and the number of tree cavities present, before any restocking is undertaken. If the forest stands have the characteristics that we found to be associated with gray squirrel occupancy (see DISCUSSION) and if they cover at least 20 percent of the surrounding land area (minimum, 2–4 sections), a reintroduction may be successful.

The problems inherent in motivating an unresponsive public to the advantages of protecting the remaining private forests in Illinois have perplexed nearly all concerned individuals during this century. The condition of most of the present private forests indicates that the existing programs have been almost total failures. Most private forests have timber of such poor quality that there is little incentive for their continued protection. It is easier to destroy the forest or to pasture it than to wait the 50 or more years that are required to produce a harvestable timber crop.

As a first step, there must be a change in the tax laws to provide an economic incentive to retain existing forests. Methods for developing markets for such forest products as medicinal herbs, edible nuts, and wild flowers should be explored. Fees for hunting rights and access fees for fishermen, bird watchers, and hikers could also help defray the costs of preserving forest land. As one example, a landowner in Shirland Township, Winnebago County, collects approximately $400 per year for the hunting rights on his farm.

The decline of the gray squirrel, although not as dramatic as the disappearance of the timber wolf, the black bear, and the passenger pigeon, is nonetheless indicative of what has happened to the magnificent landscape of forests, prairies, and marshes that our forefathers wrested from the Indians. Unless Illinois develops a rational land-use policy that recognizes the ecological necessity of preserving and protecting as much of the remaining native landscape as possible, additional species will be extirpated and the quality of life that we presently enjoy must inevitably decline. It is abundantly clear that modern man must have wild sanctuaries where he can escape the pressures of his hectic existence. It is also clear that the continued destruction of our native ecosystems, before we truly know the consequences of such despoliation, is great folly.

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APPENDIX

Common and scientific names of plants and animals mentioned in text or tables.

Plants[a]

Apple, crab—*Malus* spp.
Ash
green—*Fraxinus pennsylvanica* var. *subintegerrima*
white—*F. americana*
Aspen, bigtooth—*Populus grandidentata*
Basswood—*Tilia americana*
Beech, American—*Fagus grandifolia*
Birch, river—*Betula nigra*
Box elder—*Acer negundo*
Buckeye, Ohio—*Aesculus glabra*
Butternut—*Juglans cinerea*
Cherry, black—*Prunus serotina*
Cottonwood—*Populus deltoides*
Elm
American—*Ulmus americana*
slippery—*U. rubra*
Gum, sweet—*Liquidambar styraciflua*
Hackberry—*Celtis occidentalis*
Hawthorns—*Crataegus* spp.
Hickory
big shellbark—*Carya laciniosa*
bitternut—*C. cordiformis*
mockernut—*C. tomentosa*
pignut—*C. ovalis, C. glabra*
shagbark—*C. ovata*
Hop hornbeam—*Ostrya virginiana*
Ironwood (blue beech) —*Carpinus caroliniana*
Locust
black—*Robinia pseudoacacia*
honey—*Gleditsia triacanthos*
Maple
red—*Acer rubrum*
silver—*A. saccharinum*
sugar—*A. saccharum*
Oak
black—*Quercus velutina*
blackjack—*Q. marilandica*
bur—*Q. macrocarpa*
cherrybark—*Q. falcata* var. *pagodaefolia*
chinquapin—*Q. muhlenbergii*
northern red—*Q. rubra*
overcup—*Q. lyrata*
pin—*Q. palustris*
post—*Q. stellata*
shingle—*Q. imbricaria*
Shumard's—*Q. shumardii*
swamp chestnut—*Q. michauxii*
swamp white—*Q. bicolor*
white—*Q. alba*
Osage orange—*Maclura pomifera*
Pecan—*Carya illinoensis*
Persimmon—*Diospyros virginiana*
Sassafras—*Sassafras albidum*
Shadbush—*Amelanchier arborea*
Sugarberry—*Celtis laevigata*
Sycamore—*Platanus occidentalis*
Tulip tree—*Liriodendron tulipifera*
Walnut, black—*Juglans nigra*
Willows—*Salix* spp.

Animals[b]

Bear, black—*Ursus americanus*
Deer, white-tailed—*Odocoileus virginianus*
Pigeon, passenger[c]—*Ectopistes migratorius*
Squirrel
fox—*Sciurus niger*
gray—*S. carolinensis*
red, European—*S. vulgaris*
red—*Tamiasciurus hudsonicus*
Vole, yellow-cheeked—*Microtus xanthognathus*
Wolf, timber—*Canis lupus*

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[a] Source: Mohlenbrock (1973).
[b] Source: Hoffmeister & Mohr (1972).
[c] Source: Harrison (1948).

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