ECOLOGICAL SUCCESSION IN VEGETATION AND SMALL MAMMAL POPULATION ON A NATURAL AREA OF NORTHEASTERN KANSAS

Henry S. Fitch
and
W. Dean Kettle
Department of Systematics and Ecology, Snow Hall
The University of Kansas
Lawrence, Kansas 66045

Abstract. The University of Kansas Natural History Reservation, protected since 1948, includes a variety of habitats, both woodlands and grasslands. A 3.2 ha bottom land pasture was dominated by the introduced pasture grass *Bromus inermis,* with smaller amounts of bluegrass, and various seral weeds were prominent. About 9% of the area was shaded, mainly by American elms. After 4 years of protection the grasses had increased greatly and the seral weeds were becoming much scarcer. The Prairie Vole and the Hispid Cotton Rat increased from low levels when the area was grazed to peaks in 1951 (450 voles/ha) then decreased. By 1979 woody plants were replacing the herbaceous vegetation (tree cover 56%). Grassland small mammals formerly present had disappeared entirely (Deer Mouse, Plains Harvest Mouse) or declined to very low levels (Prairie Vole, Western Harvest Mouse, Hispid Cotton Rat, Southern Bog Lemming). The White-footed Mouse, a woodland and edge species had increased, however, and outnumbered all other species combined.

Introduction

The research reported here is a small portion of a continuing study documenting the changes in plant and animal populations as influenced by natural succession on the University of Kansas Natural History Reservation (NHR). The scope of this paper is limited to the 30-year change in vegetation and small mammals on a former bottomland posture, one of the many types of habitats constituting the NHR. Since the NHR was created in 1947, Fitch and others (see literature cited) have described succession in a variety of habitats including hilltop pastures, bottomland old fields and regenerated prairie, and the natural history of numerous species found therein.

The Study Site

House Field, an irregularly shaped 3.2 ha former bottomland pasture, was our study site. The 239 ha NHR is located 10.5 km north of Lawrence, Kansas in northeastern Douglas County. In 1947 the area was set aside as a reservation where native plants and animals might be protected and studied under natural conditions. All human disturbances such as farming, ranching, logging and hunting were eliminated in 1947. No fire has swept over the area since then.

The pre-White man vegetation of the NHR was likely a combination of tallgrass prairie and hardwood forest, each predominating in areas for which it was best adapted with well-defined boundary lines separating them. House Field, a lowland with a 3-7% slope, was probably composed of tallgrass prairie. Written records of the native vegatation in this region dated from Major W. S. Long's 1819 exploring expedition and have been described in detail by Fitch (1965). House Field was probably used solely for the grazing of domestic livestock from the time of the earliest settlers, in the 1850's, until the establishment of the NHR in 1947.

The NHR, at 38°58′ latitude and 95°16′ longitude with an elevation of approximately 300 m, has a typical continental climate with large seasonal fluctuations in temperature and large monthly variations in rainfall. Weather data have been continually collected on NHR.

Methods

Vegetation. Herbaceous vegetation was sampled in mid-summer by a series of 40.5m^2 (0.01 acre) circular plots. Each plant species within a plot and its relative density (percentage vegetative cover) was recorded. Estimates were also made of percentage ground cover and average

height of vegetation. Woody vegetation was sampled using the circular plots previously described with larger trees and dense stands described by stem counts and DBH measurements.

The percentage of House Field covered by trees and brush in 1951 was determined by measuring crown diameter of existing trees. In 1964 and 1979 the forested areas were mapped and the relative cover determined by using a compensating polar planimeter.

Scientific names for species referred to by common name in the text are given in Table 1.

Table 1. Scientific names for species of plants referred to in the text by common names

Common Name	Scientific Name
Grasses	
Big bluestem	*Andropogon gerardi* Vitman
Little Bluestem	*Andropogon scoparius* Michx.
Awnless brome	*Bromus inermis* Leyss.
Japanese chess	*Bromus japonicus* Thunb.
Fowl mannagrass	*Glyceria striata* (Lam.) Hitchc
Blue grass	*Poa pratensis* L.
Seral weeds	
Ragweed	*Ambrosia artemisiifolia* L.
Composites	*Aster novae-angliae* L.,
	A. pilosus Willd.,
	Helianthus tuberosus L.,
	Solidago missourienses Nutt.,
	S. nemoralis L.
Carex	*Carex gravida blanda hyalinolepix*
Legumes	*Desmanthus illioniensis* Michx.,
	Lespedesa violacea Michx.,
	Melilotus alba Adans.,
	M. officinalis Adans.,
Germander	*Teucrium canadense* L.
Avens	*Geum canadense* Jacq.,
	G. vernum (Raf.) T. & G.
Wood nettle	*Laportea canadenses* (L.) Wedd.
Lobelia	*Lobelia siphilitica* L.
Nightshades	*Physalis heterophylla* Nees.,
	Solanum carolinense L.
Ironweed	*Vernonia baldwini* Torr.
Trees, shrubs and vines	
Grape	*Ampelopsis cordata* Michx.
Dogwood	*Cornus drummonda* Meya
Honey locust	*Gleditsia triacanthos* L.
Walnut	*Juglans nigra* L.
Red cedar	*Juniperus virginiana* L.
Osage orange	*Maclura pomifera* (Raf.) Schneid.
Virginia creeper	*Parthenocissus quinquefolia* (L.) Planch.
Crabapple	*Pyrus ioensis* (Wood) Bailey
Sumac	*Rhus aromatica* Ait.
Poison ivy	*Rhus radicans* L.
Gooseberry	*Ribes missouriense* Nutt.
Blackberry	*Rubus ostryifolius* Rydb.
Greenbriar	*Smilax bona-nox* L.
Coral berry	*Symphoricarpos orbiculatus* Moench
American elm	*Ulmus americana* L.

Small mammals. Estimates of animal populations were based primarily on live-trapping results. The live traps used were modeled after the trap described by Fitch (1952). Traps were baited with a mixture of scratch grain (cracked corn, milo and wheat) and rolled oats. Ninety traps were positioned in a grid at intervals of 15.2m. At first captured animals were individually marked by toe-clipping. The following data were recorded for each individual captured during a trapping period: location on grid, weight, total length, sex and reproductive condition. An attempt was made to trap on a monthly schedule from December 1978 through June 1980, trapping 5-7 days each month. Exceptions were made when conditions threatened animal survival. A total of 6,600 trap days were sampled in the 1978-1980 survey. It is emphasized that all methods and locations for the 1978-1980 survey were identical to those of previous years.

Scientific names for animals referred to by common name in the text are presented in Table 2.

Table 2. Scientific names for species of animals referred to in the text by common names.

Common Name	Scientific name
Short-tailed shrew	*Blarina brevicauda*
Least shrew	*Cryptotis parva*
Prairie vole	*Microtus ochrogaster*
Pine vole	*Microtus pinetorum*
House mouse	*Mus musculus*
White-footed mouse	*Peromyscus leucopus*
Deer mouse	*Peromyscus maniculatus*
Western harvest mouse	*Reithrodontomys megaletis*
Plains harvest mouse	*Reithrodontomys montanus*
Cotton rat	*Sigmodon hispidus*
Southern bog lemming	*Synaptomys cooperi*
Meadow jumping mouse	*Zapus hudsonius*

Results

In 1952 the tree canopy cover of House Field was nearly 9%. Fourteen large American elms made up 80% of this cover. Many of these elms died from Dutch elm disease (phloem necrosis resulting from attacks of bark bettles) during the early 1960's and by 1979 only 3 of these trees remained alive. The tree cover in 1964 was similar to the total coverage of 1952 but largely composed of species that were insignificant in the early years (walnut, locust, and Osage orange). The removal of the elms opened up the canopy, allowing invasion by woody and weedy species. In 1979 the canopy cover had increased to 56%, with several species making up that total.

In 1949, after grazing on the field was discontinued, the closely cropped pasture became covered with weeds and tall grasses. Common in the 1952 sample (Table 3) were ragweeds, ironweed, nightshade and American germander-all symptomatic of previous overgrazing conditions by domestic livestock. These weeds were almost entirely eliminated by 1964, outcompeted by grasses which were no longer subject to grazing pressure. Grasses made up approximately 78% of the field vegetation in 1964. By 1979 the grasses were greatly reduced due to competition and shading from trees and shrubs. However, in unforested areas grasses remained the dominant vegetation (brome makes 75% of the cover in open areas in 1980). Meanwhile small clumps of perennial tallgrasses (big and little bluestem) have become reestablished and expanded. They compete well with the herbaceous vegetation, but cannot tolerate the shade of encroaching trees.

Table 3. Percentage cover of vegetation in unforested areas and forest understory on House Field from 1952-1979.

Type of Vegetation	1952	1964	1979
Grasses			
awnless brome	60.6	72.6	34.3
Japanese chess	7.4	trace	absent
blue grass	10.9	5.3	7.4
fowl mannagrass	trace	trace	7.5
Seral weeds			
composites	trace	trace	3.8
germander	1.9	trace	trace
carex	1.9	trace	5.0
legumes	trace	trace	1.1
ironweed	2.9	trace	trace
nightshades	0.4	trace	trace
ragweeds	1.5	trace	trace
weed nettle	trace	trace	3.9
avens	trace	trace	2.1
Shrubs and vines			
sumac	trace	1.2	1.5
coral berry	5.8	2.2	13.8
poison ivy	trace	trace	1.7
miscellaneous vines	trace	trace	1.3
Trees (DBH < 2.0 cm)	trace	9.1	13.5
Miscellaneous vegetation	6.7	9.6	6.1

By 1964 many of the annual species had been replaced by perennials, such as goldenrod, which still persist in open areas. With the establishment of a maturing forest community, the field has developed a community including herbaceous species not present previously (wood nettle, avens and lobelia) and also certain woodland shrubs and vines (blackberry, gooseberry, poison ivy, Virginia creeper, grape and greenbriar).

Since any change in vegetational structure may affect the livelihood (food supply, availability of nest sites, or protective cover) of animals, it is not surprising to note changes in the densities of animal populations as well as the species composition of House Field. The mammal community of House Field has shifted from one dominated by grassland species with high population numbers to one more characteristic of shrub or forest community as seen in Table 4. For a period of years in the early 1950's, after the closely grazed pasture became dominated by grasses with the cessation of grazing, the dominant mammal was the prairie vole. Its peak population exceeded 450 individuals/ha. The cotton rat and western harvest mouse were also common. The population of these 3 species has been reduced with the invasion of trees and shrubs until today, only isolated small populations of each exist. One previously common grassland species, the deer mouse, has been completely eliminated from the field.

The most common mammal on the grid now is the white-footed mouse, which was rare in the early 1950's. Its habitat has been greatly improved with the invasion of brush and trees. The southern bog lemming first appeared on the area in the mid-1960's and has been present in low numbers ever since.

The least shrew, short-tailed shrew and meadow jumping mouse have been present throughout the 30-year study but always in very low densities. Their low population levels combined with poor bait acceptance in live traps make population estimates of these species difficult.

Table 4. Relative densities of small mammals on House Field from 1951 - 1979, with estimated densities in ( ) as animals / ha

Species	1951	1963	1979
Prairie vole	very high (370.0)	moderate	very low (2.2)
Pine vole	P[1/]	P	P
Deer mouse	high	moderate	absent
White-footed mouse	P	P	high (28.6)
Cotton rat	high (44.0)	moderate	P
Western harvest mouse	high (37.0)	moderate	very low (1.0)
Plains harvest mouse	P	absent	absent
House mouse	moderate	moderate	P
Meadow jumping mouse	P	P	P
Southern bog lemming	absent	P	P
Short-tailed shrew	P	P	P
Least shrew	P	P	P

[1/]P, present but in numbers too low to estimate.

Acknowledgements

The authors wish to thank L. Raynor for assistance in the 1979 animal trapping and especially V. Fitch for support in the field and in data synthesis.

Literature Cited

Fitch, H. S. 1952. The University of Kansas Natural History Reservation. Univ. Kansas Publ., No. 4:1-38.

_____. 1954. Seasonal acceptance of bait by small mammals. J. Mammal. 35:39-47.

_____. 1957. Aspects of reproduction and development in the prairie vole (*Microtus ochrogaster*). Univ. Kansas Publ., Mus. Nat. Hist. 10: 120-161.

_____. 1958. Natural History of the six-lined racerunner (*Cnemidophorus sexlineatus*). Univ. Kansas Publ., Mus. Nat. Hist., 11:11-62.

_____. 1958. Home ranges, territories and seasonal movements in vertebrates of the Reservation. Univ. Kansas Publ., Mus. Nat. Hist., 11:63-326.

_____. 1963. Natural history of the black rat snake (*Elaphe obsoleta*) in Kansas. Copeia, 1963:649-658.

_____. 1978. A field study of the prairie kingsnake (*Lampropeltis calligaster*). Trans. Kansas Acad. Sci. 84:353-363.

Fitch, H. S. and R. L. McGregor. 1956. The forest habitat of the University of Kansas Natural History Reservation. Univ. Kansas Publ. Mus. Nat. Hist., 10:77-127.

Fitch, H. S. and H. W. Shirer. 1970. Comparison from radiotracking of movements and denning habits of the raccoon, striped skunk, and opossum in northeastern Kansas. J. Mamm., 51: 491-503.

Fitch, H. S. and P. L. VonAchen. 1973. Yellow-billed cuckoo nesting at University of Kansas Natural History Reservation. Kansas Ornithol. Soc. Bull. 24:12-15.

Gaines, M. S. and R. K. Rose, 1976. Population dynamics of *Microtus ochrogaster* in eastern Kansas. Ecology 57:1145-1161.

Martin, E. P. 1956. A population study of the prairie vole (*Microtus ochrogaster*). Univ. Kansas Publ. Nat. Hist., 8:366-416.

Table 4. Relative densities of small mammals on House Field from 1951 - 1979, with estimated densities in ( ) as animals / ha

Species	1951	1963	1979
Prairie vole	very high (370.0)	moderate	very low (2.2)
Pine vole	P[1]	P	P
Deer mouse	high	moderate	absent
White-footed mouse	P	P	high (28.6)
Cotton rat	high (44.0)	moderate	P
Western harvest mouse	high (37.0)	moderate	very low (1.0)
Plains harvest mouse	P	absent	absent
House mouse	moderate	moderate	P
Meadow jumping mouse	P	P	P
Southern bog lemming	absent	P	P
Short-tailed shrew	P	P	P
Least shrew	P	P	P

[1]P, present but in numbers too low to estimate.

Acknowledgements

The authors wish to thank L. Raynor for assistance in the 1979 animal trapping and especially V. Fitch for support in the field and in data synthesis.

Literature Cited

Fitch, H. S. 1952. The University of Kansas Natural History Reservation. Univ. Kansas Publ., No. 4:1-30.

_____ 1954. Seasonal acceptance of bait by small mammals. J. Mammal. 35:39-47.

_____ 1957. Aspects of reproduction and development in the prairie vole (*Microtus ochrogaster*). Univ. Kansas Publ., Mus. Nat. Hist. 10: 129-161.

_____ 1958. Natural History of the six-lined racerunner (*Cnemidophorus sexlineatus*). Univ. Kansas Publ., Mus. Nat. Hist., 11:11-62.

_____ 1958. Home ranges, territories and seasonal movements in vertebrates of the Reservation. Univ. Kansas Publ., Mus. Nat. Hist., 11:63-326.