Proceedings of the Iowa Academy of Science

Volume 88 | Number Article 11

1981

Iowa's Mammal Fauna: An Era of Decline

John B. Bowles
Central College

Proc. Iowa Acad. Sci. 88(1):38-42, 1981

Iowa's Mammal Fauna: An Era of Decline[1]

JOHN B. BOWLES

Central College, Pella, Iowa 50219

Of the 70 species of mammals reported from Iowa since European settlement, 39 (55%) are extirpated, rare, or declining. Twenty-nine (42%) are not appreciably declining and 2 (3%) are increasing in number and distribution. Continued pressure to clear and row-crop as much land as possible is placing an increasing stress on the mammals of Iowa.
INDEX DESCRIPTORS: Mammals, Iowa

The present distributional patterns of native Iowan mammals are the result of their biogeographic affinities, availability of suitable habitat, and effects of direct and indirect human interference. Because of the geological and topographical features of the state and the ecotonal nature of the natural vegetation (tall-grass prairie — deciduous forest interface), there are no clear biotic provinces in Iowa similar to those of western mountainous states. Additionally, with the cultivation of native grasslands, clearing of deciduous forests, and introduction of exotic plant species in virtually the entire state, biotic communities today are difficult to identify and categorize. Most grassy habitats, for example, consist primarily of brome (*Bromus inermis*) or bluegrass (*Poa pratenses*) or combinations of these with other introduced and native species. It is of interest, therefore, that most native mammals, of both western grassland and eastern deciduous forest biogeographic associations, have continued to exist within a state that has so high a percentage of land under intensive cultivation.

This paper presents past changes and current trends in mammal distribution in Iowa based primarily on published records summarized by Bowles (1971, 1975), unless otherwise indicated (table 1). In order to focus attention on recent effects of man on species distribution and abundance in Iowa, I have grouped the mammals according to those whose status is primarily affected either directly (e.g., hunted or trapped now or in the past) or indirectly (e.g., habitat loss). Furthermore, distribution and abundance of the latter depend primarily on amount and condition of suitable habitat. For them I have emphasized the biogeographic association (i.e., western grassland, eastern deciduous forest, northern boreal, southern, and widespread) as presented by Bowles (1975).

SPECIES DIRECTLY AFFECTED BY RECENT ACTIVITIES OF MAN

Unrestricted fur trade involving European man resulted in early pressure on mammals and, as a consequence of such trapping, beaver and otter, which had been common, all but disappeared from Iowa by the early 1900's. The beaver, with protection and reintroduction, is again found throughout the state. Likewise, the otter, under protection, has increased in the Mississippi River and, to a lesser extent, the Missouri, but few are reported to have returned inland. Recent sightings of a pair on the Swiss Valley Nature Preserve, Dubuque County, are encouraging (R. Walton, Swiss Valley Nat. Pres., pers. comm.).

Throughout early settlement, there also were no restrictions on hunting, thus the wapiti, white-tailed deer, and bison were sharply reduced in number or extirpated by the late 1800's. During winter blizzards, wapiti were slaughtered and brought to extinction in central Iowa in 1855-57 and northwestern counties in 1870-71. Similarly, white-tailed deer were extirpated in southeastern counties in 1848-49, central and northeastern Iowa in 1855-57, and the northwestern corner in 1880-81, thus few remained in the state by 1900. Subsequent protection and reintroduction by the Iowa Conservation Commission, however, returned the deer to their present high population level. On the other hand, while there are no accounts of a similar slaughter of large numbers of bison, the last of that species in Iowa was reported from Dickinson County in 1870.

Other large mammals probably were killed for a variety of reasons (including fur, food, and fear) but there are few documented early records and no historical evidence of exact cause of their decline. The gray wolf was last reported in Butler County in the winter of 1884-85, and the mountain lion was gone by 1870. Since then, no records of either have been authenticated. Likewise, there have been past and recent reports of such northern species as porcupine, fisher, wolverine, and lynx in Iowa and the pronghorn was found in extreme western counties in the early 1800's. Although the black bear disappeared from the state by the the mid-1800's, one was killed in Cedar County in 1965. Subsequently, a mother and cub were reported in Winneshiek County in the early 1970's (Bowles, 1975) and another from Dubuque County in 1979 (Des Moines Register, 13 November 1979). Additionally, mule deer, absent by 1900, now are seen occasionally in western counties. Even a few moose, new to the state mammal list, recently wandered in from the north and a bull crossed Iowa and entered northeastern Missouri. This moose entered Iowa in the fall of 1976, spent a year near Emmetsburg, Palo Alto County, then moved southeast and into Missouri in December 1977 (Bowles and Gladfelter, 1980).

Several species, however, have remained abundant despite continued hunting and/or trapping, primarily because of protection and/or management. These include the opossum (not abundant until early 1900's), eastern cottontail, woodchuck, fox squirrel, muskrat, red fox, raccoon, mink, and striped skunk. The coyote, to the contrary, was reduced in number by the 1870's, but has increased throughout Iowa in recent years, perhaps competing with the red fox for food (R.D. Andrews, Iowa Cons. Comm., pers. comm.). Such increase probably reflects cessation of eradication programs, inherent reproductive capacity, and ability to adjust to human activities. Of course, with an increase in coyote population have come efforts to reinstitute control measures despite evidence that a high percentage of domestic animal predation in Iowa is from dogs (Boggess et al., 1978). Likewise, badger numbers have increased following the drastic reduction in the 1800's (caused by poisoning of burrowing rodents) and now are statewide in distribution. However, population trends of this species in Iowa are not well documented although Lampe (Buena Vista College, unpub.) currently is investigating aspects of its biology. Despite apparently stable populations of all such game mammals, it is significant that current high world fur prices are responsible for enough trapping pressure to warrant concern (Des Moines Register, 8 March 1980). Nevertheless, it is

[1]Based on a contribution to the symposium "Perspectives on Iowa's Declining Flora and Fauna" held at the 92nd session of the Iowa Academy of Science, 18 April 1980.

Table 1. *Checklist of mammals of Iowa with estimated trends and biogeographic associations. Key to symbols: Ex = extirpated, En = endangered, Th = threatened, X = undetermined, D = declining, U = unchanged, I = increasing, + =* status different than Roosa (1977), * - *see Diersing (1980) for name change,* ** - *under taxonomic revision (includes* brevicauda, carolinensis, kirtlandii*), W = western grassland, N = northern boreal, E = eastern deciduous forest, S = southern, Wi = widespread, In = introduced.*

Order Marsupialia Family Didelphidae		
Didelphis virginiana Kerr, Virginia opossum	U	E
Order Insectivora Family Soricidae		
Sorex cinereus Kerr, masked shrew	U	N
**Sorex hoyi* Baird, pygmy shrew	X	N
***Blarina brevicauda* (Say), short-tailed shrew	U	E
Cryptotis parva (Say), least shrew	X	E
Family Talpidae		
Scalopus aquaticus (Linnaeus), eastern mole	U	E
Order Chiroptera Family Vespertilionidae		
Myotis keenii (Merriam), Keen's myotis	Th	E
Myotis lucifugus (Le Conte), little brown bat	D	Wi
Myotis sodalis Miller and G.M. Allen, Indiana bat	En	E
Lasionycteris noctivagans (Le Conte), silver-haired bat	D	Wi
Pipistrellus subflavus (F. Cuvier), eastern pipistrelle	D	E
Eptesicus fuscus (Palisot de Beauvois), big brown bat	U	Wi
Lasiurus borealis (Müller), red bat	D	E
Lasiurus cinereus (Palisot de Beauvois), hoary bat	D	Wi
Nycticeius humeralis (Rafinesque), evening bat	Th	E
Family Molossidae		
Tadarida macrotis (Gray), big free-tailed bat	Ex	S
Order Lagomorpha Family Leporidae		
Sylvilagus floridanus (J.A. Allen), eastern cottentail	U	E
Lepus townsendii Backman, white-tailed jack rabbit	D	W
Order Rodentia Family Sciuridae		
Tamias striatus (Linnaeus), eastern chipmunk	U	E
Marmota monax (Linnaeus), woodchuck	U	E
Spermophilus franklinii (Sabine), Franklin's ground squirrel	D	W
S. richardsonii (Sabine), Richardson's ground squirrel	+X	W
S. tridecemlineatus (Mitchell), 13-lined ground squirrel	U	W
Sciurus carolinenesis Gmelin, gray squirrel	D	E
Sciurus niger Linnaeus, fox squirrel	U	E
Tamiasciurus hudsonicus (Erxleben), red squirrel	U	E
Glaucomys volans (Linnaeus), flying squirrel	D	E
Family Geomyidae		
Geomys bursarius (Shaw), plains pocket gopher	U	W
Family Heteromyidae		
Perognathus flavescens Merriam, plains pocket mouse	En	W
Family Castoridae		
Castor canadensis Kuhl, beaver	U	Wi
Family Cricetidae		
Reithrodontomys megalotis (Baird), western harvest mouse	U	W
Peromyscus leucopus (Rafinesque), white-footed mouse	U	E
Peromyscus maniculatus (Wagner), deer mouse	U	Wi
Onychomys leucogaster (Wied-Neuwied), northern grasshopper mouse	En	W
Sigmodon hispidus Say and Ord, hispid cotton rat	+X	S
Clethrionomys gapperi (Vigors), red-backed vole	En	N
Synaptomys cooperi Baird, southern bog lemming	D	N
Microtus ochrogaster (Wagner), prairie vole	D	W
Microtus pennsylvanicus (Ord), meadow vole	I	N
Microtus pinetorum (Le Conte), woodland vole	En	E
Ondatra zibethicus (Linnaeus), muskrat	U	Wi
Family Muridae		
Mus musculus Linnaeus, house mouse	U	In
Rattus norvegicus (Berkenhout), Norway rat	U	In
Family Zapodidae		
Zapus hudsonius (Zimmermann), meadow jumping mouse	U	N
Family Erethizontidae		
Erethizon dorsatum (Linnaeus), porcupine	Ex	Wi
Order Carnivora Family Canidae		
Canis latrans Say, coyote	I	Wi
Canis lupus Linnaeus, gray wolf	Ex	Wi
Vulpes vulpes (Linnaeus), red fox	U	Wi
Urocyon cinereoargenteus (Schreber), gray fox	D	E
Ursus americanus Pallas, black bear	En	Wi
Family Procyonidae		
Procyon lotor (Linnaeus), raccoon	U	Wi
Family Mustelidae		
Martes pennanti (Erxleben), fisher	Ex	N
Mustela erminea Linnaeus, ermine	X	N
Mustela frenata Lichtenstein, long-tailed weasel	X	Wi
Mustela nivalis Linnaeus, least weasel	U	N
Mustela vison Schreber, mink	U	Wi
Gulo gulo (Linnaeus), wolverine	Ex	N
Taxidea taxus (Schreber), badger	U	Wi
Spilogale putorius (Linnaeus), spotted skunk	X	W
Mephitis mephitis (Schreber), striped skunk	U	Wi
Lutra canadensis (Schreber), river otter	Th	Wi
Family Felidae		
Felis concolor Linnaeus, mountain lion	Ex	Wi
Lynx canadensis (Schreber), lynx	Ex	N
Lynx rufus (Schreber), bobcat	En	Wi
Order Artiodactyla Family Cervidae		
Cervus elaphus Erxleben, wapiti	Ex	Wi
Odocoileus hemionus (Rafinesque), mule deer	U	Wi
Odocoileus virginianus (Zimmermann), white tailed deer	U	Wi
Alces alces (Clinton), moose	+X	N
Family Antilocapridae		
Antilocapra americana (Ord), pronghorn	Ex	Wi
Family Bovidae		
Bison bison (Linnaeus), bison	Ex	Wi

gratifying that some game species, at least, are protected and can be managed so as to guarantee their continued existence.

The status of other mammals hunted and/or trapped in the state is less well understood and some species may be in danger of extirpation in all or parts of their ranges. The gray squirrel, for example, locally common in eastern Iowa, is rare or absent in most of the remainder of the state. Likewise, the white-tailed jack rabbit, once at least fairly common in the grasslands of the northwestern and central parts of Iowa, has declined markedly in those areas and now rarely is seen in eastern and southern counties (J.B. Wooley, Iowa Cons. Comm., pers. comm.). For both of the above species, current habitat loss (timber and grassland, respectively) now may be the primary factor limiting distribution and abundance. Additionally, populations of gray fox, ermine, and long-tailed weasel may be stable now (R.D. Andrews, Iowa Cons.

comm., pers. comm.), but their current status is not well documented and, with the loss of timber and brush, these species could decline precipitously.

The two carnivores that now may be in the most danger of extirpation are the spotted skunk and the bobcat. The former was limited to the tall-grass prairie of northwestern Iowa at the time of settlement but spread eastward, probably in response to agricultural changes. As recently as 1953, the spotted skunk was reported as common in a statewide survey conducted by the Iowa Conservation Commission. Subsequently, however, this species declined rapidly and, inspite of recent reports from Winnebago County (Norland, 1978), Poweshiek County (D. Koenig, Poweshiek County Cons. Board, pers. comm.), Dubuque County (R. Walton, Swiss Valley Nat. Pres., pers. comm.), and Washington County (Bowles, unpub.), its status remains undetermined (Roosa, 1977). With the bobcat, however, despite rumors, I know of no documented published sightings in Iowa since 1975 (Central City, Linn County, Des Moines Register, 26 September 1975). A recent sighting of this species on the Swiss Valley Nature Preserve and adjacent areas in Dubuque County (R. Walton, Swiss Valley Nat. Pres., pers. comm.), is evidence that at least a few remain in the state. Every effort should be made to determine the current status of both the spotted skunk and the bobcat in Iowa in order to take steps necessary to reverse their population decline.

SPECIES INDIRECTLY AFFECTED BY RECENT HUMAN ACTIVITIES

While most, if not all, small mammals present in Iowa prior to arrival of European man probably are extant, data on changes in distribution and abundance are meager, at best. Small mammals generally are dependent on appropriate plant communities and, with the decline of natural vegetation (primarily tall-grass prairie and deciduous forest), many have become locally restricted to ever diminishing areas of suitable habitat.

Of the 7 species of small mammals associated with the interior grasslands of North America, the northern grasshopper mouse and plains pocket mouse, appear to be the most limited, being found primarily in grasslands of western counties. An extant population of the latter in Muscatine County (Christiansen and Sanz, 1978), however, suggests that this species may exist locally throughout most of the state. Both of these mammals were considered endangered by Roosa (1977) and there are efforts to document present distribution and abundance in western counties, especially in the loess hills (Bowles, unpub.). A recent study of the grasshopper mouse in Buena Vista County (Lampe, Buena Vista College, unpub.) indicated preference for cropland for agricultural habitat rather than fencerows or road ditches. The prairie vole, however, although not endangered, may have been more abundant throughout Iowa prior to intensive cultivation of land. This vole now is scarce and/or restricted in northern and central counties, being confined primarily to fairly xeric conditions such as railroad rights-of-way (Braband, 1979), abandonned strip-mines (Voight and Glenn-Lewin, 1979), and dry lake shore (Heideman et al., in prep.). The prairie vole was less common than the meadow vole in recent collections from southern counties (R.R. George, Iowa Cons. Comm., unpub.), but equal to or more common than the latter in western Iowa (Bowles, 1977; unpub.). To the contrary, 2 grassland species (western harvest mouse and thirteen-lined ground squirrel) increased in Iowa after settlement with eastward expansion of short-grass habitat. Efforts to eradicate the ground squirrel, along with the abundant plains pocket gopher, were attempted in the past and continue to some extent at present, although neither appears to be appreciably affected. However, the larger Franklin's ground squirrel probably has declined recently with loss of significant areas of tall-grass habitat. It is also worthy to note that Richardson's ground squirrel recently was found in northern Iowa but its statewide status is yet undetermined (Lampe et al., in prep).

There are 8 small mammals of boreal origin present in Iowa, only 2 of which were considered by Roosa (1977) to be endangered. Of those endangered, the pygmy shrew is known from two specimens taken in Clay County in 1938 and the red-backed vole only from Pilot Knob State Park (Hancock County) and a few adjacent locations but suitable habitat for the vole outside the park has declined in recent years. On the other hand, populations of the red squirrel (north-central counties) plus the masked shrew and meadow jumping mouse (both state-wide) apparently are stable. Two boreal species, however, the meadow vole and least weasel, may be more abundant in Iowa now than in the past. Recent records of the meadow vole in northwestern Missouri have extended the known range southward (Easterla, 1977). Of the boreal mammals, the status of the southern bog lemming is the least understood. Despite its lack of inclusion on the state endangered list of mammals, this species is scarce and probably declining. In the last 5 years, for example, few were taken in western counties (Bowles, 1977; and unpub.) and the only recent records in south-central Iowa were from owl pellets (Voight and Glenn-Lewin, 1979; Bowles, unpub.) despite increased trapping efforts in those areas.

Of the 7 small mammals associated with the deciduous forest (exclusive of bats), only the woodland vole was considered endangered (Roosa, 1977) and I know of only 3 documented extant populations — Waubonsie State Park, Fremont County (Bowles, 1977), Brushy Creek Recreation Area, Webster County (Wilson, 1981), and southeastern Allamakee County (J. Bednarz, Iowa State Univ., pers. comm.). Undoubtedly, loss of undisturbed deciduous forest has restricted this species. Likewise, forest habitat loss has caused a reduction and local disappearance of the chipmunk and flying squirrel, especially in the western half of Iowa. The latter is scarce in much of Iowa except in timbered areas of eastern counties. Additionally, the least shrew is restricted locally and has been reported from only a few localities. Recent records (Bowles, unpub.) of this shrew from western (Monona) and southern (Lucas) counties, plus those from Marion County (Voight and Glenn-Lewin, 1978; 1979) attest to continued existence although its status in the state remains undetermined (Roosa, 1977). On the other hand, 3 small mammals of the eastern deciduous forest are common throughout Iowa despite intensive agriculture. Of these, only the white-footed mouse is commonly taken in agricultural fields as well as brush and timber. The eastern mole is more restricted, being found less frequently in intensely cultivated fields while the short-tailed shrew is known from nearly all habitats in Iowa. However, taxonomy of the latter currently is under investigation and, while 2 forms are well-documented in the state, a third also may be present in southwestern Iowa (J.R. Choate, Ft. Hays State Univ., pers. comm.). Thjus it will be necessary to review the distributional status of each of the forms present in Iowa when the study is completed.

Excluding bats, there is a single species each of wide-spread and of southern biogeographical associations. The wide-spread deer mouse, is common throughout the state, especially in grassy habitat. Additionally, the deer mouse is the earliest reinvader of certain highly disturbed areas, e.g., strip-mines (Voight and Glenn-Lewin, 1979) and recently flooded lake shore (Heideman et al., in prep.). On the other hand, the cotton rat, which extended its range northward recently, still is known only from the owl pellet record in southwestern Iowa despite increased trapping for this species (Bowles, 1977).

There are 10 species of bats reported from Iowa. Of these, only the big free-tailed bat was considered to be extirpated by Roosa (1977) as it is known only from 2 early records. Seven of the bats, while locally numerous, are associated with wooded areas, hence any reduction in such habitat is likely to decrease most populations. In summer, the red, hoary, and silver-haired bats are known to utilize trees and still are

Table 2. *Summary of current status of mammals of Iowa according to to biogeographic association (see table 1 for key to symbols). Parentheses denote numbers of species primarily affected directly by man, without indicates species primarily affectely by habitat loss.*

	Ex	En	Th	X	D	U	I	Tot
Grassland	—	2	—	1(1)	2(1)	3	—	10
Boreal	(3)	1	—	1(2)	1	4	1	13
Deciduous forest	—	2	2	1	3(1)	4(5)	—	18
Southern	1	—	—	1	—	—	—	2
Widespread	(6)	(2)	(1)	(1)	3	2(9)	(1)	25
Introduced	—	—	—	—	—	2	—	2
Totals	1(9)=10	5(2)=7	2(1)=3	4(4)=8	9(2)=11	15(14)=29	1(1)=2	70
	14%	10%	4%	11%	16%	42%	3%	
	14%	41%				45%		

common where there is sufficient woodland. On the other hand, less is known about the habits of the evening bat, Keen's myotis, and eastern pipistrelle in Iowa. The evening bat, considered "threatened" by Roosa (1977), is known to utilize both buildings and trees as roost sites and forage in wooded areas with other bats. The available information about the Keen's myotis (also "threatened", Roosa, 1977) from Iowa and Missouri (Kunz, 1973; Caire et al., 1979, respectively), suggests that while most summer activities are associated with wooded habitat, it may also utilize caves (LaVal et al., 1977), along with the eastern pipistrelle. Likewise, the summer biology of the federally endangered Indiana bat is poorly known. Pregnant females and flying juveniles recently were captured in wooded watersheds in south-central Iowa, habitat similar to that in Indiana where small maternity colonies were found in riparian habitats (Humphrey et al., 1977). Furthermore, the capture of a banded pregnant Indiana bat in Marion County (banded at Pilot Knob Mine, Iron County, Missouri) suggests that females from Missouri winter hibernacula migrate into southern Iowa (and probably Illinois) to establish summer maternity colonies (LaVal and LaVal, 1980).

The two remaining bats are found throughout much of North America, including Iowa. The big brown bat is common throughout the state all year and, along with the little brown bat, frequently establishes roosts in both natural structures (e.g., caves, trees) as well as those associated with humans. The latter species, however, may be less common in summer in some parts of Iowa now than in the past with the loss of potential sites for maternity colonies, both man-made structures (e.g., old buildings and wooden bridges) and woodlands. Both species overwinter in caves and mines in eastern Iowa, as well as to the south, but only the big brown bat hibernates in buildings throughout the state.

Aside from domestic species, only 2 introduced mammals, the house mouse and Norway rat, have become established in Iowa and both are commonly associated with human habitation.

DISCUSSION

Of the 70 species of mammals reported from Iowa, including the 2 introduced established rodents and treating the short-tailed shrew complex as one, 39 (55%) of those known to have existed in Iowa since settlement by European man now appear to be either extirpated, rare, or undergoing at least some decrease in population and distribution (table 2). Whereas early pressure on many of these species was from trapping or hunting, recent declines are most likely due to loss of suitable habitat. Of those species declining, 10 presently are on the state list of endangered and threatened species. On the other hand, 31 species (45%) appear to have stable or increasing populations but nearly half (13) of these mammals are protected and managed as game species by the Iowa Conservation Commission.

Continued pressure to clear and row-crop as much land as possible (with consequent loss of timber and brush, as well as fence-rows) places an increasing stress on the native flora and fauna. To the contrary, creation of soil stabilization structures and seeded waterways, along with some recent shift to native grasses in pastures has created additional habitat for some grassland mammals. Likewise, steps to purchase and maintain some unique habitats under the State Preserves System and Iowa Conservation Commission are commendable but minimal.

Unfortunately, Iowa neither established a Biological Survey similar to those in adjacent states nor encouraged the state universities to conduct systematic surveys in order to determine the status of various plants and animals on a state-wide basis. Hence, current status reports concerning many species, plus the increasing number of environmental impact statements, are, at best, based on limited and generally incomplete data. Furthermore, while it is easy to focus attention on endangered species (Roosa, 1977), especially when the federal government requires such action, other species, presumed to be common, may acturally be on the decline. Unless Iowa pays serious attention to its rapidly diminishing natural habitats, its unique blend of flora and fauna (with elements from western grassland plus boreal and eastern deciduous forests) will be lost forever.

REFERENCES

BOGGESS, E.K., R.D. ANDREWS, and R.A. BISHOP. 1978. Domestic animal losses to coyotes and dogs in Iowa. J. Wildl. Manage. 42:362-372.

BOWLES, J.B. 1971. Historical records of some Iowan mammals. Trans. Kansas Acad. Sci. 73:419-430.

BOWLES, J.B. 1975. Distribution and biogeography of mammals of Iowa. Spec. Publ. No. 9, The Museum, Texas Tech Univ. 184 pp.

BOWLES, J.B. 1977. Update of mammals of Fremont County. Iowa Bird Life 7:138-140.

BOWLES, J.B., and H.L. GLADFELTER. 1980. Recent movements of moose south of the traditional range in the Upper Midwest. Proc. Iowa Acad. Sci. 87:124-125.

BRABAND, L.A. 1979. Railroad right-of-ways as wildlife habitat in Story County, Iowa. Unpubl. MS thesis, Iowa State Univ. Iv + 116 pp.

CHRISTIANSEN, J.L., and R.C. SANZ. 1978. A notable range extension for the plains pocket mouse *Perognathus flavescens perniger* Osgood, in Iowa. Iowa Acad. Sci. 85(3):97-98.

CAIRE, W., R.K. LA VAL, and R.L. CLAWSON. 1979. Notes on the ecology of *Myotis keenii* (Chiroptera, Vespertilionidae) in eastern Missouri. Amer. Midl. Nat. 102:404-407.

DIERSING, V.E. 1980. Sytematics and evolution of the pygmy shrews (subgenus *Microsorex*) of North America. J. Mamm. 61:76-101.

EASTERLA, D.A. 1977. The masked shrew and meadow vole in Missouri. Northwest Missouri State Univ. Studies 37:1-25.

HUMPHREY, S.R., A.R. RICHTER, and J.B. COPE. 1977. Summer habitat and ecology of the endangered Indiana bat, *Myotis sodalis*. J. Mamm. 58:334-346.

KUNZ, T.H. 1973. Resource utilization; temporal and spacial components of bat activity in central Iowa. J. Mamm. 54(2):14-32.

LA VAL, R.K., R.L. CLAWSON, M.L. LA VAL, and W. CAIRE. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species, *Myotis griscens* and *Myotis sodalis*. J. Mamm., 58:592-599.

LA VAL R.K., and M.L. LA VAL. 1980 Ecological studies and management of Missouri bats with emphasis on cave-dwelling species. Missouri Dept. Conserv. Terestrial Serv. no. 8. Ii + 53pp.

NORLAND, J. 1978. Predator removal on Harmon Lake. Mimeo. Rept., Iowa Conservation Commission.

ROOSA, D. 1977. Endangered and threatened mammals of Iowa. Spec. Rept. Iowa Preserves Board No. 2. 21 pp.

VOIGHT, J., and D.C. GLENN-LEWIN. 1978. Prey availability and prey taken by long-eared owls in Iowa. Amer. Mid. Nat. 99:162-171.

___. 1979. Strip mining, *Peromyscus* and other small mammals in southern Iowa. Proc. Iowa Acad. Sci. 86:133-136.

WILSON, N. 1981. Inventory of the mammalian and avian fauna of the Brushy Creek Recreation Area, Webster County. Mimeo. Rept., Univ. Northern Iowa. 61 pp.