

Small Mammal Survey of Upland Sand Habitats at the Savanna Army Depot, Carroll and Jo Daviess Counties, Illinois

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ABSTRACT

Nine species of small mammals were captured in a live-trapping survey conducted in sand prairie, sand savanna, and sand forest habitats at the Savanna Army Depot in northwestern Illinois. The Savanna Army Depot contains the largest contiguous expanse of sand prairie and sand savanna in Illinois and will be managed by the U.S. Fish and Wildlife Service and Illinois Department of Natural Resources. The survey was designed to collect baseline data on small mammals in the Depot's upland habitats and establish sites for monitoring small mammal populations following management. Small mammal numbers were high at all sites, but species richness varied considerably among habitat types and sites. Two or three species were trapped in sand savannas and sand forests, but species richness ranged from two to eight at sand prairie sites. Species richness was highest in sand prairie with dense herbaceous cover.

INTRODUCTION

The Savanna Army Depot (SAD) was established in 1917 along the Mississippi River in Carroll and Jo Daviess counties in northwestern Illinois. Until its closure under the Base Realignment and Closure Act the Depot was used primarily for munitions storage. The site covers 5,288 ha (13,062 a). More than 3,600 ha (9,000 a) of the Depot will be incorporated into the Upper Mississippi River National Wildlife and Fish Refuge and named the Lost Mound Unit. The U.S. Fish and Wildlife Service will manage the Lost Mound Unit cooperatively with the Illinois Department of Natural Resources (IDNR). An additional 120 ha (300 a) tract of land at the Depot is being transferred to the IDNR.

The SAD is recognized as a statewide significant natural area in the Illinois Natural Areas Inventory (IDNR Division of Natural Heritage). Uplands on the Depot lie within the Mississippi River Section of the Illinois River and Mississippi River Sand Areas Natural Division of Illinois (Schwegman 1973) and consist of a sand terrace nearly 19 km (12 mi) long. These uplands support the largest contiguous remnant of native sand prairie and sand savanna in Illinois (Robertson et al. 1997). The Army's main form of habitat management at the SAD was intensive cattle grazing to keep the vegetation short and minimize the risk of wildfire.

A small mammal survey at the SAD during 1994 employed snap traps in single transects in grazed and ungrazed sand prairie, grazed sand savanna, and ungrazed sand forest and documented the presence of eight species (Anderson et al. 1994). During that survey more species and individuals were trapped on the ungrazed prairie transect than in grazed prairie. Fewer cattle were placed on the Depot during 1998 and 1999 than during previous years and grazing was discontinued in 2000 (Bob Speaker, SAD Engineering Resource Management Specialist, pers. comm.). Our survey was conducted during September and October 2000 with objectives of (1) providing baseline data on small mammal populations at the SAD following the change in grazing pressure and (2) selecting sites for permanent transects for future monitoring after habitat management practices have been implemented. The survey was confined to upland habitats, with transects established in sand prairie, sand savanna, and sand forest.

STUDY AREA

The upland plant communities at the SAD are on an extensive sand terrace that has a northwest to southeast orientation and is nearly 19 km (12 mi) long and up to 2.7 km (1.7 mi) wide; they are described in detail by Robertson et al. 1997. Along the Mississippi River the sand has formed high dunes, but the rest of the terrace has gently rolling topography. The sand was originally deposited by glacial melt waters and spread over a wide area by prevailing west winds (Schwegman 1973). The most prevalent community is dry-mesic sand prairie (Robertson et al. 1997), much of which is located within a complex of munitions bunkers and storage buildings that includes more than 40 parallel roads spaced mostly at 150-m intervals. The prairie is dominated by little bluestem (*Schizachyrium scoparium*), but also contains substantial amounts of Indian grass (*Sorghastrum nutans*), June grass (*Koeleria macrantha*), sand dropseed (*Sporobolus cryptandrus*), porcupine grass (*Stipa spartea*), and non-native Kentucky bluegrass (*Poa pratensis*). Three-awn grass (*Aristida tuberculosa*) and hairy panic grass (*Panicum villosissimum*) tend to be dominant in drier areas with larger patches of bare sand. The shrubs redroot (*Ceanothus herbaceus*) and sand fragrant sumac (*Rhus aromatica* var. *arenaria*) occur throughout the prairie.

Dry or dry-mesic sand savanna occurs on dunes along the Mississippi River and in the northern part of the bunker complex. The sand savannas contain prairie vegetation with an open overstory of black oak (*Quercus velutina*) and occasional green ash (*Fraxinus pennsylvanica*). Lack of fire has allowed considerable encroachment of fire-intolerant species such as black cherry (*Prunus serotina*), honey locust (*Gleditsia triacanthos*), and red cedar (*Juniperus virginiana*). Dry sand forest occurs on the river dunes, dry-mesic sand forest mostly in the northern part of the Depot. The dry sand forest is dominated by black oak, but white oak (*Q. alba*) is important in dry-mesic sand forest. The forests also contain northern red and bur oak (*Q. rubra* and *Q. macrocarpa*), several species of hickory (*Carya*), black walnut (*Juglans nigra*), black cherry, green ash, and black locust (*Robinia pseudoacacia*).

METHODS

We established trap sites at ten locations on the SAD: six in sand prairie, two in sand savannas, and in two sand forests (Figure 1). One hundred folding, aluminum Sherman live traps (8 x 9 x 23 cm) were used at each site. Traps were spaced at approximately 10-m intervals and positioned so as to increase the chance of capturing an animal, e.g. next to a log or tree, or in a runway. At most sites traps were placed in a single line, but in two cases the size of the habitat patch precluded this. In Beaty Creek woods two roughly parallel lines of 50 traps were established and at the F800/F1200 savanna site rows of 46 and 54 traps were placed in two parts of the savanna (Figure 1). Traps were baited with millet, black oil sunflower seeds, cracked corn, wheat, and safflower seeds (Garver No Waste Mix) supplemented with striped sunflower seeds. During October we placed a ball of polyester fiberfill (batting) in each trap to protect animals from hypothermia. Trapping was conducted for three consecutive nights at each site. We checked the traps each morning and rebaited or reset them as necessary. Because we could not trap all sites simultaneously, temperature, precipitation, and the amount of moonlight, all of which can affect the activity (and, therefore, trappability) of small mammals (Call 1986), varied somewhat. However, trapping was conducted during three weeks in autumn when temperatures were similar and the moon was not full (see below).

To the extent possible, we recorded the following information for each individual: species, sex, age, reproductive condition, and weight. The sex of shrews usually cannot be determined by external examination. The position of the testes (either abdominal or scrotal) was recorded as a general indicator of the reproductive status of male rodents. Females were classified as reproductively active if they had an open vulva, were pregnant (as determined visually or by gentle palpation of the abdomen), or showed evidence of recent lactation (based on examination of the teats). Juvenile mice were identified by their juvenal pelage; juvenile and subadult voles were distinguished from adults by weight (Getz et al. 1979). Animals were weighed to the nearest 0.5 gram with a Pesola scale. To determine the number of individuals of each species trapped at a site, every animal captured on the first or second morning of a trapping session was marked temporarily by clipping a small patch of fur on its flank. Thus, it was possible to distinguish individuals that were recaptured from those that were caught for the first time. Animals were released at the trap location after examination.

We surveyed River-edge woods, F100 prairie, G-area prairie, and Beaty Creek woods on the nights of 28-30 September 2000. Overnight low temperatures during the trapping session increased from 5°C to 10.6°C at nearby Mt. Carroll, Illinois (Midwestern Regional Climate Center, Illinois State Water Survey). There was no precipitation and a waxing crescent moon. We trapped the E1200 prairie, E1700 prairie, and F800/F1200 savanna sites on the nights of 17-19 October 2000. Overnight low temperatures at the Depot increased over the period from about 5°C to 12°C. No precipitation occurred and there was a waning gibbous moon. River dune savanna, Whitton gate prairie, and E800 prairie were surveyed on the nights of 23-25 October 2000. The minimum temperature at the Depot was about 15°C for the first and third nights of the session and about 13°C on the second night. The moon was in the waning crescent phase, but the skies were cloudy or partly cloudy each night.

RESULTS

We had 886 captures of small mammals in 2998 trap-nights (one trap-night = one trap set for one night) during this survey. This represented an overall trapping success ([number of captures/number of trap-nights] x 100) of 29.5%. We captured nine species: northern short-tailed shrew (*Blarina brevicauda*), masked shrew (*Sorex cinereus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), western harvest mouse (*Reithrodontomys megalotis*), deer mouse (*Peromyscus maniculatus*), white-footed mouse (*P. leucopus*), prairie vole (*Microtus ochrogaster*), meadow vole (*M. pennsylvanicus*), and least weasel (*Mustela nivalis*) (Table 1).

The largest number of species was trapped at the sand prairie sites -- all nine species were caught in this type of habitat (Table 1). Four species were captured only in prairie and the only species trapped in all three habitat types was the white-footed mouse (Table 1). The total number of individuals caught during the survey was about 709; the exact number probably was between 704 and 711 (a few animals escaped before they could be marked or checked for marks). The most frequently trapped species was the white-footed mouse; it accounted for 49.4% of all captures and 46.1% of all individuals.

Sand prairie

There were 426 small mammal captures at the six sand prairie sites, for an overall trapping success of 23.7% in this habitat. A total of 364 individuals was caught in prairie areas (Table 2). The number of species captured at a site varied from two to eight (Table 2). The most frequently trapped species was the deer mouse, which accounted for 64.7% of all captures and 62.4% of all individuals.

G-area prairie: Part of this dry-mesic sand prairie site was enclosed with a fence and had not been grazed since the mid-1990s. The herbaceous vegetation throughout the site was relatively tall and very dense. There were 101 captures in this prairie, a trapping success of 33.7% (Table 2). Eight species were captured, giving the site the highest species richness in the survey (Table 2). The most frequently trapped species was the meadow vole (28% of identified captures, 28.6% of individuals), but numerous prairie voles, deer mice, and northern short-tailed shrews also were caught (Table 2).

F100 prairie: At this dry-mesic prairie site the herbaceous cover was very sparse and there were large areas of exposed sand. Trapping success was high (34.3%), but the deer mouse was essentially the only species caught at the site (Table 2).

E1200 prairie: There were 60 captures, representing a trapping success of 20.0%, at this dry and dry-mesic prairie site (Table 2). Six species were caught, a relatively high species richness in this survey (Table 2). The most frequently trapped species was the deer mouse, which accounted for 66.7% of all captures and individuals (Table 2).

E1700 prairie: Trapping success was only 17.7% (53 captures) at this dry and dry-mesic prairie site, but it had the second highest species richness (seven species) of all sites surveyed (Table 2). The deer mouse accounted for 71.7% of all captures and 68.1% of individuals.

Whitton gate prairie: There were areas of dense herbaceous cover at this dry-mesic sand prairie, but large patches of bare sand were present as well. There were 58 small mammal captures (a trapping success of 19.3%) and species richness was relatively high (six species) (Table 2). The deer mouse accounted for 74.1% of all captures and 68.1% of individuals.

E800 prairie: There were 51 captures at this dry-mesic sand prairie site, giving it the lowest trapping success in the survey (17.1%; Table 2). Only four species were caught and species richness was lower than at all other prairie sites except F100 (Table 2). Once again, the species caught most often was the deer mouse (64.7% of all captures, 60.0% of individuals).

Sand savanna

There were 206 small mammal captures at the two sand savanna sites that we surveyed, a combined trapping success of 34.4%. The total number of individuals trapped was 165, but only two species were captured in this habitat type (Table 2). The white-footed mouse was the most frequently trapped species at sand savanna sites (86.8% of captures, 85.5% of individuals).

F800/F1200 savanna: This dry-mesic savanna contained scattered oak trees interspersed with herbaceous vegetation. Trapping success was 29.3% (Table 2; 87 captures). There was uncertainty about the identification of a few of the *Peromyscus* caught at this site. Both species were present, but the white-footed mouse was trapped in greater numbers (Table 2).

River dune savanna: Parts of this dry sand savanna, located on the dunes bordering the Mississippi River, had the open canopy typical of a savanna, but elsewhere the canopy was closed or dense shrub thickets were present. There were 118 captures at this site (a trapping success of 39.5%) and all but one animal were white-footed mice (Table 2).

Sand forest

There were 254 small mammal captures in the two forested sites trapped at the SAD. The combined trapping success in this habitat type was 42.3%. Three species were trapped at each site, but only the white-footed mouse was caught in appreciable numbers (97.6% of all captures, 97.2% of individuals).

River-edge woods: Trapping success in this tract of dry sand forest, located on the dunes along the Mississippi River, was 49.0% (Table 2; 147 captures). The three species trapped at this site included the prairie vole, which is a grassland species. The white-footed mouse accounted for 97.3% of all captures and 96.9% of all individuals.

Beaty Creek woods: There were 107 captures in this tract of dry-mesic sand forest, a trapping success of 35.7% (Table 2). Captures included one meadow vole, primarily a grassland mammal. It was trapped in an opening in the forest that had dense herbaceous cover. White-footed mice accounted for 98.1% of all captures and 97.6% of individuals.

DISCUSSION

To evaluate the benefits and success of a conservation and restoration program such as that to be developed for the Lost Mound Unit of the Upper Mississippi River National Wildlife and Fish Refuge, it will be essential to have baseline data documenting conditions at the onset of the program. Populations of small mammals are notoriously variable in both time and space (e.g. Heske et al. 1997, Fryxell et al. 1998, Getz and Hofmann 1999). Although it may not be practical to conduct a controlled scientific experiment that includes numerous replicates of “managed” and “unmanaged” sites to evaluate the effects of conservation efforts, an adaptive management approach that documents changes in faunal communities over time in relation to changing management practices can be highly informative. The ten small mammal survey sites we established in this study (two sand forests, two sand savannas, and six sand prairies) should provide good spatial coverage of the Lost Mound Unit and replication of major upland habitat types adequate for monitoring the diversity and relative abundance of small mammals. Continued monitoring of these sites at regular intervals could provide insight into the responses of the small mammal communities to new management practices.

Sixteen species of native, terrestrial mammals small enough to be captured in Sherman traps (i.e., total length < 30 cm) are known or likely to occur in northwestern Illinois (Hoffmeister 1989). Thus, the nine species that we trapped at the SAD represented 56% of the region’s terrestrial small mammal fauna. Most of these are common, widespread species (no terrestrial small mammal in the region is listed as threatened or endangered by the Illinois Endangered Species Protection Board [1999]). We may have failed to catch some species because a single trapping method does not work equally well for all types of small mammals (Call 1986). The southern flying squirrel (*Glaucomys volans*) is arboreal and rarely caught in live traps placed on the ground, but is likely to be present in wooded areas at the Depot. Similarly, the fossorial eastern mole (*Scalopus aquaticus*) would not be caught in aboveground traps. Shrews are best surveyed with pitfall traps (Kirkland and Sheppard 1994) that were impossible for us to use at the Depot because of restrictions on ground disturbance. Use of pitfall traps at the SAD might have resulted in the capture of the least shrew (*Cryptotis parva*), a grassland species. However, Hoffmeister (1989) located no least shrew specimens from northwestern Illinois and none have been caught during recent surveys in the region using a variety of methods (Kelt 1991, Anderson et al. 1994, Hofmann and Handel 1995).

The woodland vole (*Microtus pinetorum*) also can be difficult to trap and might be found at the SAD with additional effort, but we are aware of only one record for this species in northwestern Illinois (Hoffmeister 1989). It is possible that the sandy soil at the SAD is not suitable for this semi-fossorial species. The southern bog lemming (*Synaptomys cooperi*) and meadow jumping mouse (*Zapus hudsonius*) generally occur in mesic habitats (Hoffmeister 1989) and might have been caught if we had trapped at an emergent wetland at the Depot. Hoffmeister (1989) lists only one record for the southern bog lemming in northwestern Illinois so it would be interesting to know if this species occurs at the Depot. Additional sampling at the SAD should seek to confirm the presence or absence of these species. Eastern chipmunks (*Tamias striatus*), on the other hand, are readily detected and should have been caught if they were present in wooded areas. Anderson et al. (1994) also did not trap chipmunks at the SAD. Their apparent absence is

noteworthy because chipmunks have been documented in forests in Jo Daviess County (Hofmann and Handel 1995) and at nearby Mississippi Palisades State Park in Carroll County (Hoffmeister 1989). The absence of non-native house mice (*Mus musculus*) and Norway rats (*Rattus norvegicus*) from our transects, despite the abundance of human-made structures at the Depot, suggests that the benefits of conservation efforts would accrue primarily to native species.

Sand forest and savanna displayed the lowest diversity of small mammal species in this survey, with only two or three species trapped per site and numerical dominance by white-footed mice (Table 2). Anderson et al. (1994) also caught fewer species on forest and savanna transects than on prairie transects at the SAD (one, three and eight, respectively). Similarly, only two small mammal species and a preponderance of white-footed mice were trapped in a sand savanna in Winnebago County, Illinois (Szafoni 1989) and sand forests in Cass County, Illinois (Hofmann and Handel 1997). The white-footed mouse is such a common woodland species in Illinois (Hoffmeister 1989) that the large numbers caught in the sand forest were not surprising. Variation in results between the two sand forest sites at the SAD was minimal. We captured only one northern short-tailed shrew at each site; these results, however, undoubtedly underestimate this species' abundance because shrews are not as readily caught in live traps as white-footed mice are (Call 1986, Kirkland and Sheppard 1994). The meadow and prairie voles caught in the forests are grassland species and presumably not a major component of the forest small mammal community. Although both species of *Peromyscus* were captured at each sand savanna, their relative numbers varied greatly between sites. Both deer mice and white-footed mice occurred in considerable numbers at the F800/F1200 savanna, but only a single deer mouse (a grassland inhabitant in Illinois) was trapped at the River dune savanna. These two savannas differed in that the latter included areas with greater tree densities and closed canopies as well as areas with dense shrub cover. Anderson et al. (1994) caught prairie voles (although no deer mice) on their savanna transect, where the vegetation was similar to our F800/F1200 site. Restoration of degraded savannas at the SAD could increase the diversity of their terrestrial small mammal fauna by making this habitat more suitable for grassland species.

Sand prairie at the SAD had a greater overall species richness and diversity although there was considerable variation among the sites we surveyed. The number of species per site varied from two to eight and trapping success ranged from 17.1% to 34.3% (Table 2). At one site a single species displayed numerical domination (the deer mouse at F100), but other sites had a more diverse assemblage. Species richness at a site was not related to the number of individuals captured or to trapping effort, which was constant among sites. Thus, the variation is not an artifact of sampling. Rather, we believe that the small mammal communities at each site reflect the complexity, diversity, and maturity of the prairie vegetation. The most diverse small mammal assemblage was at the site (G-area prairie) where the prairie vegetation, part of which had been protected from grazing in the past, was tall and most dense. This site yielded the only captures of least weasels and masked shrews as well as the greatest numbers of meadow voles and northern short-tailed shrews. Similarly, Anderson et al. (1994) caught more species at the G-area prairie than on their grazed prairie transect. In contrast, we caught essentially only deer mice at the F100 site, which had very sparse vegetative cover. Despite the marked difference in the vegetation at the G-area and F100 sites, they yielded the largest

numbers of individuals captured in the sand prairie (Table 2). Although other sites may not be able to support similar vegetative complexity, the G-area prairie provides a benchmark of the diverse small mammal community possible in sand prairie habitat at the newly designated Lost Mound Unit of the Upper Mississippi River National Wildlife and Fish Refuge.

Although no rare species of terrestrial small mammals were found at the SAD, common and widespread species play important roles in ecosystems. Herbivorous and burrowing species can, for example, affect the species composition of plant communities, increase nitrogen mobility in plants, and affect the process of succession (Huntly 1991, Ostfeld and Canham 1993, Howe and Brown 1999, Sirotnak and Huntly 2000). In addition, many species of small mammal provide a significant prey base for higher trophic levels. Maintenance of overwintering raptors as well as the nesting success of hawks and owls can be dependent on healthy populations of rodents (e.g. Hamerstrom 1979, Hamerstrom et al. 1985, Plumpton and Andersen 1998). Bird surveys during 1994-1998 showed no breeding by several raptors (e.g., northern harrier [*Circus cyaneus*] and short-eared owl [*Asio flammeus*]) that were observed occasionally at the Depot (Anderson et al. 1995, 1996; Anderson and Kirk 1998; Anderson in litt.). Although the failure of these species to breed at the SAD has been attributed to a lack of suitable nesting habitat resulting from intensive grazing (e.g., Bowles 1993), an inadequate prey base also may have been a factor. Mammalian carnivores from least weasels to coyotes (*Canis latrans*) and bobcats (*Lynx rufus*) also rely on small mammals as prey to varying extents, as do many species of snake. Voles are particularly important for many predators because they are active diurnally as well as nocturnally. We found that small mammals were numerous even in areas of sand prairie with sparse vegetation, but species richness was greater and more voles were caught in prairies with denser cover. Conservation efforts that benefit small mammals not only protect a component of biodiversity important in its own right, but can aid other taxa and trophic levels as well.

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Table 1. Small mammal species trapped in three upland habitats, Savanna Army Depot, Carroll and Jo Daviess counties, Illinois, September and October 2000.
(inds = individuals, SP = sand prairie, SS = sand savanna, SF = sand forest)

Species	No. captures	No. inds	SP	SS	SF
<i>Sorex cinereus</i>	2	2	X		
<i>Blarina brevicauda</i>	25	24	X		X
<i>Spermophilus tridecemlineatus</i>	14	11	X		
<i>Reithrodontomys megalotis</i>	13	12	X		
<i>Peromyscus leucopus</i>	437	327	X	X	X
<i>P. maniculatus</i>	302	251	X	X	
<i>Microtus ochrogaster</i>	53	51	X		X
<i>M. pennsylvanicus</i>	36	29	X		X
<i>Mustela nivalis</i>	2	2	X		
Totals	884*	709 ⁺	9	2	4

* total = 884 because two animals escaped before they were identified

⁺ range 704-711

Table 2. Numbers of small mammals captured at ten live-trapping sites in upland sand habitats, Savanna Army Depot, Carroll and Jo Daviess counties, Illinois, September and October 2000.
(299 trap-nights at E800 prairie and River dune savanna, 300 trap-nights at each other site)

Species	Sand Prairie						Sand Savanna		Sand Forest	
	G-area	F100	E1200	E1700	Whitton	E800	800/1200	River	River	Beaty
<i>Sorex cinereus</i>	2									
<i>Blarina brevicauda</i>	17			1	4				1	1
<i>Spermophilus tridecemlineatus</i>	7		1	2	1					
<i>Reithrodontomys megalotis</i>	4		6	1	1					
<i>Peromyscus leucopus</i>			1	2	4	4	46	95	93	82
<i>P. maniculatus</i>	15	83	38	32	32	27	23	1		
<i>Microtus ochrogaster</i>	15	1	8	7	5	13			2	
<i>M. pennsylvanicus</i>	22		3	2		1				1
<i>Mustela nivalis</i>	2									
Total no. individuals	84	84	57	47	47	45	69	96	96	84
Total no. species	8	2	6	7	6	4	2	2	3	3
Trapping success (%)*	33.7	34.3	20.0	17.7	19.3	17.1	29.0	39.5	49.0	35.7

* (number of captures/number of trap-nights) x 100

Figure 1. Locations of small mammal trapping sites, Savanna Army Depot, Carroll and Jo Daviess counties, Illinois, September and October 2000.

