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Cover and Soil Drainage Influence Burrow Location of Franklin's Ground Squirrel (*Spermophilus franklinii*) in Champaign County, Illinois

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ABSTRACT

Franklin's ground squirrel (*Spermophilus franklinii*) is declining in the eastern portion of its range, and was listed as state threatened in Illinois in 2004. During spring 2002, we examined locations of burrows of a group of *S. franklinii* inhabiting a 12-ha tallgrass prairie restoration located south of Urbana, Champaign County, Illinois. Burrow systems were located most often in areas of cool season grasses with well-drained and moderately well-drained soils. Burrow systems also were often associated with trees, trash heaps, and buildings which may offer some degree of protection from predators and weather. Although descriptions of *S. franklinii* habitat in the Midwest emphasize tallgrass and mid-grass prairies, surveys for *S. franklinii* in Illinois and selection of sites for potential introductions should include other types of cover and consider soil drainage.

INTRODUCTION

Franklin's ground squirrel (*Spermophilus franklinii)* has decreased in abundance in much of the Midwestern United States (Van Petten and Schramm 1972, Lewis and Rongstad 1992, Johnson and Choromanski-Norris 1992, Pergams and Nyberg 2001, Martin et al. 2003). The Illinois Endangered Species Protection Board listed *S. franklinii* as state threatened in 2004. Evidence supporting this action included field surveys that confirmed the presence of *S. franklinii* at only 3 of 26 trapping sites where habitation seemed probable based on historical occurrences (Martin et al. 2003) and the recommendations of biologists. Locating and conserving additional populations will require data on habitat associations in Illinois for this cryptic and patchily distributed species.

Unlike thirteen-lined ground squirrels (*S. tridecemlineatus*), which can readily be seen along roadsides and in mowed areas like lawns, graveyards, and golf courses, *S. franklinii* are associated with the thick vegetation of tallgrass and mid-grass prairies and are rarely

seen in open areas (Haberman and Fleharty 1972, Ellis 1982, Jones et al. 1983, Hoffmeister 1989, Benjamin 1991, Kurta 1995). However, prairie remnants and restorations in Illinois typically lack the extent, natural disturbance regimes, and species composition of the historical prairies that *S. franklinii* once inhabited. Soil drainage also can affect the suitability of an area for burrowing mammals such as *S. franklinii*. Haberman and Fleharty (1972) noted that *S. franklinii* in Nebraska occupied an area with silty, well-drained soils, Benjamin (1991) suggested that soil characteristics affected the location of burrows in Indiana but did not provide quantitative analyses, and *S. franklinii* often excavate burrows in the mounded substrate of raised railroad beds (Ellis 1982, Benjamin 1991, Johnson and Choromanski-Norris 1992, Martin et al. 2003). Whether drainage influences burrow location more than type of vegetation is not known.

Kennicott (1857), Sowls (1948), Ellis (1982), Jones et al. (1983), Erlien and Tester (1984) and Choromanski-Norris et al. (1989) all noted that individual trees, tree lines, and shrubs were present in areas occupied by Franklin's ground squirrels. Large cover-providing objects, such as shrubs or buildings, may benefit ground squirrels by offering protection from predators and weather. The relationship of *S. franklinii* to woody vegetation and other cover-providing objects in Illinois is not clear. In this study, we examined the location of *S. franklinii* burrows in relation to vegetation, soil drainage characteristics and the presence of large cover-providing objects.

METHODS

Our study was conducted at the Barnhart Grove Prairie, a 12-ha tallgrass prairie restoration located 3 km south of Urbana, Illinois, that is maintained by the Barnhart Grove Prairie Restoration Project, a not-for-profit corporation, in conjunction with the Champaign County Soil and Water Conservation District and the Illinois Department of Natural Resources. Martin et al. (2003) reported *S. franklinii* at Barnhart Prairie, and subsequent live trapping determined that 19 adults were present on the site (Martin 2003). At the time of our study, Barnhart Prairie included four areas totaling 5.82 ha that had been seeded with warm season grasses and forbs between 1987 and 1990 (Fig. 1A). The remaining areas included a farm homestead (1.53 ha) and other grassy fields and borders dominated primarily by brome grass (*Bromus* sp.). The homestead was unoccupied and all grassy areas were unmowed during the time of our study, although the homestead area had been kept mowed the previous year. Agricultural fields planted with either corn (*Zea mays*) or soybeans (*Glycine max*) surrounded the entire site. We defined the study area as all non-agricultural areas of the Barnhart Prairie.

The Barnhart Prairie was situated atop Yankee Ridge, a moraine of the Wisconsin glaciation. Soil types present on the property were identified using Soil View 2.0 (U.S. Department of Agriculture, Natural Resources Conservation Service and the Illinois Cooperative Soil Survey, 2001). Well-drained and moderately well-drained soils characteristic of moraines covered most of the property (Wyanet silt loam, Catlin silt loam, Dana silt loam, and Blackberry silt loam) (Fig. 1B).

We searched the Barnhart Prairie exhaustively for *S. franklinii* burrows from late January through early April 2002. Locations of all burrow openings were recorded using a GeoExplorer3 GPS unit (Trimble Navigation Limited, Sunnyvale, CA), and differentially

corrected to within 1 m using data from the University of Illinois GPS community base station. Burrow entrances clustered within 5-10 m were assumed to constitute single burrow systems. All burrow systems were examined on 20 May and again on 24 June for signs of *S. franklinii* activity. Live trapping confirmed that *S. franklinii* was the species using these burrows (Martin 2003).

We grouped the well-drained and moderately well-drained soil types present on the site into the single category "drained" and defined all other soil types as "non-drained." We then categorized placement of burrow systems in relation to four habitat types: drained prairie, non-drained prairie, drained cool season grass, and non-drained cool season grass. A chi square goodness-of-fit test was used to compare the number of burrow systems in each habitat type to the expected number of burrow systems based on the relative area of each habitat. A second goodness-of-fit test was used to examine selectivity of burrow system placement in relation to large, cover-providing objects. We counted the number of burrow systems within a 5-m buffer around the edges of all trees, trash heaps, and buildings on the site and compared this number to the expected value based on the total buffered area.

RESULTS

We located 215 individual burrow entrances that constituted 82 burrow systems (Fig. 1B). As of 20 May, 26 of these burrow systems were active, all but two of which were located in the non-prairie grass areas. The number of burrow systems being used increased to 42 by 24 June, including 12 located in the prairie plots. The numbers of burrow systems in the four habitat types (drained prairie, non-drained prairie, drained cool season grass, non-drained cool season grass) were not distributed in proportion to the available habitat ($\chi^2 = 26.42$, df = 3, $P < 0.05$). Fewer burrow systems than expected were located in non-drained prairie and more burrows than expected were in drained cool season grass (Table 1). Placement of burrow systems also was not random in relation to large cover-providing objects ($\chi^2 = 41.8$, df = 1, $P < 0.05$). More than one-third (25/82) of the burrow systems were located within 5 m of trees, trash heaps and buildings, whereas this habitat comprised only 9.5 % of the study area (Table 2).

DISCUSSION

Although *S. franklinii* is usually considered an inhabitant of tallgrass and mid-grass prairie (Jones et al. 1983), the majority of burrows used by *S. franklinii* during the early part of the summer at Barnhart Prairie were located in areas dominated by cool season grasses, primarily *Bromus* sp. At the time when the squirrels emerged from hibernation, these grasses provided cover and a source of food and nesting material. Haberman and Fleharty (1972), Iverson and Turner (1972), and Ellis (1982) also found an association between *S. franklinii* and habitat with cool season grasses. Given the difficulties in restoring certain aspects of historically accurate prairies, including extent, disturbance regimes, and complete vegetation communities that include cool season grasses, management efforts aimed at conserving or restoring tallgrass prairie vegetation alone may not be the best strategy for conserving *S. franklinii*. Restorations that incorporate adjacent patches of cool season grasses may be more beneficial to *S. franklinii*.

One area of restored prairie at our study site, the 2.95-ha North Prairie, was burned in the spring of 2002. We found several burrows from the previous year in this area, but *S. franklinii* did not use them until the grasses and forbs re-grew and vegetative cover was restored. Choromanski-Norris et al. (1989) also found that *S. franklinii* avoided a burned area that had previously been used, and Benjamin (1991) noted a case of possible avoidance of a recently burned area. Similarly, burrows near the homestead where the grass had been mowed until the previous fall were not used until the grass re-grew.

Twice as many burrow systems were located in drained cool season grass than expected based on the area of this habitat type. The greater density of burrows in drained cool season grass than in non-drained cool season grass or drained prairie areas implies that cover or drainage alone did not maximize the suitability of an area for *S. franklinii*. Few burrow systems were located in non-drained prairie areas. Well-drained areas with permanent cover are likely to be particularly important for hibernation burrows, a likely explanation for the association of *S. franklinii* with railroad rights-of-way in the Midwest (Kurta 1995). Many burrow entrances at Barnhart Prairie were positioned on the tops of small mounds and none were located in depressions large enough to collect water. Many prairie restorations occur on areas formerly used for agriculture where natural topographic contours have been leveled and the soil drainage altered. Although such areas may look like good prairie habitat, they may not provide habitat features needed by *S. franklinii* such as well-drained sites for hibernation burrows. Restoring topographic relief may improve the quality of grassland habitat for *S. franklinii*.

In other parts of its range, *S. franklinii* is often associated with forest-prairie borders (Jones et al. 1983, Erlien and Tester 1984). Large cover-providing objects also can provide protection from terrestrial predators and to some extent weather. Our data suggest that individual trees, shrubs, treelines, and other cover-providing objects may improve the attractiveness of an area to *S. franklinii*. We recognize that our conclusions are derived from a small group of individuals at a single site and their generality needs to be confirmed. Further, our focal group of *S. franklinii* may be part of a larger, undetected metapopulation (Martin and Heske 2005), and factors such as the size and distribution of suitable habitat patches may be tantamount. Still, future surveys for *S. franklinii* in Illinois might improve their efficiency by focusing on areas with good soil drainage, permanent herbaceous cover that includes a component of cool season grasses, and scattered woody vegetation or nearby woody edges.

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Table 1. Location of Franklin's ground squirrel burrow systems and in relation to the availability of four habitat types in the Barnhart Grove Prairie.

HABITAT	**AREA** (m^2)	**BURROW SYSTEMS** observed (expected)
Drained prairie	35,105	24 (29)
Non-drained prairie	23,131	7 (20)
Drained cool season grass	26,946	42 (23)
Non-drained cool season grass	11,779	9 (10)

Table 2. Location of Franklin's ground squirrel burrow systems in relation to cover-providing objects (trees, trash heaps, and buildings) in the Barnhart Grove Prairie.

PROXIMITY TO COVER	**AREA** (m^2)	**BURROW SYSTEMS** observed (expected)
$\leq$ 5 m from cover object	9,217	25 (8)
> 5 m from cover object	87,744	57 (74)

Figure 1. A) Landcover of the Barnhart Grove Prairie during summer 2002.
B) Franklin's ground squirrel burrow locations and soil drainage on the Barnhart Grove Prairie.