Direct Mortality and Reappearance of Small Mammals in an Illinois Grassland After a Prescribed Burn Francis M. Harty Division of Natural Heritage Illinois Department of Conservation 8 Henson Place Champaign, Illinois 61820 Jeffrey M. Ver Steeg Division of Wildlife Resources Illinois Department of Conservation 600. N. Grand Avenue West Springfield, Illinois 62706 Randy R. Heidorn Division of Natural Heritage Illinois Department of Conservation 110 James Road Spring Grove, Illinois 60081 Lorree Harty 630 W. Marion Monticello, Illinois 61856

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ABSTRACT: One masked shrew (*Sorex cinereus*) and 57 meadow voles (*Microtus pennsylvanicus*) were killed when a ring fire was used to burn a 2.7-ha grassland in northeastern Illinois. Meadow voles, masked shrews, thirteen-lined ground squirrels (*Spermophilis tridecemlineatus*), white-footed mice (*Peromyscus leucopus*), and meadow jumping mice (*Zapus hudsonius*) were captured on the burned area four months after the fire. When burning small areas, the ring fire technique can be executed so quickly that the encircling fire may be connected before voles, shrews, and other small mammals can escape. Because reestablishment of small mammals in burned areas seems highly dependent on immigration, it is important to establish burn units and burning schedules that leave unburned habitat adjacent to burned areas.

INTRODUCTION

Fire in grassland and savanna communities has direct and indirect effects on small mammals. The most obvious direct effect of fire on small mammals is death or injury from exposure to smoke or flames. Lyon et al. (1978) reviewed 360 papers describing the effects of fire on fauna and concluded that "although some evidence of direct mortality has been reported, the consensus is that vertebrates are rarely killed by fires and where death does occur it is usually considered minimal." Nevertheless, preweaned young of cottontail rabbits (*Sylvilagus floridanus*), western harvest mice (*Reithrodontomys megalotis*), meadow voles (*Microtus pennsylvanicus*), prairie voles (*Microtus ochrogaster*), and nestlings of other ground nesting vertebrates are susceptible to direct mortality from fire (Erwin and Stasiak 1979). The greatest changes in small mammal populations after a fire are attributable to abrupt habitat alteration rather than direct mortality (Kaufman et al. 1983, Schramm and Willcutts 1983, Crowner and Barrett 1979, Moreth and Schramm 1973, Beck and Vogl 1972, Springer and Schramm 1972, Schramm 1970, Vogl 1967, Tester 1965, Tester and Marshall 1961, Cook 1959).

During a postfire reconnaissance of a prescribed burn conducted on March 24, 1981, we discovered 57 dead adult meadow voles and one dead adult masked shrew (*Sorex cinereus*). Based on the literature and our experience, we considered this unusually high adult mortality. Consequently, we monitored the burned area to document the reappearance of small mammals after the burn.

The objectives of this study were to document the high direct mortality of adult meadow voles as a result of a ring fire in a small grassland, to monitor the reappearance of meadow voles and other small mammals after the burn, and to provide grassland managers with management recommendations based on our observations and a review of the literature.

STUDY AREA

The 2.7-ha study area is located in Moraine Hills State Park, McHenry County, Illinois. The site is classified as dry-mesic and the soil is a well-drained, gravelly silt loam. Historically the study area was used for pasture and was planted with brome grass (*Bromus inermis*) and alfalfa (*Medicago sativa*). More recently a portion was seeded with big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), and switch grass (*Panicum virgatum*). This area is adjacent to larger tracts of former pasture containing brome/alfalfa and reed canary grass (*Phalaris arundinacea*).

METHODS

The study area has been treated with biennial spring burns to favor the growth and expansion of the prairie grasses. On March 24, 1981 the study area was burned using two back fires joined with a head fire to form a ring fire. The fire was hot, fast, and complete, leaving no vegetation unburned within the firebreaks.

A research project was not the purpose for implementing the burn, therefore no preburn samples were collected and no control plots were established. However,

when we discovered 57 dead voles after the burn we felt it would be useful to monitor the reappearance of voles and other small mammals on the burned area. This is not a demographic or repopulation study, but it provides managers with a case study documenting the duration of fire impacts on small mammals.

After a routine postfire survey of the burn revealed several dead meadow voles and one dead masked shrew, we undertook an intensive search for small mammals killed during the fire. A leaf rake was an effective tool for locating blackened vole nests and charred dead voles in the ashes. Thirty-one voles were recovered using this technique. An additional 26 voles were recovered on the morning of March 25, 1981, after rain removed much of the ashes.

To monitor the reappearance of small mammals on the study area we trapped at 4, 7, 12, and 19 months after the burn. Museum special snap traps were arranged in two transects, one primarily in the prairie grass planting and the other primarily in the brome/alfalfa planting (Figure 1). Twenty-three stations were placed approximately 9 m apart along both transects. Three traps baited with a mixture of rolled oats, peanut butter, and bacon grease were set at 22 of the 23 stations. The last station in each transect had four traps.

RESULTS AND DISCUSSION

Meadow voles, masked shrews, northern short-tailed shrews (*Blarina brevicauda*), a few white-footed mice (*Peromyscus leucopus*), thirteen-lined ground squirrels (*Spermophilis tridecemlineatus*), and meadow jumping mice (*Zapus hudsonius*) were captured. Results of meadow vole and shrew captures are presented separately from that of the other species.

Meadow Voles

Immediately after the burn, we observed 4 apparently undamaged voles and 4 singed and blinded voles running through the ashes. We collected 57 dead meadow voles and 1 dead masked shrew on the burned area and inspected 125 vole nests. No nests contained pups.

According to the literature, direct mortality of meadow voles as a result of prescribed fire is uncommon. By radio-tracking voles in a tallgrass prairie in Nebraska, Geluso (1986) determined that meadow voles avoid fire by (1) seeking refuge in underground burrows, (2) fleeing into adjacent unburned areas, and (3) hiding on the raised mounds of pocket gophers. However, Komarek (1969), using the ring fire technique, was able to intentionally kill cotton rats (*Sigmodon hispidus*) in a pasture of tall bahia grass (*Paspalum notatum*) where the ground was hard from over 25 years of grazing. But in part of the pasture where there were abandoned fire ant (*Solenopsis s. richteri*) mounds, the cotton rats had burrows and escaped the fire.

We believe a combination of three factors created conditions resulting in the unusually high mortality of voles on our study area.

1. Aboveground nests were common but underground burrows were few. The compacted soil and gravelly substrate may have inhibited burrow excavation.
2. The high fuel load of dense prairie grasses generated a hot fire.
3. The encircling flames closed so quickly that the opportunity for voles to escape into adjacent unburned areas was limited.

Trapping dates, number of trap nights, and species capture rates for small mammals captured on the study site are summarized in Table 1. Four months after the burn (560 trap nights), 60 voles were trapped within the burn area, indicating that recolonization occurred within 125 days after the fire.

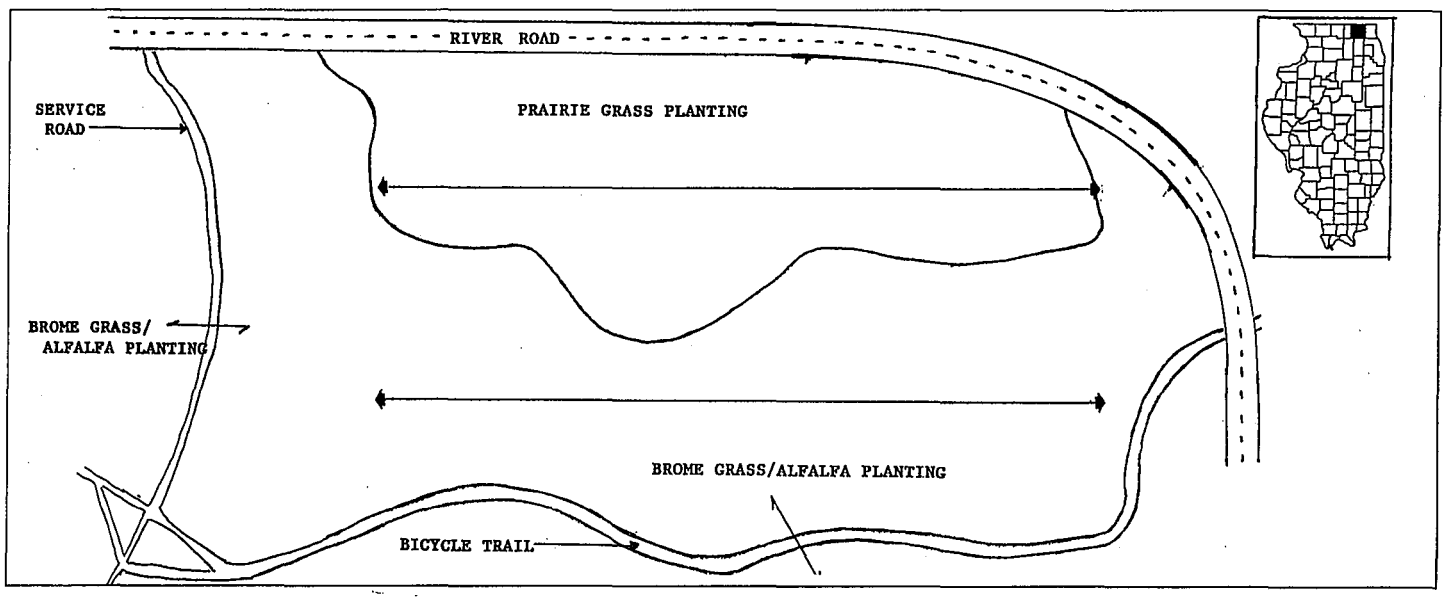

FIGURE 1. Study area at Moraine Hills State Park, McHenry County, Illinois. The wavy, single line approximates the boundary between the prairie grass planting and the brome grass/alfalfa planting. Approximate locations of the sampling transects are indicated by the arrows. The area within the roads and the bicycle trail is 2.7 ha.

Table 1. Trapping dates, number of trapnights, direct mortality, and species capture rates for small mammals recolonizing a burned grassland at Moraine Hills State Park, McHenry County, Illinois.

Date	Trap Nights	Meadow Vole[a]	Masked Shrew	Northern Short-Tailed Shrew	Thirteen-lined Ground Squirrel	White-Footed Mouse	Meadow Jumping Mouse	TOTALS
March 24, 1981 (burn date)	—	(57)[b]	(1)	0	0	0	0	58
July 29, 30, 31 & Aug. 1, 1981	560	60	4	0	14	2	1	81
Oct. 27, 28, 29, 30, 31, 1981	700	177	1	0	0	1	1	180
March 22, 23, 24, 25, 26, 1982	560	48	14	0	0	0	0	62
Oct. 26, 27, 28, 1982	560	7	17	6	0	0	2	32
Totals	2380	349	37	6	14	3	4	413

[a] Scientfic names of species:
meadow vole (*Microtus pennsylvanicus*)
masked shrew (*Sorex cinereus*)
northern short-tailed shrew (*Blarina brevicauda*)
thirteen-lined ground squirrel (*Spermophilis tridecemlineatus*)
white-footed mouse (*Peromyscus leucopus*)
meadow jumping mouse (*Zapus hudsonius*)

[b] Direct mortality due to the prescribed fire

Seven months after the first burn and only three months after the first trapping session, 177 voles were trapped within the burned area. This seven-month block of data documents that free-living meadow voles can recolonize vacant habitat created by a spring burn within four months and rebound from the added effects of snap-trapping within three months. One year after the burn, 48 voles were trapped within the study area. Collectively, over a 19-month period we removed 349 meadow voles from within the 2.7-ha study area.

Getz et al. (1987), studying the population fluctuations of meadow voles and prairie voles in east-central Illinois, attributed the recovery of vole populations following a burn to dispersal by a few adults into the burned area after the regrowth of vegetative cover. The investigators suspected that subsequent repopulation primarily resulted from recruitment of young born within the burn area.

The importance of vegetative cover to meadow voles is well documented (Eadie 1953, Getz 1971, Birney et al. 1976). The general finding from studies assessing the effects of fire on meadow voles is that vole populations decline precipitously after a burn and that recovery is directly dependent on the regrowth of vegetative cover (Schramm 1970, Moreth and Schramm 1973, Schramm and Willcutts 1983). Vacanti and Geluso (1985) monitored meadow vole recolonization of a burned tallgrass prairie in Nebraska and determined that voles did not recolonize the burned area until 93 days after the burn, and that it took between 12 and 16 months before vole densities on the burned plot equaled the numbers on the control plot. Lemen and Clausen (1984), studying the effects of mowing on rodents in a tallgrass prairie in eastern Nebraska, also reported that recovery of meadow vole populations on mowed prairies is dependent on the rate of growth of the grass and that optimum conditions can take at least a year to develop, maybe several years with low rainfall.

The differences observed between recovery times may be an artifact of the regional population levels of voles before and following each burn. In other words, if the

regional vole population is in a general increase phase following a burn, a greater number of dispersing individuals may be available to immigrate into vacant habitat; but if the population is in a trough phase following a burn, there will be reduced opportunity for population recovery (L. Getz, pers. comm. 1989).

Shrews

During the 4- and 7-month postburn trapping sessions we captured only 5 masked shrews. However, we captured 14 and 17 masked shrews after 12 and 19 months, respectively (Table 1). The first capture of northern short-tailed shrews (6 individuals) occurred 19 months after the burn (Table 1).

Our success at capturing masked shrews with snap traps (as opposed to pit falls) deviates from that reported in the literature (MacLeod and Lethiecq 1963, Pucek 1969, Williams and Braun 1983); we attribute our success to adding bacon grease to our bait.

In our study, voles appeared on the burned area more quickly than shrews. The recolonization of the study area by shrews may be related directly to the recovery of vegetation or indirectly to the development of vegetation-dependent prey, such as Lepidopteran and Coleopteran larvae and soil macroinvertebrates like snails, slugs, earthworms, and millipedes. Perhaps voles, being herbivorous, can utilize recovering areas sooner than shrews because vegetation may develop faster than insect or arthropod populations.

There is strong evidence supporting the contention that both the northern short-tailed shrew and masked shrew prefer sites with accumulated litter. Schramm (1970), Springer and Schramm (1972), and Schramm and Willcutts (1983) concluded that the northern short-tailed shrew prefers areas of accumulated litter because litter provides protection; an easy medium for tunneling; and a moist microclimate that attracts earthworms, snails, and slugs. Getz (1961) reported that the most important factor influencing the local distribution of the northern short-tailed shrew and the masked shrew is high humidity associated with moist site conditions. He considered food to be the second most important factor influencing the local distribution of the northern short-tailed shrew. However, because of the smaller size of the masked shrew and the more general availability of smaller-sized food items over a wider range of habitats, food does not seem to limit the local distribution of the masked shrew. Getz concluded that the primary importance of cover (litter, moss, or dense graminoid vegetation) is its ability to maintain high humidity near the ground.

Hamilton (1930) reported that insects comprised 47.8% of the stomach contents of 224 northern short-tailed shrews, but Whitaker and Ferraro (1963) reported that earthworms, snails, and slugs made up 58.5% of the stomach contents of 221 northern short-tailed shrews. Both studies were conducted near Ithaca, New York. The varied diet reported for the northern short-tailed shrew suggests that it is an opportunistic forager and apparently is not restricted to a specific type of prey. Moreover, Platt and Blakley (1973) reported that the species composition of the litter fauna in an Iowa prairie changes seasonally and that masked shrews exploit seasonally transient members of the litter fauna.

It is reasonable to assume that habitat conditions for insects and other arthropods will vary with the structure, age, and species composition of habitats recovering from a fire. Warren et al. (1987), in their review of the responses of grassland arthropods to burning, divide the impacts of burning into combustion, shock, and recovery phases. During the combustion and shock phases some species of arthropods may die immediately from the intense heat; other species may experience desiccation, exposure, and increased susceptibility to predation as a result of removal of the standing vegetation and mulch; while more mobile species may emigrate to adjacent habitats. As vegetation regrowth begins during the recovery phase, microclimatic extremes ameliorate and food and cover increase. Herbaceous arthropods, attracted by the lush regrowth of vegetation, may immigrate into the postburn habitat. They in turn may attract predaceous arthropods from surrounding unburned habitats. The fact that voles recolonized our study area several months earlier than shrews provides indirect evidence supporting the contention that shrew populations may be responding to developing prey populations, which in turn are dependent upon improving microhabitat conditions.

Other Species

Thirteen-lined ground squirrels were captured four months after the burn (14 captures), but no captures occurred after four months. Conditions may have become less attractive to thirteen-lined ground squirrels as vegetation height and density increased. Only three white-footed mice and four meadow jumping mice were captured on the study site; no discernable patterns were observed for either species.

SUMMARY AND MANAGEMENT RECOMMENDATIONS

Under certain circumstances, prescribed fire can cause high direct mortality of adult meadow voles. Meadow voles, northern short-tailed shrews, and masked shrews apparently abandon a burned area. Recolonization occurs sometime after the regrowth of vegetation. Meadow voles can recover from high direct mortality from a spring burn within four months. It appears that postburn habitat conditions become suitable for masked shrews and northern short-tailed shrews much later than for voles. Because recolonization of burned areas by voles and shrews seems highly dependent on immigration, it is important to establish burn units and burning schedules that leave unburned habitat adjacent to burned areas. This will facilitate recolonization of the burned area. Moreover, the smaller and more isolated the burn unit, the more critical it is to leave at least one-half of the area unburned as a source for recolonization. On larger areas where topography and hydrology cause a mosaic of burned and unburned patches, the unburned patches or "skips" should not be reignited because they provide insular refuges and sources of future immigrants. This strategy also benefits fire-sensitive invertebrates, which use adjacent unburned habitat as sanctuaries from which to reinvade burned areas (Panzer 1988).

On small areas, the ring fire technique can be executed so quickly that the encircling fire may be connected before voles, shrews, and other small mammals can escape. Although the ring fire method may be the technique of choice when burning near busy highways or when there is a need to complete the burn quickly, managers need to be aware of the potential for direct mortality to small mammals in these situations, especially if there is a high fuel load, compacted soil, or gravelly substrate.

ACKNOWLEDGMENTS

We thank the staff at Moraine Hills State Park, especially Greg Behm and John Laskowski for assisting with the prescribed burns. We also wish to thank Sue Penza for typing early drafts of the manuscript and Arlene Gallagher for preparing the final draft. Acknowledgment is given to the following reviewers: Carl Becker, Daniel Fagre, Lowell Getz, Randy Nyboer, Lynn Robbins, and an anonymous reviewer.

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