1989

Effects of Prescribed Fire on Small Mammals in Aspen Parkland

Garry C. Trottier

Ludwig N. Carbyn

George W. Scotter
Canadian Wildlife Service, Room 210,4999-98 Avenue, Edmonton, Alberta T6B 2X3

EFFECTS OF PRESCRIBED FIRE ON SMALL MAMMALS IN ASPEN PARKLAND

Garry C. Trottier, Ludwig N. Carbyn, and George W. Scotter
Canadian Wildlife Service, Room 210, 4999-98 Avenue, Edmonton, Alberta T6B 2X3

Abstract. Relative abundance of small mammals was monitored in an area of aspen parkland burned periodically in spring or fall over eight years to control trembling aspen (*Populus tremuloides* Michx.) encroachment into grassland meadows. Seven small mammal species were trapped on the burned and control areas. Meadow voles (*Microtus pennsylvanicus* Ord) and red-backed voles (*Clethrionomys gapperi* Vigors) dominated the captures prior to burning. Meadow voles were the most abundant species trapped throughout the study, but abundance was affected by frequency of burning and habitat. After three vegetative growing seasons, meadow voles had not recovered to pre-burn abundance in burned grasslands. Red-backed voles declined in burned areas while deer mice (*Peromyscus maniculatus* Wagner) and meadow jumping mice (*Zapus hudsonius* Zimmermann) were more prevalent. No differences were observed in small mammal abundance related to spring versus fall burns.

Key Words. prescribed fire, small mammals, aspen parkland, Prince Albert National Park, Saskatchewan

INTRODUCTION

In 1975, the Canadian Parks Service initiated a study in Prince Albert National Park to examine the role of fire as a management tool to maintain grassland communities. The objectives were to determine the optimal burn frequency and season to control trembling aspen (*Populus tremuloides* Michx.) encroachment into grassland areas and to monitor wildlife responses to a severe regime of burn treatments involving annual and biennial burns.

METHODS

Description of the Study Area

Prince Albert National Park (2,407 km²) is located in central Saskatchewan. The northern two-thirds of the park is covered by dense coniferous and mixedwood forests. Although the whole area is included in the Mixedwood Forest zone (Rowe 1959), the southern one-third of the park more closely resembles the aspen parkland, which is the transition zone between northern coniferous forests and the grasslands of the mixed prairie and fescue prairie (Rowe and Coupland 1984). Trembling aspen and balsam poplar (*Populus balsamifera* L.) form groves which are interspersed with patches of open to semi-open rough fescue [*Festuca hallii* (Vasey) Piper] grasslands (Carbyn 1971). Scattered jack pine (*Pinus banksiana* Lamb.) are present. Most of the large grasslands are located on gently undulating glacial outwash deposits in the southwest corner of the park at about 53° 30″ N latitude.

The burn treatments were conducted at Westrom Flats, a rough fescue grassland surrounded by predominantly trembling aspen forest. Aspen bluffs and isolated jack pine trees were scattered throughout the grassland. Soils were very well-drained, stony Brown Chernozems.

Plowed fire guards divided the central portion of the grassland into three adjacent burn treatment areas. Two unburned control areas were left at the east and west ends of the grassland, respectively. Over the period 1975 through 1982, spring and fall burns were conducted as weather permitted. Treatment Area A (16.2 ha) was burned five times in the fall. Area B (16.0 ha) was burned three times in the fall, and Area C (33.6 ha) was burned four times in the spring.

Patches of ecotone habitat (trembling aspen trees and suckers) scattered throughout the grassland were variably stocked with aspen suckers up to 1.5 m tall in 1983 following the burn treatments. In general, spring-burned ecotone experienced 24-92% tree mortality and increased sucker density compared with 60-96% tree mortality and reduced sucker density with fall burning. Sucker density averaged 5.6 stems/m² in the former and 2.3 stems/m² in the latter.

Small Mammal Trapping Studies

The three small mammal trapping studies conducted over the term of the management burns employed different procedures and timing. A pre-burn study was conducted from 11 June through 21 August 1975 on four grids each consisting of 206 unbaited Sherman live traps set for five consecutive nights. Two grids were placed in grassland habitat and two in ecotone habitat. Information on locations of these grids was not available to the authors, therefore, it was not possible to assign 1975 captures to the specific burn treatment areas. All 1975 captures were reported as unburned control rather than as pre-burn data points for the various treatments.

The 1976 study, which followed the first burn sequence, employed lines of museum special snap traps baited with peanut butter. Three traps were set at each of ten stations at 20 m intervals along two lines in each treatment and the controls. Habitat type for each cluster was recorded. Sampling was conducted for three nights per trap line from 21 May through 9 June.

Fire effects of different burn frequencies and seasons were evaluated by comparing residual small mammal communities on the treatment areas and controls using snap trap lines set during August, 1983. Trap lines consisted of 40 museum special traps baited with peanut butter and set in pairs at approximately 10 m intervals. Traps were set for three consecutive nights within homogeneous habitat. Different burn treatments were trapped simultaneously for each habitat type (e.g. three nights in grassland cover, then three nights in ecotone cover). This served to control the effects of varying weather conditions.

In 1983 the cover of accumulated organic matter (litter) and exposed soil in each treatment and control area were estimated within a grid of 25 1 m² microplots by the canopy-coverage method of Daubenmire (1959). Two vegetation grids were established in ecotone and grassland habitat in each burn treatment and one in an unburned control area.

Where sufficient captures of small mammals were obtained, the data were evaluated using a Chi-square test to assess the effect of burn frequency and habitat on small mammals inhabiting post-burn vegetation. Vegetation litter and soil variables for grassland and ecotone habitat on the study area were compared using the two-sample Mann-Whitney U test.

RESULTS

The number and timing of prescribed burns dictated the number of vegetation growing seasons that had elapsed prior to the final small mammal trapping survey conducted on the treatment areas during August 1983 (Table 1). Fall burn Area A, which was burned more frequently than fall burn Area B, had three growing seasons for recovery. Area B and spring burn Area C had two growing seasons for recovery. n nSeven small mammal species were captured on the study area over the term of the study. They were, in order of relative abundance, meadow vole (*Microtus pennsylvanicus* Ord), red-backed vole (*Clethrionomys gapperi* Vigors), deer mouse (*Peromyscus maniculatus* Wagner), meadow jumping mouse (*Zapus hudsonius* Zimmermann), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus* Mitchell), northern pocket gopher (*Thomomys talpoides* Richardson), and least chipmunk (*Eutamias minimus* Bachman). Only the four most frequently captured species (Table 2) are discussed further in this paper.

Meadow voles were the most abundant on the study area in contrast to the other species whose relative status changed following the burns (Table 2). Red-backed voles, which were quite abundant in unburned ecotone areas prior to burning, had not recovered to pre-burn abundance after three post-burn vegetative growing seasons. Conversely, deer mice and meadow jumping mice responded positively to burning, particularly in the ecotone areas, although the small number of captures precluded a statistical test of the trend.

Captures of meadow voles in spring 1976 were almost none as compared with 1975 (Table 2). Little vegetation recovery would have occurred at that time nor would there have been sufficient time for displaced populations to reoccupy and repopulate the burn areas. However, the capture rate in unburned control areas was also extremely low suggesting that other factors, perhaps population cycle or season of trapping, had an effect.

Burn frequency had a pronounced residual impact on meadow vole numbers in grassland habitat but not in ecotone habitat (Table 2). Four spring and five fall burns significantly reduced meadow voles compared with unburned grassland and the area burned three times (Chi-square = 58.28, d.f. = 3, $P < 0.005$). In contrast, meadow vole captures were the same in burned and unburned ecotone and for the different burn frequencies (Chi-square = 1.758, d.f. = 3, $P = 0.624$). This latter observation was not expected because ground cover of vegetation litter in the burned grasslands was either greater or not significantly different from that in the burned ecotone areas (Table 3).

The interaction of habitat had an influence on small mammal numbers in the burn treatment areas. More meadow voles (Chi-square = 30.7, d.f. = 3, $P < 0.005$), red-backed voles, deer mice, and meadow jumping mice were captured in ecotone than in grassland habitat.

Visual examination of the capture results indicated no difference in the effect of burn season on small mammals (Table 2). Lack of a spring burn treatment area with low burn frequency and the low capture rates precluded any evaluation of burn season effects.

DISCUSSION

The major effect of burning on small mammals is related to vegetation modification which, in turn, affects food resources and cover. Vegetation modification also alters microclimate (moisture

Table 1. Prescribed burns at Westrom Flats, Prince Albert National Park, Saskatchewan.

			Burn years: 1975-1982							
Burn study area	*Burn season*	*Number of burns*	*75*	*76*	*77*	*78*	*79*	*80*	*81*	*82*
A	Fall	5	X	X			X	X	X	
B	Fall	3	X				X	X		
C	Spring	4		X	X				X	X

Table 2. Small mammal captures for three different years on burn treatment sites and unburned controls at Westrom Flats, Prince Albert National Park, Saskatchewan ("—" = not evaluated).

	Grassland habitat				*Ecotone habitat*			
		Burn area[1]				*Burn area*[1]		
Species and year	*Control*	*A*	*B*	*C*	*Control*	*A*	*B*	*C*
Meadow vole								
1975	65	—	—	—	50	—	—	—
1976	5	0	0	—	1	0	0	—
1983	25	1	9	—	33	30	26	33
Red-backed vole								
1975	0	—	—	—	38	—	—	—
1976	0	0	0	—	0	0	3	—
1983	0	0	0	0	0	0	0	0
Deer mouse								
1975	0	—	—	—	1	—	—	—
1976	0	0	0	—	0	0	2	—
1983	0	0	0	0	0	6	2	0
Meadow jumping mouse								
1975	0	—	—	—	2	—	—	—
1976	0	0	0	—	0	0	0	—
1983	1	0	0	0	2	6	0	0

[1]Area A five fall burns.
Area B three fall burns.
Area C four spring burns.

Table 3. End-of-study litter (%) and bare ground (%) measured in 1983 at Westrom Flats, Prince Albert National Park, Saskatchewan.

Treatment	Growing[1] seasons	Litter: Grassland	Litter: Ecotone	Soil: Grassland	Soil: Ecotone
		% cover			
Control	N/A	94[2]	38[2]	2	6
3 fall burns	3	69[2]	44[2]	19[2]	33[2]
4 spring burns	2	27	28	67	51
5 fall burns	2	20	22	67[2]	50[2]

[1]Number of growing seasons since the last prescribed burn.
[2]Grassland and ecotone values differed significantly different (Mann-Whitney U test, $P < 0.001$).

regime and temperature) at ground level (Ream 1981, Wright and Bailey 1982). Over the short term, burning results in loss of cover and food, injury and death to some individuals, and increased exposure to predation. Over the long term, some species increase following burns due to the surge in herbage growth, increased seed production, and increased density of certain insect populations.

The depressed capture rate of meadow voles on the more frequently burned grassland areas in this study was probably due to loss of litter. Litter decreased and exposed soil increased as fire frequency increased (Table 3). This effect was tempered by the fact that the area with the lowest burn frequency also experienced one more year of vegetation recovery than the more frequently burned areas. However, the area burned five times had less litter cover than the area burned four times, with the same recovery time.

In contrast to the burned grassland areas, meadow vole captures in the ecotones were unaffected by burning. Litter cover did not appear to be a factor limiting the presence of small mammals in ecotones, because even in unburned ecotones, the ground cover of litter was less than one-half that of unburned grassland and was considerably less than in grassland burned three times (Table 3). Perhaps the abundance of trembling aspen suckers and the large amount of dead and downed woody material provided sufficient cover, particularly for protection from predators. Cover was an important habitat factor affecting site occupancy by meadow voles (Cook 1959, Ream 1981). Vacanti and Geluso (1985) also observed that meadow voles were not killed by fire and emigrated to better cover when disturbed.

Two vegetative growing seasons following fire disturbance appeared to be sufficient time for meadow voles to reoccupy burned ecotone in the aspen parkland. It appeared to take more than three growing seasons for populations to recover in burned grassland habitat. Meadow voles have been observed to be severely depleted for up to two years following prescribed burning in grasslands and then to recover as organic matter accumulates at ground level (Cook 1959, Vacanti and Geluso 1985, Driver 1987). Chance (1986), however, found that meadow voles recovered to pre-burn numbers in grassland ten months after a fall burn.

Ahlgren (1966) and Viereck (1979) found that red-backed voles were sensitive to burning and that populations remained low for at least two years following a burn. Three red-backed voles were captured in burned ecotone three growing seasons after the last burn, but the numbers were much depressed compared to the pre-burn trapping study in 1975. Since no red-backed voles were captured in unburned ecotone during 1983, it is possible that some other factor was affecting overall presence of this species in the study area. Tester (1965) postulated that the post-burn flush of herbs attracted the red-backed voles that were captured in burned areas, because this species traditionally occupies a variety of habitats within its home range.

Deer mice and meadow jumping mice were expected to occur more frequently in areas that had been recently burned. Although insufficient numbers of these species were captured for confirmation, an increase did occur in capture of these species compared with pre-burn conditions in 1975 and with the unburned control areas in 1983. The immediate invasion of burned areas by deer mice has been reported in a variety of habitats (Tester 1965, Ahlgren 1966, Sims and Buckner 1973, Kaufman *et al.* 1983, Vacanti and Geluso 1985, Driver 1987).

The evidence for viable mouse-vole populations in burned ecotone areas in Prince Albert National Park indicated that refuges were maintained from which adjacent burned grassland could be repopulated when habitat conditions recovered. The treatment areas together sustained a diverse small mammal prey base under a burn management regime.

ACKNOWLEDGEMENTS

The authors wish to thank the following technicians and contract employees who participated in the field work during the three small mammal trapping studies: Duane Sept, Howard Samoil, Anne Gunn, Robert Hutchison, Tom Peart, and Alan Arsenault. Statistical analyses were prepared by Sam Barry. The manuscript was ably reviewed by Andrew Radvanyi, Ed Driver, Thomas Bragg, and an anonymous reviewer. Financial support for this project was provided by the Canadian Parks Service and the Canadian Wildlife Service, both part of Environment Canada.

LITERATURE CITED

Ahlgren, C.E. 1966. Small mammals and reforestation following prescribed burning. Journal of Forestry 64:614-618.

Carbyn, L.N. 1971. Description of the *Festuca scabrella* association in Prince Albert National Park, Saskatchewan. Canadian Field-Naturalist 85:25-30.

Chance, R.L. 1986. The effect of fall burning on small mammals in Blue Mounds State Park, Luverne, Minnesota. Pages 157-159. *In* G.K. Clambey and R.H. Pemble (eds.). Proceedings of the Ninth North American Prairie Conference, Tri-College University Center for Environmental Studies, Moorhead, Minnesota.

Cook, S.F. 1959. The effects of fire on a population of small rodents. Ecology 40:102-108.

Daubenmire, R.F. 1959. A canopy coverage method of vegetation analysis. Northwest Science 33:43-61.

Driver, E.A. 1987. Fire on grasslands - friend or foe? Blue Jay 45:217-225.

Kaufman, D.W., Kaufman, G.A., and E.J. Finck. 1983. Effects of fire on rodents in tallgrass prairie of the Flint Hills region of eastern Kansas. Prairie Naturalist 15:49-56.

Ream, C.H. 1981. The effects of fire and other disturbances on small mammals and their predators; an annotated bibliography. United States Department of Agriculture Forest Service General Technical Report INT-106.

Rowe, J.S. 1959. Forest regions of Canada. Department of Northern Affairs and Natural Resources, Ottawa. Bulletin 123.

Rowe, J.S., and R.T. Coupland. 1984. Vegetation of the Canadian Plains. Prairie Forum 9:231-248.

Sims, H.P., and C.H. Buckner. 1973. The effects of clearcutting and burning of *Pinus banksiana* forests on populations of small mammals in southeastern Manitoba. American Midland Naturalist 90:228-231.

Tester, J.R. 1965. Effects of a controlled burn on small mammals in a Minnesota oak-savanna. American Midland Naturalist 74:240-243.

Vacanti, P.L., and K.N. Geluso 1985. Recolonization of a burned prairie by meadow voles (*Microtus pennsylvanicus*). Prairie Naturalist 17:15-22.

Viereck, L.A. 1979. Ecological effects of the Wickersham Dome fire near Fairbanks, Alaska. United States Department of Agriculture Forest Service General Technical Report.

Wright, H.A., and A.W. Bailey. 1982. Fire ecology, United States and southern Canada. John Wiley & Sons. New York.