Notes and records

Delayed effects of fire on habitat use by large herbivores in *Acacia drepanolobium* savanna

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Introduction

Fire is frequently used as a wildlife management tool in savanna habitats (Trollope, 1982). Burning stimulates sprouting of plants (Vesey-Fitzgerald, 1971), improving forage quality (Komarek, 1967; Dorgeloh, 1999). Several studies have supported quantitatively what has been well-known by managers for some time, namely that ungulates are attracted by resprouting vegetation in recently burned areas (Moe, Wegge & Kapela, 1990; Wilsey, 1996; Tomor & Owen-Smith 2002). Rapid resprouting initiated by fire, and reinforced by herbivory (cf. McNaughton, 1985), may contribute to attract herbivores consistently to the same areas in a feedback loop (Fuhlendorf & Engle 2004). Most of these studies have generally taken place shortly after burning occurred, so the present work was conducted with the aim of testing whether herbivores prefer burnt areas in subsequent growing seasons, i.e. when the short-term response to fire is no longer important.

Materials and methods

The study was conducted at the Mpala Research Center, Laikipia, Kenya. The climate is semi-arid, with annual rainfall averaging 300–600 mm, and the vegetation is dominated by *Acacia* sp., with *Acacia drepanolobium* (Sjost.) being the dominant species. Some of the more common large herbivores found are giraffe (*Giraffa camelopardalis* L.), buffalo (*Syncerus caffer* Sparrman), cattle (*Bos taurus* Linnaeus), greater kudu (*Tragelaphus strepsiceros* Pallas), eland (*Taurotragus oryx* Pallas), Grant's (*Gazella granti* Brooke) and Thompson's (*Gazella thomsoni* Brooke) gazelles, impala (*Aepyceros melampus* Lichtenstein), bushbuck (*Tragelaphus scriptus* Pallas), dik-dik (*Madoqua kirkii* Günther), and Burchell's zebra (*Equus burchelli* Gray).

Large (>1 km^2) areas were designated for prescribed burns within an ecologically homogeneous site. Interspersed among them were unburned areas that were used as control sites in the present study. Burning was carried out in March 1991 for two of the burn areas, and in April 1992 for the remaining one. The fires were typical of prescribed burns used for game management in the area. In December 1993 and January 1994 a single 2-ha plot was set up within each of the three burn and control sites for estimation of herbivore density. Direct counts of terrestrial animals can be biased towards locating large and gregarious species (Wilson & Johns, 1982), so we estimated herbivore abundance through pellet group counts. We walked three 100 m transects in each plot, starting from an arbitrary spot and with a random angle selected from a table that would place transects inside the plot. We recorded all dung piles within 2 m of the transect midline and classified them according to species. We counted adjacent groups of similar appearance as different piles, unless they were definitively connected by scattered pellets, and piles with pellets redistributed by water or other agents were not recorded. Dung was classified into four categories: giraffe, cattle and buffalo, medium ungulates (Grant's gazelle, impala) and small ungulates (dik-dik, steinbuck). Mean dung counts and their standard deviations were computed for control and burned plots.

Results and discussion

Given the small number of replicates in the study, only descriptive statistics are presented. Burned plots appeared to have a greater number of dung piles than control plots (Fig. 1), suggesting more intensive use of burned areas than control areas. Our study assumes that none of the

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dung piles counted in the survey were present during the season immediately following the burns, given that the primary purpose of the study was to investigate the long-term effect (i.e. not those resulting from short-term vegetation growth caused by burning) of fire on habitat use by herbivores. In at least two studies examining dung-decay rates in African ungulates (Plumptre & Harris, 1995; Nchanji & Plumptre, 2001), the longest recorded duration of a dung pile was 10 months. To a large extent in the plot burned in April 1992, and certainly in the case of the plots burned in 1991, dung deposited during the growing season immediately following burning would have fully decayed by the time of the survey.

Previous studies have shown that fire may cause short-term changes in forage quality and availability that attract herbivores, but less is known about the longer term effects of fire on plant nutritional quality. It is therefore unclear if the persistence of the preference for formerly burned areas by herbivores responds to a residual effect of fire. An alternative explanation for the observed pattern is that a fire effect may initially attract herbivores to burned patches, but the subsequent maintenance of high herbivore numbers may be the result of a positive feedback loop, whereby high browsing (Bergstrom, Skarpe & Danell, 2000) and grazing pressure (McNaughton, 1985) by the herbivores themselves promotes repeated regrowth of high-quality forage. Regardless of the mechanism responsible for the observed pattern, it is suggested that the interaction between fire and herbivory may exert lasting effects on the landscape. This interaction has seldom been explicitly investigated, but its importance in maintaining habitat heterogeneity and biodiversity is increasingly recognized (Fuhlendorf & Engle 2004). A factorial experiment combining burning treatments with herbivore exclosures would contribute significantly to elucidating the relative contribution of main versus synergistic effects in savanna ecosystems.

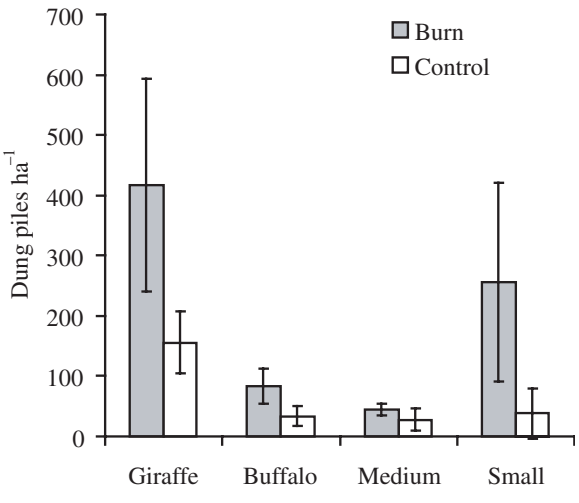

Fig 1 Dung pile density (mean ± SD) for four ungulate classes in burned plots and unburned control plots (n = 3) in Mpala Research Center, Laikipia, Kenya

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References

Bergstrom, R., Skarpe, C. & Danell, K. (2000) Plant responses and herbivory following simulated browsing and stem cutting of *Combretum apiculatum*. *J. Veg. Sci.* **11**, 409–414.

Dorgeloh, W.G. (1999) Chemical quality of the burnt and non-burnt grass layer in the Nylsvlei Nature Reserve, South Africa. *Afr. J. Ecol.* **37**, 168–179.

Komarek, E.V. (1967) Fire and the ecology of man. In: Proceeding of the Sixth Annual Tall Timbers Fire Ecology Conference. Tall Timbers Research Station, Tallahasee, Florida, pp. 143–170.

McNaughton, S.J. (1985) Ecology of a grazing ecosystem: the Serengeti. *Ecol. Monogr.* **55**, 259–294.

Moe S.R., Wegge, P. & Kapela, E.B. (1990) The influence of man-made fires on large wild herbivores in Lake Burungi area in northern Tanzania. *Afr. J. Ecol.* **28**, 35–43.

Nchanji, A.C. & Plumptre, A.J. (2001) Seasonality in elephant dung decay and implications for censusing and population monitoring in south-western Cameroon. *Afr. J. Ecol.* **39**, 24–32.

Plumptre, A.J. & Harris, S. (1995) Estimating the biomass of large mammalian herbivores in a tropical montane forest: a method of faecal counting that avoids assuming a 'steady state' system. *J. Appl. Ecol.* **32**, 111–120.

Trollope, W.S.W. (1982) Ecological Effects of Fire in South African Ecosystems (Eds B. J. Huntley and B. H. Walker). Springer Verlag, New York.

Vesey-Fitzgerald, D. (1971) Fire and animal impact on vegetation in Tanzania National Parks. In: Proceeding of the 11th Annual Tall Timbers Fire Ecology Conference. Tall Timbers Research Station, Tallahasee, Florida. pp. 297–317.

WILSEY, B.J. (1996) Variation in use of green flushes following burns among African ungulate species: the importance of body size. *Afr. J. Ecol.* **34,** 32–38.

WILSON, W.L. & JOHNS, A.D. (1982) Diversity and abundance of selected animal species in undisturbed forest, selectively logged forest and plantations in East Kalimantan, Indonesia. *Biol. Conserv.* **24,** 205–218.

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