Rangeland Ecology & Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Rangeland Ecology & Management

journal homepage: http://www.elsevier.com/locate/rama

Generation of Ecosystem Hotspots Using Short-Term Cattle Corrals in an African Savanna☆,☆☆,★

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ARTICLE INFO

Article history:
Received 26 November 2013
Accepted 10 November 2014
Available online xxxx

Keywords:
Fragmentation
Grazing lawn
Islands of fertility
Laikipia
Legacy effects
Ol Pejeta

ABSTRACT

Worldwide, many rangelands are managed for multiple uses, and it is increasingly important to identify livestock management practices that maximize rangeland productivity, biodiversity, and wildlife conservation. In sub-Saharan Africa, pastoralists and ranchers use temporary thorn-fence corrals ("bomas") to protect livestock at night. Traditional boma sites (used for months or years, then abandoned) develop into productive ecosystem hotspots ("glades") that attract diverse wildlife and persist for decades or even centuries. In central Kenya, livestock managers have recently begun using metal-fenced "mobile bomas," which are moved after only days or weeks. Although the assumption is that mobile boma sites will also develop into glades, whether or not this is true remains unclear. We used a broad-scale manipulative experiment to evaluate the ecosystem-level effects of mobile bomas used for 1 month. We also investigated impacts of initial boma density on glade development. We randomly assigned 12 plots to one of three density treatments: one boma, two bomas 200 m apart, or two bomas 100 m apart. Before the experiment and at 1, 6, 12, 18, and 32 months after boma abandonment, we sampled soil nutrients, foliar nutrients, plant communities, and wildlife use (via dung counts) within abandoned boma sites (experimental glades) and at paired reference sites (200 m away). After 18 months, surface soil nutrient concentrations in experimental glades were similar to those in traditionally formed glades. Experimental glade plant communities became dominated by a palatable, rhizomatous grass species, *Cynodon plectostachyus*. After 32 months, wildlife use by browsing and mixed feeding ungulates was 9 times higher in experimental glades than at paired reference sites. Boma density had few impacts on within-glade development patterns. These results demonstrate that by concentrating livestock in short-term corrals, managers can create ecosystem hotspots that increase functional heterogeneity, attract wildlife, and provide palatable forage for livestock.

Introduction

Rangelands worldwide are increasingly being managed for multiple ecosystem services, often including both livestock production and wildlife conservation. Management of the livestock that dominate many of these systems can have long-term impacts, including shifting ecosystems across thresholds into alternative ecological states. A common example is bush encroachment, wherein heavy or prolonged livestock grazing can lead to increases in woody plant cover (Scholes and Archer, 1997; Coetzee et al., 2008). Recently, however, some attention has focused on how livestock can be used as a tool to achieve restoration and conservation objectives; for example, by rejuvenating sagebrush for sage-grouse habitat improvement (Dziba et al., 2007; Petersen et al., 2014); increasing plant diversity in ephemeral wetlands (Marty, 2005); or reducing undesirable invasive annual grass cover and associated fire risk (Diamond et al., 2009; Workgroup, 2010). In sub-Saharan Africa, centuries-long traditional livestock husbandry practices led to the creation of ecological hotspots with high nutrient availability, high productivity, unique plant communities, and preferential use by wildlife (Blackmore et al., 1990; Reid and Ellis, 1995; Young et al., 1995; Augustine et al., 2003; Treydte et al., 2006b; Muchiru et al., 2009; Söderström and Reid, 2010; van der Waal et al., 2011; Veblen, 2012; Donihue et al., 2013). Here we investigate the conditions necessary to create these hotspots and follow their initial development over 2.5 years in order to learn how livestock can be used as a tool for increasing long-term rangeland productivity and biodiversity.

Across eastern and southern Africa, livestock are traditionally kept in thorn-fence corrals, or "bomas," at night for protection against predation and theft (Western and Dunne, 1979; Blackmore et al., 1990). Traditional bomas range from 10 to more than 100 m in diameter and

☆ Research was funded in part by the National Science Foundation (GRF and DDIG 09-09539 to L.M.P., LTREB DEB-08-16453 to T.P.Y.) and the University of California at Davis (Plant Sciences Dept Fellowships, Jastro-Shields and Benjamin Madson Research Scholarships).

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★ At the time of research, Porensky was a graduate student in the Department of Plant Sciences, University of California, Davis, CA 95616, USA, and both authors were researchers at Mpala Research Centre, PO Box 555, Nanyuki 10400, Kenya.

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http://dx.doi.org/10.1016/j.rama.2015.01.002
1550-7424/

are used for months or years before being abandoned (Blackmore et al., 1990; Augustine, 2003; Muchiru et al., 2009; Söderström and Reid, 2010; van der Waal et al., 2011; Veblen, 2012). The accumulated dung layer (which can be more than 50 centimeters deep: Augustine, 2003; Muchiru et al., 2009; Veblen, 2012) results in large amounts of nitrogen, phosphorus, organic carbon, and other nutrients being concentrated at abandoned sites (Reid and Ellis, 1995; Augustine, 2003; Augustine et al., 2011; van der Waal et al., 2011; Veblen, 2012). Livestock disturbance and associated dung deposition have lasting effects on the vegetation that establishes at these sites (e.g., Stelfox, 1986; Reid and Ellis, 1995; Young et al., 1995; Muchiru et al., 2009; van der Waal et al., 2011; Veblen, 2012; Vuorio et al., 2014). Similar patterns have been observed in North America, where temporary sheep bedding sites develop into sites with more available nutrients and distinctive plant communities (Leytem and Seefeldt, 2008; Seefeldt and Leytem, 2011).

In central Kenya, abandoned boma sites develop into treeless, lawn-grass-dominated, highly productive and nutrient-rich "glades" that persist for at least 50 years (Augustine, 2003; Augustine et al., 2003, 2011; Veblen, 2012) through a combination of legacy effects and animal-mediated feedbacks (e.g., Augustine et al., 2003; Veblen and Young, 2010; Porensky and Veblen, 2012; Veblen, 2012). In this region, novel livestock management practices have prompted increased interest in the process of glade development. Livestock managers have recently developed metal-fenced bomas (Fig. 1A and B) designed to better protect livestock against lion predation. These metal-fenced bomas have the added advantage of being highly

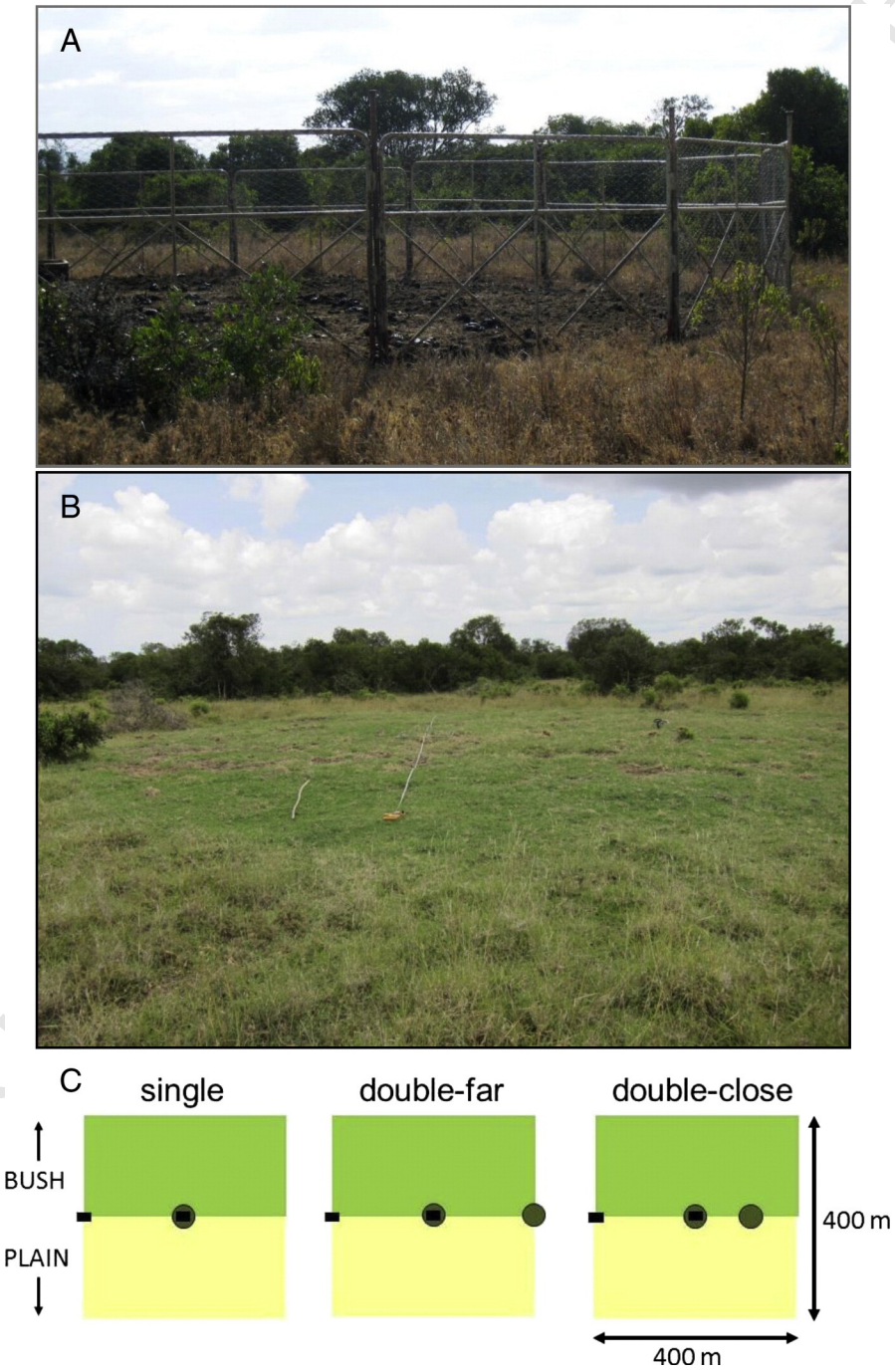

Fig. 1. A, Metal-fenced bomas protect livestock from predators and are easy to move. B, Experimental boma site 32 months after abandonment. C, Sampling design. Circles represent experimental boma sites (17.4 ± 0.7 m in diameter), and small rectangles represent 8 × 14 m sampling subplots.

Please cite this article as: Porensky, L.M., Veblen, K.E., Generation of Ecosystem Hotspots Using Short-Term Cattle Corrals in an African Savanna, Rangeland Ecology & Management (2015), http://dx.doi.org/10.1016/j.rama.2015.01.002