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Interactions between native tree species and environmental variables along forest edge-interior gradient in fragmented forest patches of Taita Hills, Kenya

C. Wekesa[a,b,*], E.K. Maranga[b], B.K. Kirui[b], G.M. Muturi[c], M. Gathara[c]

[a] Kenya Forestry Research Institute, Coast Eco-Region Research Programme, P.O. Box 1078-80200, Malindi, Kenya
[b] Egerton University, Department of Natural Resources, P.O. Box 536-20115, Egerton, Kenya
[c] Kenya Forestry Research Institute, Headquarters, P.O. Box 20412-00200, Nairobi, Kenya

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ABSTRACT

Comparative investigations were undertaken in five forest fragments (Chawia, Fururu, Mbololo, Ngangao and Vuria) of varying sizes in Taita Hills, Kenya to examine the effects of forest edge on soil moisture, nitrogen, phosphorus, potassium, pH, electrical conductivity and organic carbon (hereafter referred to as environmental variables) along forest edge-interior gradient and relate them to tree species distribution and abundance. For each of the forest fragment, belt transects proportional to the forest area were established for data collection. Within each belt transect, plots of 10.0 × 10.0 m were systematically established and replicated three times in a stratum at an interval of between 10.0 and 50.0 m along forest edge-interior gradient depending on the size of the forest fragment for assessment of environmental variables and tree species distribution and abundance. Results showed significant edge effect on the distribution and abundance of dominant and adaptable tree species i.e. *Macaranga conglomerata*, *Albizia gummifera*, *Syzygium guineense*, *Xymalos monospora*, *Tabernaemontana stapfiana* and *Maesa lanceolata* ($p = .012$). Edge effect was also noted among the following environmental variables; soil pH in Mbololo ($p < .001$), Ngangao ($p < .001$) and Vuria ($p = .042$), electrical conductivity ($p = .048$) and nitrogen ($p = .038$) in Fururu and potassium in Mbololo ($p = .002$) and Ngangao ($p = .035$). The distance from the forest edge influenced the distribution and abundance of 36.7% and 36.4% of most abundant species and less abundant species respectively. The environmental variables-tree species relationships established in this study could be utilized in selecting native tree species for rehabilitation programs to restore the degraded sites within the forest fragments.

1. Introduction

Forest fragmentation is among the greatest threats to biodiversity (Pardini et al., 2010; Laurance et al., 2011; Magnago et al., 2014; Magnago et al., 2015), species interactions and ecosystem processes in tropical forests (Steffan-Dewenter et al., 2007; Morris, 2010). Fragmentation of forests into small isolated patches increases susceptibility of forest remnants to edge effects (Matlack, 1993). The microclimate at the forest edge differs from that of the forest interior in attributes such as incident light, humidity, ground and air temperature, wind shear, and wind turbulence that sharply elevate rate of tree mortality and damage and influences most of the biotic variables (Jose et al., 1996; Laurance and Bierregaard, 1997; Laurance et al., 2011). These physical changes affect biological processes such as litter decomposition and nutrient cycling, and the forest structure, composition of vegetation and ecological function along forest edges exposed to non-forested habitats (Bennett and Saunders, 2010).

Effects of increased forest edge alter species interactions by increasing the degree of interaction among edge and forest interior species (Laurance and Bierregaard, 1997; Laurance et al., 2000, 2011). Tree species growing on the edge are usually those adapted to edge microclimates and are often pioneer species found in the early stages of forest succession in any given region (Kupfer and Malanson, 1993). The responses of forest interior species to conditions that develop along the newly created forest edge vary, some species are advantaged and increase in abundance (Bennett and Saunders, 2010) while others are unable to survive in the newly created conditions and hence decline, becoming locally extinct (Laurance, 2002; Bennett and Saunders, 2010).

Edge effects are among the most significant drivers of ecological

* Corresponding author at: Kenya Forestry Research Institute, Coast Eco-Region Research Programme, P.O. Box 1078-80200, Malindi, Kenya. Tel.: +254 722 985279.
E-mail address: chemukukefri@gmail.com (C. Wekesa).

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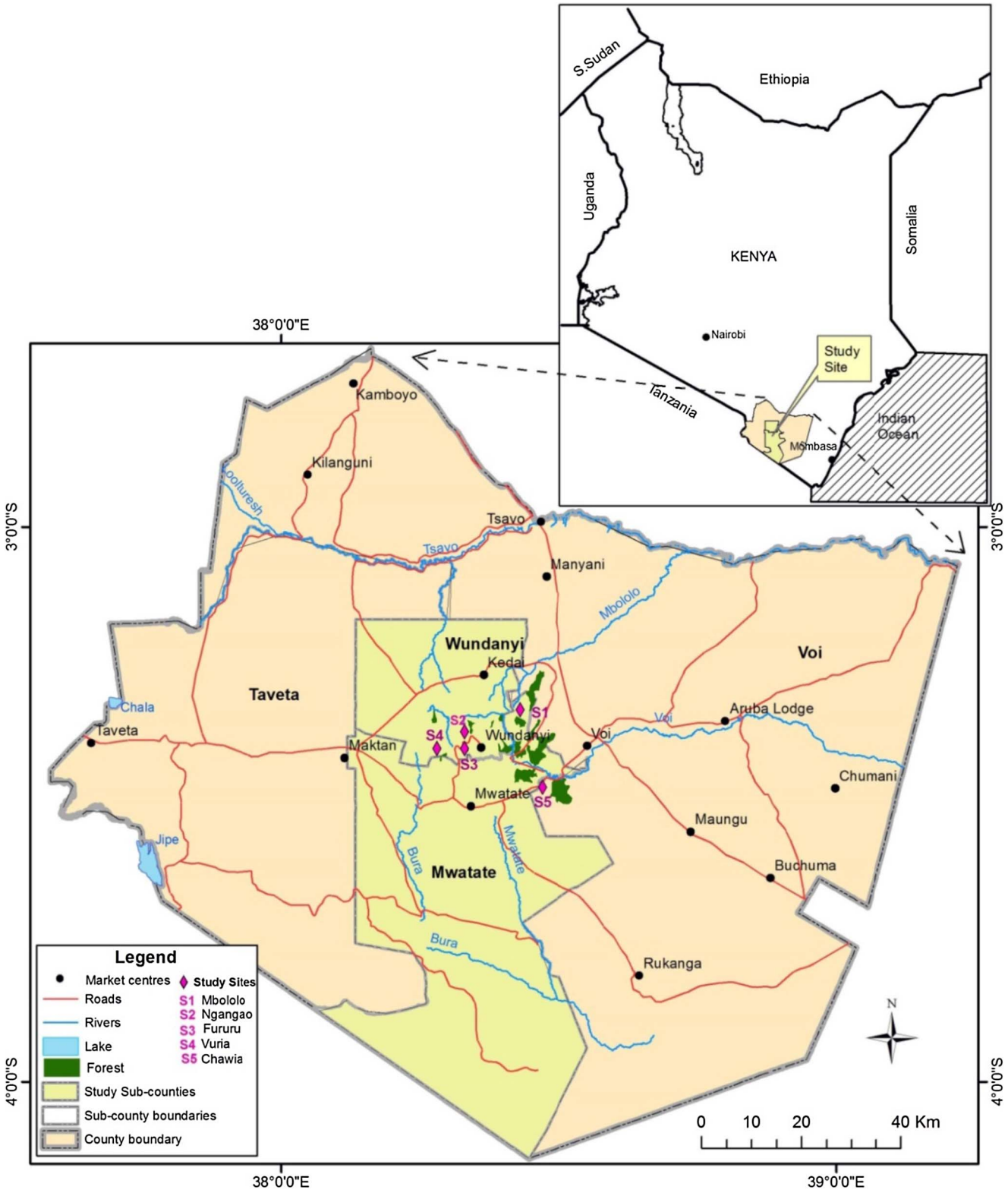

Fig. 1. A map of Taita Taveta County showing the study sites.

change in small forest fragments (Laurance et al., 2011) and are responsible for wide ranging changes in community composition of trees (Laurance et al., 2000, 2006a, 2006b) and lianas (Laurance et al., 2001). Stresses related to edge effects reduce establishment of shade-tolerant species in fragmented forests leading to drastic changes in tree species richness and composition along forest edge-interior gradient (Benítez-Malvido and Martínez-Ramos, 2003; Laurance et al., 2006a, 2006b; Laurance, 2007; Laurance et al., 2011). The distance to which different edge effects penetrate into fragments varies widely, ranging from 10 to 300 m (Jose et al., 1996; Laurance et al., 2002). The environmental conditions progressively change with distance from the forest edge (Matlack, 1993; Jose et al., 1996; Marchand and Houle, 2006; Bergès et al., 2013). Besides, the distribution and occurrence of woody and herbaceous plants in a forest community changes from the