Acta Oecologica 35 (2009) 573–580

Contents lists available at ScienceDirect

Acta Oecologica

journal homepage: www.elsevier.com/locate/actoec

Original article

# Moving window analysis and riparian boundary delineation on the Northern Plains of Kruger National Park, South Africa

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ARTICLE INFO

Article history:
Received 19 December 2008
Accepted 14 May 2009
Published online 5 June 2009

Keywords:
Boundary
Vegetation
Delineation
Kruger National Park

ABSTRACT

Landscapes commonly comprise of mosaics, patches and boundaries. Riparian boundaries are complex to delineate and characterize, with a multitude of variables available for delineation. Multiple methods exist for boundary delineation such as two-dimensional wombling, constrained classification techniques and discontinuity detection. One method that has proven to be reliable in boundary delineation with one-dimensional transect data is the moving split window (MSW) analysis. This study demonstrates the efficacy of MSW to delineate grass species turnover and environmental boundaries across two geologically dissimilar riparian zones in the Kruger National Park, South Africa. There are few studies that have delineated riparian boundaries of Kruger National Park, and none that have used the MSW analysis. MSW detects significant changes in dissimilarity indices of variables along gradients. Significant shifts in dissimilarity designate boundaries at various spatial scales dictated by window sizes. Significant boundaries emerge by altering window sizes, increasing quadrat width and removing infrequent herbaceous species. By utilizing these three methods, MSW background variance was reduced and riparian and wetland/upland boundaries were sharper and more easily defined.



## 1. Introduction

Landscapes are heterogeneous entities (Gosz, 1991) with sharp transitions in habitat attributes at irregular intervals (Turner et al., 1989). These transitions are termed boundaries and can be distinguished compositionally (i.e. species diversity), structurally (i.e. elevation gradients) and functionally (i.e. nutrient flux). A boundary is defined as a zone of transition between adjacent ecological systems (Holland et al., 1991) at various spatial and temporal scales (Pickett and Cadenasso, 1995), and are inherent features of a landscape (Fortin et al., 2000). Abrupt transitions between forests and grasslands, riparian and upland vegetation or between wetland and upland patch types are clear examples of boundaries.

Ephemeral wetlands are dominant patch types on the northern basaltic plains of Kruger National Park (KNP), South Africa (Harrington et al., 1999). These wetlands are distinctly separated from the *Colophospermum mopane* (Kirk ex Benth.) Kirk ex J.Léon shrubveld matrix by a compositionally unique (*Sporobolus ioclados* (Trin.) Nees [Family Poaceae]) wetland/upland boundary (Kröger and Rogers, 2005). Several major rivers also traverse the plains including the Shingwedzi, Bububu, Mphongolo and Phugwane. Riparian fringes along these rivers act as transition zones between purely lotic and terrestrial/upland systems (Naiman and Decamps, 1997). Understanding the complex array of boundaries across the riparian zone requires explicit elucidation of which boundary one is dealing with. Examples include: grass species turnover boundary, tree-canopy boundary, and a nutrient flux boundary. Boundaries between patches in the landscape will have important influences on system properties both within and between patches (Gosz, 1991). Patches are adjacent systems distinguished by a unique set of compositional, structural and functional attributes.

The scale at which boundaries are detected provides context for the nature of the boundary. Transect data can show edge locations where the transect intersects a patch, thus defining the boundaries to the patch (Brunt and Conley, 1990). There are various techniques for detecting boundaries: moving window analysis (Ludwig and Cornelius, 1987; Turner et al., 1992) two-dimensional wombling (Fortin, 1994; Fortin et al., 1996; Fortin, 1999a), constrained or conditional classification techniques (Legendre and Fortin, 1989),

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doi:10.1016/j.actao.2009.05.007

and co-efficient of similarity indices (Beals, 1969). For one-dimensional transect data the moving split window (MSW) analysis is the most useful (Brunt and Conley, 1990; Fortin and Dale, 2005). Moving split window analyses detect one-dimensional boundaries using dissimilarity indices such as squared Euclidean distance (SED), Maholobis, Orloci, or Hotellings-Lawley trace (Wierenga et al., 1987). There are numerous examples describing the use of the MSW analysis (Ludwig and Cornelius, 1987; Wierenga et al., 1987; Johnston et al., 1992; Choesin and Boerner, 2002); however, very few describe riparian boundary delineation using one-dimensional vegetation and environmental data. Characterizing spatial patterns of patches and boundaries (i.e. the distribution of species) is essential for understanding the ecology of an area (Fortin, 1999b; Kent et al., 2006).

The aim of this study was to use one-dimensional transect data and the MSW analysis to detect grass species and environmental boundaries across two different riparian zones on the Northern Plains of KNP. We also highlight various techniques used within the MSW analysis to delineate and characterize boundaries more effectively.

## 2. Materials and methods

### 2.1. Study sites

The study occurred at two different sites on the Northern Plains of KNP, South Africa (Fig. 1). The Northern Plains are classified as *C. mopane* shrubveld (Acocks, 1988) and stretch from the Punda Hills in north to the Shingwedzi River in the south, with the Lebombo mountains flanking the plains to the east. Gertenbach (1983) described the Northern Plains landscape as consisting of flat to concave plains with numerous drainage depressions. The plains have a dominant basalt underlying rock formation in the east and a granitic base in the west (Fig. 1). The first study took place along the N'washitsumbe ephemeral wetland (22°30′S–31°30″E) and the second along the Phugwane river (23°04′56″S–31°25′17″E) (Fig. 1). The N'washitsumbe wetland is 10.9 km long and drains into the Shisha river to the south. The Phugwane river flows west–east within the granitic western plains and eventually discharges into the Mphongolo and Shingwedzi rivers. Both sites are situated within the greater Shingwedzi watershed. Though both communities comprise both understorey and overstorey species, this study specifically examined the herbaceous understorey component of each. The herbaceous component was identified and described using gradient-orientated transects perpendicular to the respective water courses. In total there were 30 and 38 herbaceous species recorded for the N'washitsumbe and Phugwane sites respectively. The median number of species encountered per transect at the N'washitsumbe and Phugwane river sites were 10 and 15 species respectively. Species common to both sites included: *Panicum maximum* Jacq, *Setaria incrassata* (Hochst.) Hack., *Urochloa mosambicencis* (Hack.) Dandy (upland species); *Phragmites australis* (Cav.) Steud, *Eriochloa meyeriana* (Nees.) Pilg (wetland species); *S. ioclados, Cynodon dactylon* (transition/boundary species).

Transects were placed in a stratified manner across transition zones on both study sites running from river/wetland systems to upland ecosystems. Stratification followed the geomorphic heterogeneity of both geologies. On the N'washitsumbe site, 15 transects were spaced longitudinally along the wetland profile. Similarly, the Phugwane river site had 17 transects spaced along the river, covering smallest stream orders through to main stem. Contiguous quadrats were sampled along all transects on both sites for grass species abundance (% aerial cover), presence/absence and

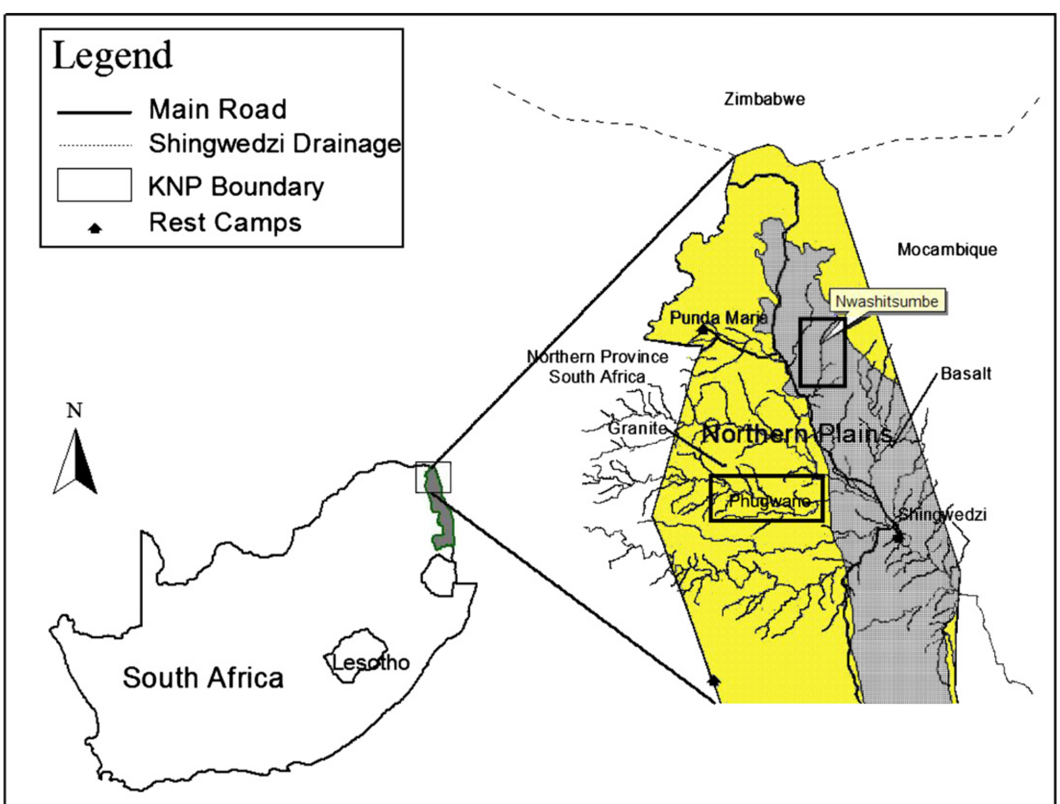


**Fig. 1.** Study site map showing the location of Kruger National Park (KNP), the Northern Plains, the Phugwane river site and the N'washitsumbe wetland site. Fifteen transects were sampled along a single wetland at the N'washitsumbe site, while 17 transects were sampled from 1st order to main stem reaches of the Phugwane river.