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Cattle browsing impacts on stunted *Avicennia marina* mangrove trees

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ABSTRACT

Mangroves in South Africa are threatened by over-utilization through harvesting for firewood and building materials as well as excessive browsing and trampling by livestock. At Nxaxo Estuary (32°S; 28°E) the response of *Avicennia marina* to cattle browsing and trampling was investigated by using exclusion plots. These were established by fencing in five 25 m^2 quadrats and adjacent to each experimental quadrat a browsed quadrat. Trees were tagged and measured annually from 2010 to 2012. Sediment salinity, pH, moisture, organic content, compaction as well as sediment particle size did not differ between browsed and non-browsed quadrats. Significant increases in mean tree height (5.41 ± 0.53 cm), crown volume (0.54 ± 0.01 m^3) and crown diameter (7.09 ± 0.60 cm) from 2010 to 2012 were recorded for the non-browsed plots. Trees in the browsed plots had significantly lower growth ($p < 0.05$). The browsed trees were stunted with horizontal spreading of branches while the trees in the non-browsed plots showed an increase in vertical growth and expansion. There was a greater percentage of flowering (54%) and fruiting (19%) for trees in non-browsed plots compared to the browsed sites where 34% of the trees were flowering and 6% of the trees carried immature propagules. The study concluded that browsing changes the morphological structure of mangrove trees and reduces growth and seedling establishment. This is the first study to document the impact of browsing on mangroves.

1. Introduction

More than 50% of mangroves worldwide have been lost to urban development, aquaculture, mining along coastal zones and over-exploitation (Hogarth, 1999; Alongi, 2002, 2008). Many coastal communities rely on mangrove forests for fish, crustaceans and shellfish; however it is the harvesting of trees for timber, through practices such as clear-felling, which causes the greatest changes in mangrove forests. The demand for natural resources is continually increasing due to population growth and about 1–2% of mangrove forests are being lost annually on a global scale due to over-utilization (Alongi, 2002, 2008). The many uses of, and hence source of pressure to mangrove ecosystems have been widely researched (Lugo and Snedaker, 1974; Dahdouh-Guebas et al., 2006).

In South Africa, there have been several reported threats to mangrove forests. For example they are commonly used as a source of fuel for firewood, in construction as building material, eaten by cattle, and as fishing poles for recreational and subsistence fishing (Adams et al., 2004; Rajkaran et al., 2004). Other threats include modified freshwater flows, prolonged mouth closure (and subsequent changes to the intertidal habitat), inappropriate coastal development and poor catchment practises. Mangroves in South Africa are of interest as they occur at one of the most southernly distributions in the world. Climate change will influence future distribution patterns (Quisthoudt et al., 2013; Saintilan et al., 2014) while present anthropogenic impacts are causing mangrove loss. For example harvesting has decreased the size of the mangrove forest at the Mngazana Estuary and has changed the size structure of the population. This has lead to decreased recruitment and regeneration of the forest (Rajkaran and Adams, 2012).

Mangroves have numerous characteristics of pioneer-phase species which allow them to survive and regenerate after disturbance. These characteristics include the ability to produce large and continuous numbers of propagules, long periods of propagule dormancy and viability and rapid rates of succession and tree growth, which allow mangroves to rapidly recover after disturbance events (Jimenez et al., 1985; Alongi, 2008; Feller et al., 2010). The rate of recovery is however dependent on the nature of the disturbance, its persistence and recurrence and the availability of seedlings (Jimenez et al., 1985; Feller et al., 2010; Morrisey et al., 2010). Initial differences in the mangrove stand structure, establishment rate of saplings (Alongi, 2008) and the dispersal rate and ability of new propagules (Jimenez et al., 1985) largely control the recovery trends of mangroves following disturbances.

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Out of 17 estuaries along the east coast of South Africa, the most frequent anthropogenic impacts observed in mangrove areas were trampling (occurring in 82% of the estuaries) and livestock browsing (occurring in 76% of the estuaries). A prominent browse line was evident on the old *Avicennia marina* trees where all foliage below 2 m was removed and browsing on propagules appeared to prevent seedlings from establishing (Hoppe-Speer, 2013). This was identified as a significant pressure on mangrove forests and a previously unreported threat which was investigated in this study. Little has been reported on this topic internationally and this would be the first study of this kind in South Africa. Dahdouh-Guebas et al. (2006) investigated short-term mangrove browsing by feral water buffalo in India. Spurgeon (2002) reported mangrove browsing impacts from camels in Egypt while Shah et al. (2007) mentioned the effect of livestock such as cattle, goats and camels on mangroves in Pakistan. Overgrazing in the Indus Delta (Pakistan) was a major factor in the destruction of mangroves. Around 26 000 domestic camels, sheep, goats, water buffalo and cattle fed on *Avicennia*, demolishing branches, trampling seedlings and compacting the soil to such an extent that propagules could not establish themselves (Hogarth, 1999). Mangrove foliage appears to be an important source of food for domesticated stock particularly in dry regions and therefore the results from this study are of interest to a wide audience.

The study site was at the Nxaxo/Ngqusi Estuary (32°S; 28°E) in the Eastern Cape Province. The estuary had 15 ha of mangroves (Adams et al., 2004) but presently only 9.5 ha of this area remain. There are three mangrove species present, namely *Bruguiera gymnorrhiza, Rhizophora mucronata* and *A. marina.* The latter species was dominant and fringed the estuary water channel from the mouth to the upper reaches, with the exception of some scattered individual *B. gymnorrhiza* trees. Along the waters edge *A. marina* trees grew up to 3.5 m in height and behind these trees was a zone of stunted trees less than 1.5 m in height. The browsing experiment

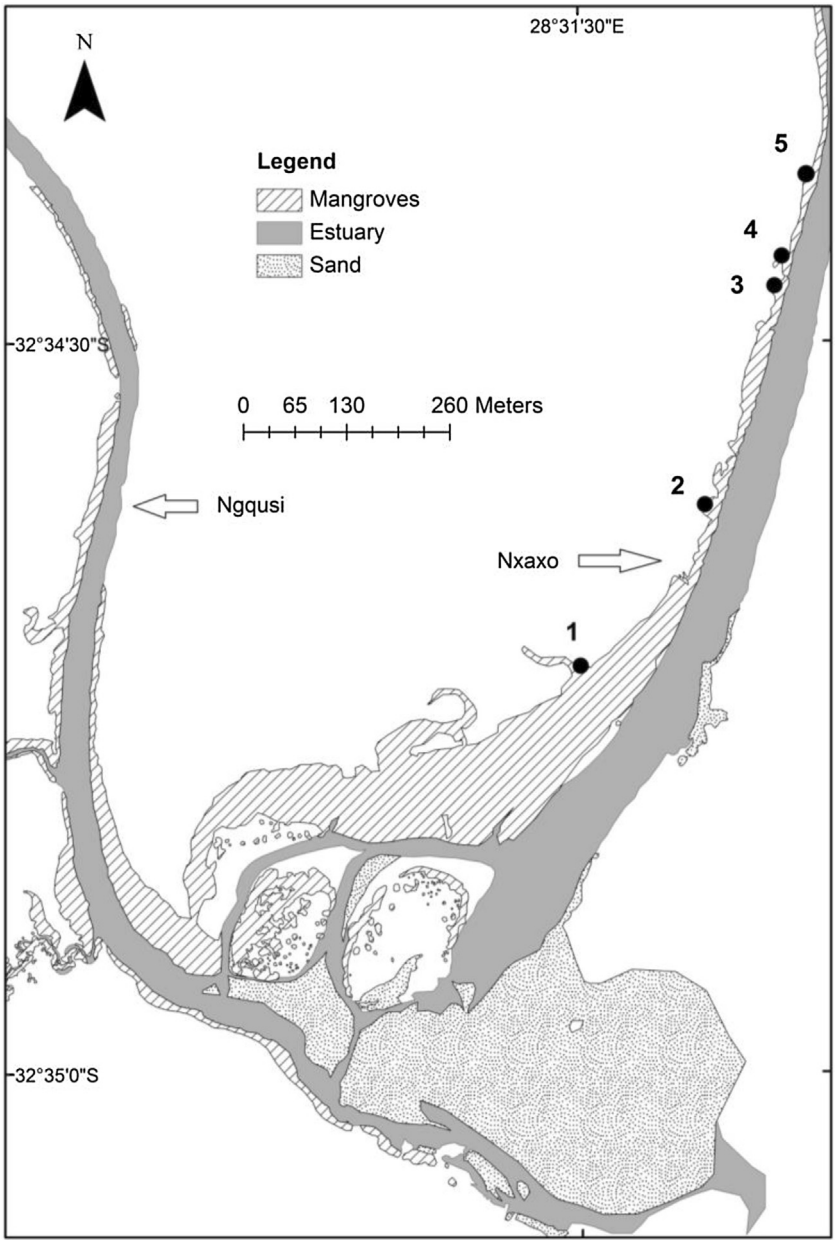

Fig. 1. The Ngqusi/Nxaxo Estuary and the location of the plots (1–5) sampled.