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Research Article

An assessment of alien plant species in Gonarezhou National Park, Zimbabwe

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ABSTRACT

This study investigated the occurrence of alien plant species in Gonarezhou National Park (GNP), Zimbabwe. We focused on two main habitat types, namely riparian areas of the major rivers and dry land areas. Sampling was carried out from 42 sampling plots in both habitat types. Variables studied included the numbers of alien plant species per plot, density, frequency and diversity. A total of 15 alien plant species were identified in GNP. Our results indicate a high density of forbs and shrubs in riparian areas as compared to dry land areas. Similarly, riparian areas had higher species diversity than dry land areas. Our study represents the first step to monitor alien plants which includes the identification of alien plant species and basic information on their distribution in GNP. This is important for enabling effective monitoring of both new introductions and the distribution of species already present.

INTRODUCTION

Globally, protected areas are under threat from invasive alien plants; as they change habitats, threaten resources, ecosystem services and indigenous species (Pauchard and Alaback, 2004). Alien plant species enter protected areas in various ways; they are brought into the park by people, domestic animals, wildlife, wind, water and vehicles (Masubelele et al., 2009; Gandiwa et al., 2011). The invasion of alien plant species is a widespread phenomenon that threatens the integrity and functioning of natural ecosystems (Higgins et al., 2000). The impacts of alien plant invasion in some cases are so significant that they are a recognized component of global change (Vitousek et al., 1996). Accordingly, Vitousek et al. (1997) reported that in protected areas alien plant species have continued to be an ongoing problem to persistence of native assemblages of plants because they out compete native species or alter ecosystem functions, making it difficult to return the ecosystem to its prior or desirable condition.

Alien plant invasion can be defined as the process from the arrival of a new species into a community, to establishment and maintenance in that community, to its further spread into neighboring communities (Prieur-Richard and Lavorel, 2000; Renteria et al., 2012). According to Crawley (1997), alien plant species have been regarded as the biggest single threat to plant conversion in nature reserves in many parts of the tropics and subtropics. Case studies from around the world have shown that some alien plant species can increase carbon assimilation rates, change soil nutrients status, increase flammability, threaten plant species and change habitat suitability for native animal species (Higgins et al., 1999; Dukes and Mooney, 2004; Hiremath and Sundaram, 2005). Therefore, understanding the status of alien plant species in protected areas is important for nature conservation.

Biological invasion have been studied well but poorly in some parts of southern Africa (Cowling et al., 2004; Foxcroft et al. 2010). In South Africa invasive alien plant species are threatening both floristically distinctive fynbos vegetation and water resources (Holmes et al., 2000). Furthermore, in Kruger National Park, South Africa, about 366 alien plant species have been listed and these are predicted to disperse along the park through major river systems that originate outside (Foxcroft and Richardson, 2003). Timberlake and Musokonyi (1994) indicated that the moist evergreen rain forests of the eastern highlands of Zimbabwe were also being threatened by alien plant species such as eucalyptus, lantana and wattle

In Gonarezhou National Park (GNP), Zimbabwe, several studies have been conducted which investigated changes in native vegetation but not specifically focusing on invasive species (e.g. Tafangenyasha, 2001; Gandiwa et al., 2012a; Mpofu et al., 2012). Only one study by Chatanga et al. (2008) investigated the existence of lantana (*Lantana camara)* along Runde River in GNP, to show the status of invasion. Therefore, the overall aim of this study was to develop an inventory and establish distribution of alien plant species in riparian and dry land areas of GNP.

MATERIALS AND METHODS

Study area

GNP is a state protected conservation area covering 5053 km² and is situated in the south-east of Zimbabwe (Fig. 1). The park lies on latitudes 21º 00˝ to 22º 15 S and longitudes 33º 15˝ to 32º 30 E, and altitude varies between 165 and 575 m above sea level. The entire GNP constitutes the catchment of the Guluene, Chefu, Save, Runde and Mwenezi rivers. Other natural surface waters in the park are the seasonal pans and which hold water to varying durations into the dry season (Gandiwa et al., 2012b). The climate of GNP is characterized by high temperatures and low rainfall. Mean annual rainfall ranges between 400 and 600 mm with a short dry winter season in June and July, and hot summer season lasting from November to April (Gandiwa and Kativu, 2009).

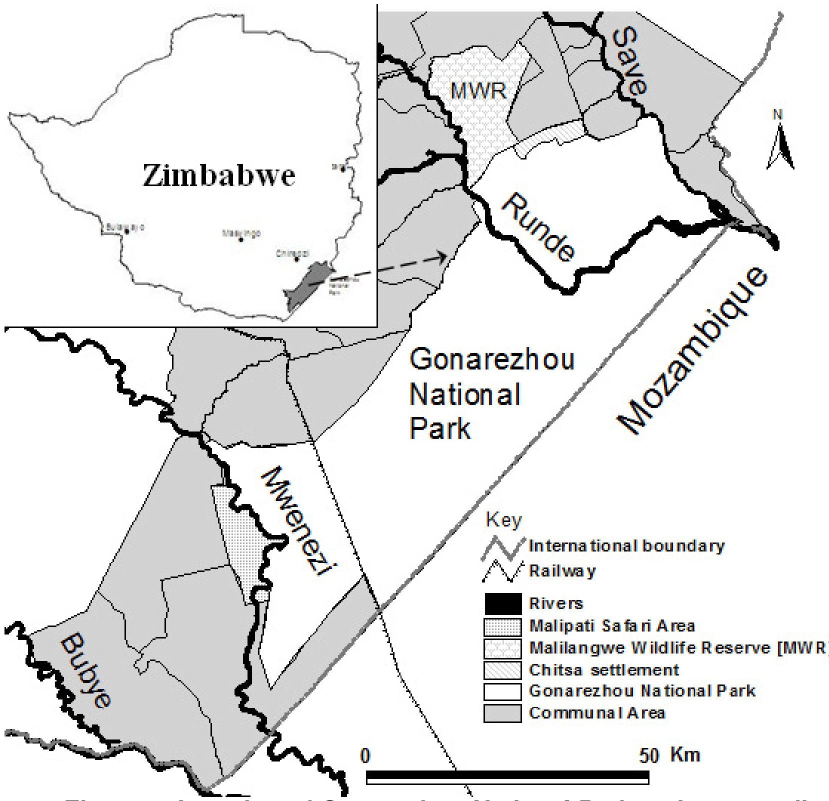

Figure 1: Location of Gonarezhou National Park and surrounding areas in south-eastern Zimbabwe

Experimental design and data collection

This study was based on a stratified random sampling design with sections of GNP's three major rivers being sampled. The rivers were divided into three sections namely: upper, middle and lower. Habitat categories were classified as riparian and dry land. Along the riparian area of the three major rivers, two sample plots of 30 × 20 m were randomly placed on each of the upper, the middle and the lower part of Save and Mwenezi rivers. Plots were increased to three on each of the upper, the middle and the lower sections of Runde River which is longer than the other two rivers. Within each of these plots, 5 sub samples of 5 × 2 m were randomly placed for shrub assessment and 5 sub-samples of 1 × 1 m were used for the forbs (Kelly and Walker, 1976).

The sections of dry land about 1 km from the riparian were also sampled. The same number of plots and plots sizes were used. Plots were placed perpendicular to the sample points selected in the riparian area and at least 30 m from the riparian boundary where water level could not influence vegetation. A total of 42 plots were sampled for both habitat types at different sections of the rivers. Vegetation assessments were conducted in May 2010 when species composition was at its best. The vegetation was classified into trees, shrubs and forbs. Trees were defined as rooted, woody, self-supporting plants ≥ 3 m high with one or definite trunks whereas shrubs were defined as rooted, woody, self-supporting, multi- or single stemmed plants < 3 m high (Gandiwa and Kativu, 2009). Forbs were defined as non-woody plants other than grasses. For each tree, shrub, and forb that was rooted in the plot, the species name and number of stems were recorded on the data sheet. All alien plant species in the plots were identified using vegetation identification guides..

Data analysis

Frequency of each alien plant species was calculated. Densities were determined for each plot using the number of alien plant species available per unit plot. Trees, shrubs and forbs were summed separately to provide the total number of stems per plot. Plot densities were found by dividing the total number of stems by the plot area. Differences in densities of alien plant species between the two habitats were tested using Mann-Whitney *U*-test. Species diversity indices for the riparian and dry land were calculated using the Shannon-Weiner Index (*H'*) (Ludwig and Reynolds, 1988). Furthermore, analysis of potential alien plant species overlap for the two study sites was computed using the Jaccard index of similarity. The Jaccard index is based on the presence-absence relationship between the number of species in each habitat and the number of alien plant species in the study area (Ludwig and Reynolds, 1988)..

RESULTS

A total of 15 alien plant species were recorded in GNP's three major rivers in May 2010, with eight species found in the riparian areas, three found on dry land and four found on both habitats (Table 1). The recorded invasive plant species comprised of 12 families. Of all the alien plant species identified trees contributed 6.6%, shrubs 26.7% and forbs 66.7%. Tree densities of alien plant species were as follows: 16 stems per hectare in riparian and 0 stems per hectare in dry land (Mann-Whitney *U*-test, $P < 0.05$). The density per hectare for alien forbs was found to be 166000 stems and 38000 stems for riparian and dry land habitats respectively whilst alien plant shrub density for the riparian was 1300 whereas it was 600 for the dry land (both, Mann-Whitney U-test, $P < 0.05$). The riparian area had higher numbers of alien plant species per plot than the dry land areas. Species diversity of alien plants species was higher in the riparian area ($H' = 1.6$) than dry land habitat ($H' = 1.4$). Furthermore, the Jaccard index of community similarity (27%) showed that there was a relatively high overlap of species between the riparian and dry land areas.

Table 1: List of alien plant species recorded in Gonarezhou National Park, Zimbabwe

Family	Species	Riparian Habitat	Dry land Habitat	Attribute
Convovulaceae	*Ipomea purpurea*	X	X	Forb, climber
Verbinaceae	*Lantana camara*	X		Shrub
Fabaceae	*Senna occidentalis*	X		Shrub
Fabaceae	*Sesbania bispinosa*		X	Shrub
Solanaceae	*Datura stramonium*	X		Forb
Asteraceae	*Biden pilosa*	X	X	Forb
Asteraceae	*Xanthium strumarium*	X		Forb
Euphorbiaceae	*Ricinus communis*	X		Shrub
Merliaceae	*Merlia azerdarach*	X		Tree
Sapindaceae	*Cardiospermum grandiflorum*	X		Forb, climber
Portulacaceae	*Portulaca orelacea*		X	Forb
Nyctaginaceae	*Boerhervia erecta*	X	X	Forb
Asteraceae	*Acanthospermum hispidum*	X	X	Forb
Malvaceae	*Hibiscus micranthus*		X	Forb
Amaranthaceae	*Amaranthus spinosum*	X		Forb

DISCUSSION

Effective management of alien plant species is based on knowledge of the species location and distribution, modes and rates of spread, potential and known effects, and control methods (Campbell et al., 2002; van Wilgen et al., 2012). Our study has shown that riparian areas have been more invaded by different alien plant species than dry land habitats. This may be due to the carriage of invasive plant species propagules by water in the major rivers in GNP. According to Crawley (1997), periodic disturbances in the form of floods disperse seeds, prepare riparian areas for seedbed, and remove competing plants thereby promoting germination and invasion. For example, species like *X. strumarium* and *D. stramonium* are known to invade disturbed areas including flood prone areas. GNP has a dry and hot climate and this makes these low-lying areas and riparian areas with high moisture levels, the most favourable habitats for the alien plant species invasion. Fox and Fox (1986) indicated that alien plant species are commonly distributed in riparian areas. Species found to be abundant in riparian areas in this study were *A. hispidum, X. strumarium, D. strumarium* and *L. camara.* The common invasive alien plant species found in this study are consistent with other studies (e.g., Milton et al., 2008). Some species although present in GNP, are yet to spread to the dry land habitats. However, it is likely that they have potential to become problematic, thereby likely to threaten biodiversity within the park. The overlap of species which indicated 27% similarity in alien plant species is evidence that these species are shared by both study habitats.

Our study showed that the number of individual stems of alien plant species were significantly different for shrubs and forbs between the two habitat types. High stem density was recorded in the following species *L. camara, X. strumarium, D. stramonium and A. hispidum*. Richardson et al. (2000) reported that when alien plant species are established, positive feedback mechanisms promotes the spread of certain plant species at the expense of others via habitat alteration, and thus, likely resulting in the development of extensive, dense thickets of alien vegetation in riparian areas as demonstrated by the four species recorded in this study. According to Holmes et al. (2000), many harmful alien plant species have persistent seed banks and the ability to grow under a variety of conditions resulting in a continuous seed supply, if such plants are not controlled. Furthermore, increase in fuel loads by *L. camara* dense stands will result in some species being extensively burnt during fires thereby negatively affecting the native plant species. Elsewhere, Achhireddy and Singh (1984) and Achhireddy et al. (1985) observed no growth or only stunted growth for plant species growing close to *L. camara, D. stramonium and X. strumarium* due to allelopathic effects. Our findings indicate that species diversity was higher in the riparian areas than the dry land areas.

Our findings are consistent with Richardson et al. (2000) who reported that diversity and abundance of alien plants increase in and towards riparian areas.

The present study has demonstrated that alien plants have mostly invaded the riparian areas than the dry land areas in GNP. Therefore, this study provides a first step in coming up with an alien plant species list, their distribution and abundance in GNP so as to monitor for both new introductions and potential threats to native flora and fauna. It is likely that the areas invaded and densities of alien plants will increase in GNP. Some shrub and forb species identified in this study show some aggressive growth characteristics which may pose serious conservation and management challenges to GNP if the species are not actively controlled..

CONCLUSION AND RECOMMENDATION

The existence of alien plant species in GNP is of major concern to biodiversity conservation. GNP has three major rivers which start outside the protected area and these seem to be the major pathway of alien plant invasion which likely leads to a higher chance of introduction of alien plant species into the park. Riparian areas are mostly susceptible to invasion by alien plant species (Foxcroft and Richardson, 2003; Richardson et al., 2007) yet they play a vital role to both aquatic and terrestrial ecosystem (Vyas et al., 2012). The invasion of alien plant species in GNP, however, conflict with the purpose of state protected areas in Zimbabwe which strives to manage protected areas in their natural ecological set-up of native plants and animal communities. The proliferation of alien plant species may, therefore, alter habitat use by wild animals, animal distributions, thus negatively affecting wildlife viewing opportunities in GNP (Gandiwa, 2011). This study only provides a snapshot of where specific alien plant species are common, however, detailed studies at relevant spatial scales should be undertaken in future. We suggest that GNP management should develop strategies to monitor and control alien plant species invasion within the protected area..

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