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Vegetation response to clearing of exotic invasive plants along the Sabie River, South Africa

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CHAPTER 7

CONCLUSIONS

7.1 Environmental modification

Invasion by exotic species and the subsequent clearing has been shown in this dissertation to alter both soil chemical, physical and ground cover parameters within the affected communities. The extent of these modifications was found to be dependant on the extent of invasion and clearing. Clearing of exotic species however, acted as an additional disturbance on top of that caused by invasion, as the impact of clearing is directly related to the invasion intensity of the site prior to clearing. As a consequence, the most modified sites were those where high invasion intensity and clearing took place. Under these conditions a return to the "original" state will take longer and may never occur.

The type of community modifications that occur with the introduction and subsequent clearing of exotic plant species were related to only some key environmental variables. One such set of variables was the type and extent of ground cover present in the community. Deposition of litter, the reduction of surface vegetation cover and exposure of soils to erosion and leaching were the variables most changed as a direct consequence of invasion and clearing.

From a management perspective, the modification to the environment needs to be measured and followed or monitored through time. Ease and cost of measurement is however an important factor. By focusing on key variables such as percentage soil organic matter, and ground cover (soil, litter, vegetation) against invasion intensity, a good indication of the extent of disturbance to the community can be established. A monitoring plan to measure these key performance variables through time should be implemented which could be used to determine the extent of modification and follow the return of communities to their "original" state after clearing, should this occur.

The consequences of the modifications and the ultimate effect these will have on the community can only be hypothesized and will be site specific. The findings of this study indicate that the largest environmental modifications will possibly result because of soil exposure. Consequences of soil exposure may take the form of leaching of soil nutrients, erosion of the soil surface and/or changes to soil physical characteristics. This will have a number of consequences for the community.

7.2 Vegetation structure

Invasion of the riverine community by exotic species alters vegetation structure. The extent of the alteration of vegetation structure was directly related to the invasion intensity. The main source of vegetation structure modification in the riverine communities studied is attributed to tall growing exotic species such as *E. grandis* and *S. mauritianum* which both predominate in the riverine areas (particularly *E. grandis*) (Forsyth *et al.* 2004). Both of these species dominated over indigenous vegetation, *E. grandis* by expanding the upper canopy and *S. mauritianum* by dominating the mid canopy. These exotic species resulted in shading out of many indigenous species with shorter (less tall) growth forms and a thinning of the lower and mid vegetation height classes. This has implications for soil erosion and river resource management.

Similar to the effects seen in the environmental modification chapter, the disturbance caused by clearing of invasive vegetation resulted in an additional disturbance proportional to the extent of invasion intensity. Clearing in high invasion intensity sites resulted in a decrease in the total vegetation aerial cover in the upper and mid vegetation height classes. The lower height classes either increased or remained unchanged, which is attributed to vegetation regeneration within the community.

From a disturbance perspective, invasion by exotic species did not result in any large changes to the vegetation when occurring in low intensity. Clearing of the exotic vegetation at these levels did however, increase the disturbance and as a consequence the alteration of vegetation structure. The vegetation structure of highly invaded communities is extremely modified by the presence of exotic vegetation. The additional disturbance of clearing of these exotic plant species, although an additional disturbance, does not have as great an additional vegetation structural impact for the remaining vegetation due to the initial effects caused by the invasion. The disturbance caused by clearing exotic species in low invasion communities was more noticeable on the remaining indigenous vegetation than the alien invasion itself, and was seen as the predominant disturbance in these communities.

Success in eradication of exotic species from a vegetation structural perspective had mixed results. Clearing of high invasion sites was successful, with only a limited number of individuals being missed during clearing. In lower invasion categories however, a number of exotic individuals were missed due to them being “hidden” in the remaining indigenous vegetation. In the longer term, *S. mauritianum* will

become a larger problem species as evidence of considerable regeneration and early dominance of the lower height class indicates.

From a management perspective, diligence in the removal of exotic species in low invasion sites needs to be maintained. At the same time the disturbance caused by clearing activities needs to be kept to a minimum and disturbance to indigenous vegetation restricted. Follow up operations after clearing should not be done too long after the initial activity as key species such as *S. mauritianum* regain domination of the vegetation in a short period.

7.3 Soil seed banks

Soil seed banks in the study community were found to be limited in number of species. The soil seed banks were dominated by two exotic species propagules, and those of woody species related in number to the richness of species found in the community. Total soil seed bank richness did not relate to the species richness of the community. This was attributed to seed vectors and seed size, which were not catered for in the seed bank sampling strategy.

The soil seed bank did not relate to the invasion intensity or clearing thereof. The individual species propagules within the soil seed banks however, related to invasion intensity and clearing according to their life history strategies. Hence, invasive species propagules increased with invasion intensity, weedy species were more abundant in the seed bank with increased disturbance, and indigenous species propagules generally declined with invasion.

The soil seed banks of the key weed species, *A. mearnsii* and *S. mauritianum,* once again illustrated that burial is a prerequisite for persistence in the soil seed bank. Seeds of these species were found to have different half-life's, with *A. mearnsii* having up to a 25 year half life and *S. mauritianum* up to 13 months half-life in the soil. This has significant repercussions for the clearing programme, as the seed bank persistence coupled with the excessively large seed banks associated with these species may prevent effective eradication.

Coppicing is also a large regenerative property of the key invasive species found within the study sites. This was generally not an issue for *P. patula,* but is significant for *E. grandis* and *S. mauritianum.* By

modifying the mechanical clearing techniques for key species such as *S. mauritianum,* a significant improvement in the success of clearing can be achieved.

7.4 Biodiversity

The species richness and diversity varies only marginally because of invasion and clearing. Typically, invasion of the community results only in marginal reduction of species richness. Species alpha diversity however, increases with clearing (the higher the invasion intensity the higher the alpha diversity). This was attributed to the establishment of weedy and pioneer species (exotic and indigenous) as a consequence of the disturbance to the community.

The alpha diversity and species richness results did not give an indication of the changes to the community composition brought about by clearing and invasion. Species diversity needs to be reviewed keeping in context the species that were "lost" from the community, and those that have re-established. Beta diversity however, can be used as an indicator of the extent of modification to the species composition of the community, as this effectively highlights the species turnover with clearing and increasing invasion by exotic species.

7.5 Future areas of research

As this study was limited in scope and resources, a number of areas where further research and improvements to the current approach could be implemented. The key areas where further research is needed are listed below:

- Investigation into the mechanical clearing and success of eradication for key exotic species such as *E. grandis* that coppice similar to that seen in *S. mauritianum*. A number of smaller exotic species also need to be studied. This is because with the clearing of the larger exotic species in the communities, the opportunity has been created for smaller species such as *Rubus cuneifolius* (American Bramble), *Lantana camara* (Lantana), *Caesalpinia decapetala* (Mauritius Thorn) and *Sesbania punicea* (Red Sesbania) to establish.
- Identification and quantification of the animal/avian vector effect on the soil seed banks. More samples are required from the soil seed bank and further research into the seed species that are

animal/avian dispersed but found in the seed bank needs to be undertaken. This may aid in determining why the seed bank does not directly relate to the species composition of the community.

- Water loss through transpiration by key exotic species such as *S. mauritianum* needs to be measured and quantified at appropriate scales. A water balance which identifies species that result in excessive water loss (both indigenous and exotic) and how much water is being "saved" by the Working for Water Program is required. Research could follow on from work done by Gorgens & Van Wilgen (2004) on predictability of water resource availability using exotic vegetation presence into account in catchments.
- Follow-up sampling of the vegetation and soil seed banks to pick up the impacts of invasion and clearing with time is required. The current study was restricted to sampling 18 months to 2 years after clearing. Further changes not evident at the time of sampling may become evident with time.
- Predictive modeling and understanding of the vectors facilitating key weed species spread within the communities affected and linking these to achievable goals and measurable criterion upon which to measure success in clearing of invasive alien species (Richardson & Van Wilgen 2004).

7.6 Objectives and Hypothesis

A number of objectives were set at the initiation of this study. These were aimed at obtaining a better understanding of the riverine community, the interactions of invasion by exotic species and the subsequent clearing of these individuals. The study also aimed at trying to provide useful information on the RDP Water conservation Programme and to managers within this sphere of activity.

To do this several questions were posed. These have been discussed in detail throughout the content of this document. Here however, a final closing statement for each of the objectives set out has been compiled.

1. Firstly the question, "Has the Mpumalanga Province Working for Water Programme been successful in permanently removing exotic species from the riverine environment and preventing re-establishment of invasives?", was posed.
   The programme has been successful in removing the exotic biomass and vegetation. The program fails to address however, the regenerative properties of some of the exotic species. Unless the Working for Water Programme follows a rigid schedule of subsequent clearing treatments, the

subsequent exotic species establishment will result in an even larger invasion problem for the region.

2. It was proposed to determine if clearing operations have disturbed the riverine ecosystem in such a manner as to alter its function, structure and diversity.
   It was determined that clearing of exotic species from the community constituted an additional disturbance to an already disturbed community. This was proportional to the invasion intensity (i.e. the modification to the riverine ecosystem was mainly as a consequence of invasion). Clearing did not contribute significantly to the impact on the remaining indigenous community diversity, but did alter the community structure (but as a function of the prior invasion intensity).

3. The study also aimed to locate problem areas in the clearing programme's strategy and application, which have resulted in poor clearing efficiency.
   Several areas of poor clearing efficiency were noted in the study. These included the "missing" of individuals in low invasion sites, the coppicing of individuals after clearing, and the very large exotic seed bank present in most study sites. This seed bank will lead to re-establishment of the exotic vegetation and may be exacerbated by the disturbance caused by the clearing programme, which could create opportunities for establishment.

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