The impact of *Eucalyptus* plantations on herpetofaunal diversity, Maputo National Park, Mozambique

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Abstract

Exotic afforestation has proven detrimental to biodiversity in general, however only a few studies documenting the impact of timber plantations on herpetofaunal diversity have been published within a southern African context. To determine if variations in herpetofaunal species assemblages could be detected between derelict *Eucalyptus* plantations, cleared plantation woodlots, and untransformed sand thicket vegetation, a pitfall and funnel trap survey was conducted in coastal southern Mozambique. Herpetofaunal species richness for derelict *Eucalyptus* plantations was 13 ± 2.24 species, untransformed sand thicket vegetation 17 ± 2.34 species and cleared plantation woodlots 18 ± 3.14 species. Both Shannon-Weaver and Simpson Diversity Indices estimated the highest herpetofaunal species diversity in untransformed sand thicket vegetation and the lowest diversity in derelict *Eucalyptus* plantations. The herpetofaunal species assemblages of derelict *Eucalyptus* plantations and natural sand thicket vegetation were least similar (0.507 ± 0.041), while cleared plantation woodlots and derelict *Eucalyptus* plantations were most similar (0.753 ± 0.032) in terms of herpetofaunal community composition. In contrast to our expectations, significantly higher capture rates were reported for a fossorial anuran in derelict *Eucalyptus* plantations compared to both cleared plantation woodlots and untransformed sand thicket vegetation, which requires further investigation and discussion. As with most other studies investigating the effects of exotic timber plantations on biodiversity, our results indicate that the detectable herpetofaunal diversity decreased in *Eucalyptus* plantations when compared to natural or cleared plantation woodlots. Subsequently it would seem as though the active clearing of dilapidated timber plantations as part of rehabilitation efforts may positively affect herpetofaunal diversity.

Keywords: *Breviceps mossambicus*; Exotic timber afforestation; Futi Corridor; Maputo Special Reserve; Mozambique Coastal Plain; Pitfall and funnel trap arrays

Introduction

The use of exotic timber species in commercial plantation forestry has resulted in large scale habitat fragmentation throughout southern Africa, transforming diverse habitats into a plantation monoculture and impacting multiple ecological processes such as regional hydrology, soil chemistry, and biodiversity (Armstrong and Hensberg 1995; Armstrong et al. 1998; Russell and Downs 2012). As such, current and proposed expansions by the commercial plantation industry or community programmes promoting exotic forestry in support of economic and social development across southern Africa (Clarke 2018, Almeida and Delgado 2019) are likely to impact regional faunal diversity (Armstrong et al. 1998) including herpetofauna (Branch 2014).

Negative effects on herpetofauna arising from alterations in land use (Masterson et al. 2009) such as exotic timber afforestation (see Russell and Downs 2012; Bates and Jacobsen 2014) is considered a major threat for many reptile and amphibian species (Minter et al. 2004; Branch 2014). However, few studies have been published on the impacts of exotic vegetation, including plantation forestry, on regional herpetofaunal communities (Clusella-Trullas and Garcia 2017) despite conservation concerns (Branch 1988; Minter et al. 2004; Bates et al. 2014). Such information may be pertinent for mitigation efforts and to inform conservation assessments, actions and monitoring programmes. Of the limited regional studies that have been conducted on herpetofauna and plantations, all publications have documented lower reptile and amphibian diversity or richness when compared to untransformed habitats (e.g. Russell and Downs 2012; Trimble and van Aarde 2014).

With the inclusion of abandoned *Eucalyptus* plantations into Maputo National Park (MNP) during its most recent expansion, the opportunity arose to assess the variation between herpetofaunal diversity across untransformed vegetation, as well as derelict and rehabilitated plantations. A localised pitfall and funnel trap (PFT) survey was conducted to compare reptile and amphibian species assemblages and diversity across this patchwork landscape, demonstrating the effects of exotic timber plantations on the herpetofauna of coastal southern Mozambique.

Materials and Methods

Study site

This study was conducted within MNP (previously Maputo Special Reserve 1969–2022, and Maputo Elephant Reserve 1932–1969), a protected landscape which stretches from the southern bank of Maputo Bay and the Indian Ocean coastline to the international border with South Africa through the recently proclaimed Futi corridor (DNAC 2010). The site receives rainfall predominantly during the austral summer although rain can occur throughout the year. MNP is situated along the Mozambican/Maputaland coastal plain with its terrestrial edaphic environment dominated by deep aeolian sand underlying a range of different vegetation types including sand forest, coastal dune forest, grassland, woodland, and savanna (Ntumi et al. 2005; DNAC 2010).

Several derelict *Eucalyptus* plantations or woodlots were assimilated into MNP with the inclusion of the Futi corridor. These plantations follow the recently constructed tarmac road north from the southern road gateway (26°35’ 33.50” S 32°44’ 35.63” E) to the MNP headquarters (26° 30’ 32.22” S 32° 43’ 04.48” E). The negative impact of these *Eucalyptus* woodlots on the hydrology of the nearby Futi river led to these plantations never being formalised or expanded upon necessitating their eventual abandonment (Oglethorpe 1997; DNAC 2010). This lack of appropriate plantation management resulted in the overall derelict condition of these woodlots ultimately leading to the decreased density of *Eucalyptus* trees (see Schneider 2003). Subsequently, MNP instigated a systematic programme to manually eradicate the remaining *Eucalyptus* stands, felling trees and spraying the freshly cut stumps with herbicides to prevent regrowth (DNAC 2010). The prolonged eradication process resulted in a mosaic landscape of untransformed sand thicket vegetation (a specific savanna vegetation types as described in DNAC 2010), cleared plantation woodlots, where all *Eucalyptus* trees were felled, and remaining sections of derelict *Eucalyptus* plantations in the vicinity of the MNP headquarters during April and May 2018 when this study was conducted (see below).

To best illustrate the environmental impacts of exotic afforestation on herpetofaunal diversity, derelict *Eucalyptus* plantation blocks with the highest density of *Eucalyptus* trees at the time of the survey were selected for the study. These derelict *Eucalyptus* plantations exhibited a mixture of mature primary and secondary tree growth, a sparse canopy reaching up to an estimated height of 15 m, with a denser herbaceous layer than *Eucalyptus* plantations under more active management in the region (see Schneider 2003) (Figure 1A). High levels of leaf litter and woody material were observed forming a continuous dense compacted matted accretion of amalgamated detritus ranging in thickness between 20 mm and 100 mm. Decomposition of the leaf litter layer was limited and appeared to take a lengthy period to partially degrade, likely due to the sclerophyllous nature of *Eucalyptus* leaves (see O'Connell and Shankaran 1997; Ratsirarson et al. 2002).

Despite felling operations and multiple fires, cleared plantation woodlots maintained dense but more scattered deposits of this *Eucalyptus* detrital litter. The herbaceous layer throughout cleared plantation woodlots generally consisted of low growing scattered grass patches with a woody component dominated by *Sclerocroton integerrimus* shrubs up to 2 m in height (Figure 1B). The untransformed sand thicket vegetation exhibited a varied open woodland structure with *Strychnos* sp., *Syzigium cordatum*, and *Garcinia livingstonei* trees and shrubs and a continuous dense herbaceous component (Figure 1C). No surface water was present in the survey area with the nearest aquatic habitat being the Futi River, situated a minimum of 150 m away from the closest survey array.

Whilst some herpetological research has been conducted on MNP, such as the collection of museum vouchers during 1962 (Broadley 2018), and the publication of preliminary amphibian and reptile species lists by Tello (1973), the current study is the first PFT survey quantitatively documenting herpetofauna for the protected area. A habitat scale PFT survey has subsequently been conducted (Jordaan et al. 2020; Jordaan in prep.).

Sampling protocol

To assess the effect of exotic plantations on reptile and amphibian species assemblages, a pitfall and funnel trap (PFT) survey, was conducted within a radius of 700 m around the MNP headquarters. PFT arrays are considered the standard passive trapping technique for surveying terrestrial herpetofauna, relying on the movement of reptiles or amphibians across the terrain surface to encounter drift fences, which direct animals to a series of traps (Fisher and Rochester 2012; Willson 2016; SANBI 2020).

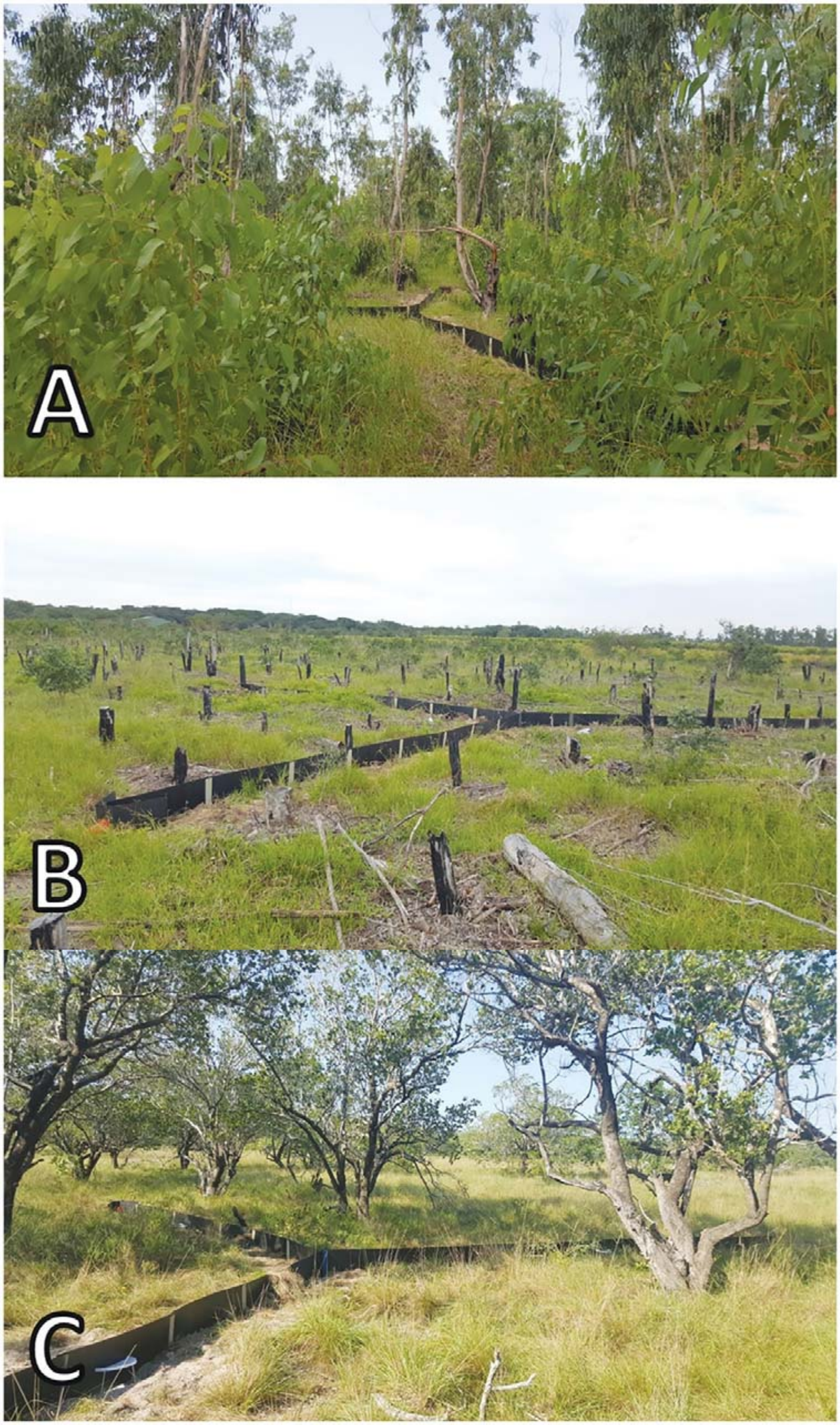

Figure 1. Pitfall and funnel trap arrays installed across derelict *Eucalyptus* plantations (A), cleared plantation woodlots (B), and in untransformed sand thicket vegetation (C). Photos: PR Jordaan.

The PFT array design followed the overall layout promoted in SANBI (2020) with some alterations. Arrays are orientated around a central pitfall trap, with three drift fences radiating from this point roughly 120° relative to each other depending on the physical limitations of survey sites. Drift fences were constructed from eight corru-board sheets, 0.4 m × 1.25 m, connected with contact adhesive and canvas strips. The bottom edge of each drift fence was sunken 0.1 m below the soil surface, to prevent reptiles and amphibians from moving under the corru-board. Steel pegs 0.5 m in length, 3–5 mm in diameter, were inserted along the canvas links to anchor drift fences into position. An additional pitfall trap was installed at the 5 m mark along each of the drift fence arms resulting in a total of four pitfall traps for each PFT array. Pitfall traps consisted of 20 litre plastic buckets, sunken entirely below the terrain surface. Drainage holes in the bottom of pitfall trap buckets prevented traps from flooding during rainstorms. Halved bucket lids suspended on stilts on either side of drift fences provided cover over pitfall traps. A layer of sand ± 30 mm deep was added in the bottom of pitfall traps to allow burrowing species to seek shelter underground when captured.

Two double-sided funnel traps, made from plastic funnels and enamelled iron mesh netting with a 2 mm × 2 mm aperture, were installed on opposite sides along each drift fence. A one-sided terminal funnel trap was positioned at the end of each drift fence (see SANBI 2020). Bundles of grass were placed over double-sided funnel traps and terminal funnel traps to protect captured specimens from exposure. Survey arrays were inspected twice a day to remove all captured animals.

Amphibians and reptiles were identified using Du Preez and Carruthers (2017) and Branch (1998) respectively, with reptile nomenclature and common names updated in accordance with Uetz et al. (2023). Captured specimens were released in the same area, at a minimum distance of 400 m away from PFT arrays to prevent recapture. Voucher specimens were not collected but photographic records of captured herpetofauna were accessioned in the Animal Demographic Unit Virtual Museum (ADU VM) FrogMap (FM) and ReptileMap (RM) projects (www.vmus.adu.org.za). All invertebrate and small mammal bycatch was immediately released at the site.

Trap arrays were activated on the 13th of April 2018 and closed on the 8th of May 2018, equalling a survey period of 25 nights. Capture effort for each PFT array was calculated as 325 trap nights (13 traps for 25 trap nights), with each habitat category surveyed by a total survey effort of 975 trap nights (325 trap night effort for the three PFT arrays). Species richness (N0) for each habitat category was calculated using the sample rarefaction method of Mao Tau (Colwell et al. 2004; Mao et al. 2005) as well as the total captures (presented as capture percentages) in each of the three habitat categories.

Daily capture rates were calculated by dividing the total number of individuals per species, total herpetofaunal, total reptile, and total amphibian captured across the three habitat categories by the total number of trap nights per category. The Catch Per Unit Effort (CPUE) metric (Fischer and Rochester 2012) was calculated by dividing the total number of individuals (herpetofauna, reptile, and amphibian) captured across the three habitat categories by the total number of traps deployed.

Using the CPUE derived from the PFT captures, we calculated herpetofaunal, reptile and amphibian multiple-community (similarity) composition (in terms of relative abundance) using the Morisita Similarity Index (Wolda 1981; Chao et al. 2008; Jost 2008). Data were imported into R (SpadeR) as an online version of SPADE via the interactive web application https://chao.shinyapps.io/SpadeR/ using R Shiny, a web application framework. The Morisita's Similarity Index varies from 0 (no similarity) to 1 (complete similarity). Morisita's Similarity Index is nearly independent of sample size, except for very small samples. Wolda (1981) recommended the Morisita's Similarity Index as the best overall measure of similarity for ecological use, and it was recognised by Krebs (2014) as one of the preferred Similarity Index measures.

The differences in diversity between derelict *Eucalyptus* plantations, cleared plantation woodlots, and untransformed sand thicket vegetation was assessed using the Shannon-Weaver (1948) and Simpson's (1949) diversity indices, the two most commonly used diversity indices in biodiversity studies (e.g. Gorelick 2006), using the statistical programme R (R Core Team 2019). The Shannon-Wiener index (Shannon 1948) assumes that all taxa are represented in the sample and that all individuals are randomly sampled from an infinite population (it does not reflect the sample size). The main source of bias arises from the failure to include all taxa in the sample: this bias/error increases as the proportion of species sampled declines (Peet 1974; Magurran 1988). The Simpson index (Simpson 1949) expresses the probability that two individuals are randomly picked from a finite sample belong to two different types. It can be interpreted as the weighted mean of the proportional abundances. This metric is a true probability value, it ranges from 0 (perfectly uneven) to 1 (perfectly even).

A species accumulation curve was constructed to assess the effectiveness of the survey to detect all available amphibian and reptile species across the survey and for each habitat type.

Results

We documented 32 species of herpetofauna in total including 28 reptile (88 individuals) and four amphibian (85 individuals) species. Total herpetofaunal captures numbered 173 individuals over the 2925 trap night of the survey (Table 1). Fifteen species of reptiles were captured in cleared plantation woodlots, 10 in derelict *Eucalyptus* plantations, and 13 in untransformed sand thicket vegetation (Supplementary Table 1). Amphibians were represented by four species of frogs in derelict *Eucalyptus* plantations and untransformed sand thicket vegetation, and three species in cleared plantation woodlots. The total species accumulation curve for reptiles did not asymptote over the survey period (Figure 2A), in contrast, amphibian species reached an asymptote on day eight (Figure 2B), despite several storms and periods of continuous rainfall during the survey period which generally stimulates amphibian activity and movement (e.g. Jordaan et al. 2023). Herpetofaunal species richness for cleared plantation woodlots was estimated at 18 ± 3.14 species; derelict *Eucalyptus* plantations 13 ± 2.24 species; and untransformed sand thicket vegetation 17 ± 2.34 species (Figure 3). The highest herpetofaunal diversity by both the Shannon-Weaver and the Simpson Diversity Indices were estimated for untransformed sand thicket vegetation (2.57 and 0.92 respectively), followed by cleared plantation woodlots (2.29 and 0.84 respectively), while derelict *Eucalyptus* plantations exhibited the lowest overall herpetofaunal diversity (1.51 and 0.63 respectively) (Table 1).

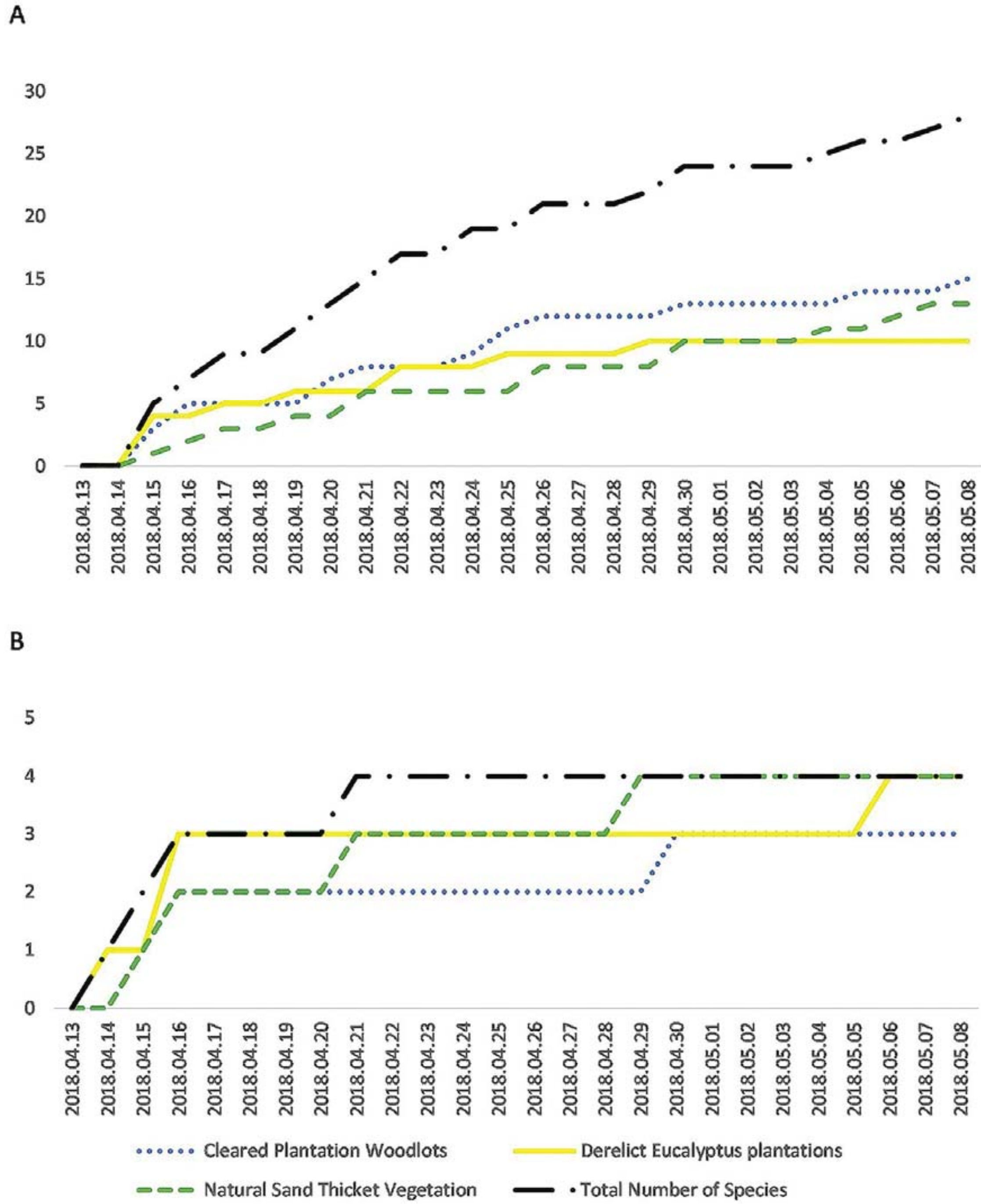

Figure 2. The species accumulation curves for reptiles (A) and amphibians (B) with the sum of species for cleared plantation woodlots (dotted blue), untransformed sand thicket vegetation (dashed green), and derelict *Eucalyptus* plantations (solid yellow), as well as the total species accumulation (dashed and dotted black) for the duration of the 2018 Maputo National Park survey.

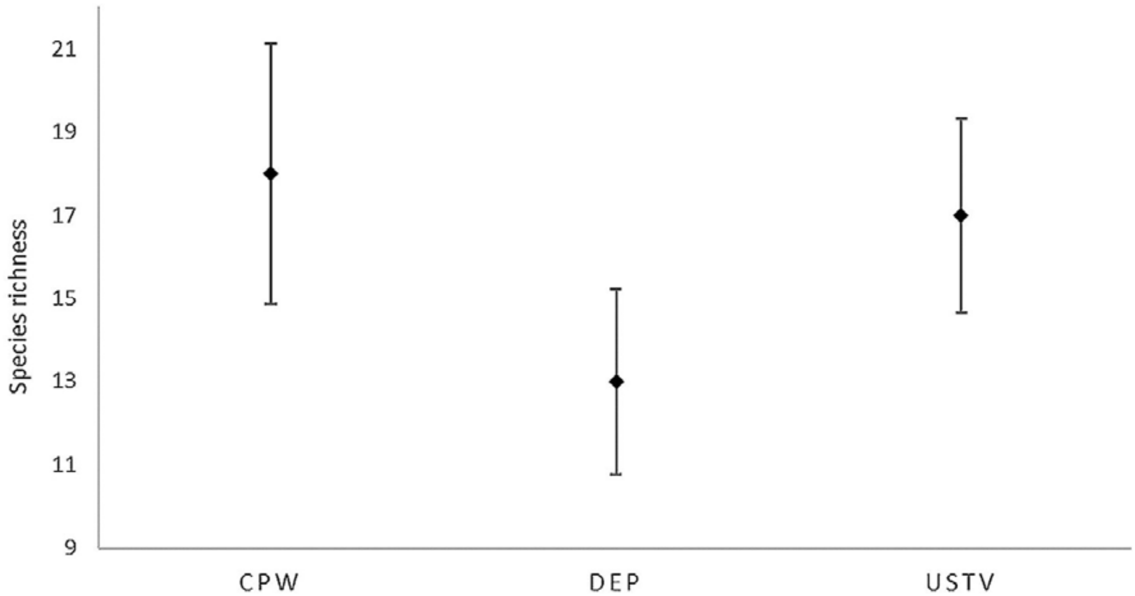

Figure 3. Species richness (N0) estimated using sample rarefaction method of Mao tau of herpetofauna in cleared plantation woodlots (CPW), derelict *Eucalyptus* plantations (DEP) and untransformed sand thicket vegetation (USTV) during the 2018 Maputo National Park survey.

Table 1. Total herpetofaunal captures and diversity for cleared plantation woodlots, derelict *Eucalyptus* plantations and untransformed sand ticket vegetation, during the pitfall and funnel trap survey, 13th of April till the 8th of May 2018**.**

	Cleared Plantation Woodlots	Derelict *Eucalyptus* Plantations	Untransformed sand thicket vegetation	Total captures
Total reptile captures	26	33	29	88
Shannon-Weaver Diversity Index: Reptiles	2.485	1.844	2.219	
Simpson Diversity Index: Reptiles	0.929	0.813	0.879	
Total amphibian captures	19	55	11	85
Shannon-Weaver Diversity Index: Amphibians	0.410	0.246	1.342	
Simpson Diversity Index: Amphibians	0.205	0.106	0.800	
Total herpetofaunal captures	45	88	40	173
Shannon-Weaver Diversity Index: Herpetofauna	2.289	1.507	2.566	
Simpson Diversity Index: Herpetofauna	0.839	0.628	0.923	

More than half of all herpetofaunal captures were recorded in derelict *Eucalyptus* plantations (50.9%), compared to 26% of the sample in cleared plantation woodlots, and 23.1% in untransformed sand thicket vegetation. The most abundant reptile species were *Lygodactylus capensis* (Smith 1849) and *Panaspis wahlbergi* (Smith 1849), each with 19 captures. *Breviceps* cf. *mossambicus* Peters 1854 (see Heinicke et al. 2021 for a preliminary phylogenetic assessment of *Breviceps* in the general area) was the most abundant amphibian and the most abundant species of herpetofauna with 73 captures, 85.9% of the entire amphibian sample and

42.2% of the total herpetofaunal sample, most of which were captured in derelict *Eucalyptus* plantations (52 captures, 71% of the total *B.* cf *mossambicus* sample). When excluding *B.* cf *mossambicus*, herpetofaunal captures were more even, with untransformed sand thicket vegetation, cleared plantation woodlots, and derelict *Eucalyptus* plantations representing 36%, 28%, and 36% of the sample respectively. The mean daily captures for herpetofauna across the survey was 6.92 individuals per day and the total herpetofaunal CPUE across the entire survey was 0.06 (Table 2).

Table 2. Mean daily captures for amphibians, reptiles and herpetofauna as well as the most captured species, *Breviceps* cf *mossambicus* Peters 1854 in derelict *Eucalyptus* plantations (DEP), cleared plantation woodlots (CPW), and untransformed sand thicket vegetation (USTV).

	Daily Capture Rate			Catch Per Unit Effort		
Herpetofaunal samples	DEP	CPW	USTV	DEP	CPW	USTV
Amphibians	2.2	0.76	0.44	0.056	0.019	0.011
(Excluding *Breviceps* cf *mossambicus*)	(0.12)	(0.08)	(0.28)	(0.003)	(0.002)	(0.007)
Reptiles	1.32	1.04	1.16	0.034	0.027	0.03
Total herpetofauna	3.52	1.8	1.5	0.09	0.046	0.041
(Excluding *Breviceps* cf *mossambicus*)	(1.44)	(1.12)	(1.44)	(0.037)	(0.029)	(0.037)
Breviceps cf *mossambicus* Peters 1854	2.08	0.68	0.16	0.053	0.017	0.004

Cleared plantation woodlots and derelict *Eucalyptus* plantations was most similar in terms of their respective herpetofaunal, reptile, and amphibian communities based on relative abundance (0.75 ± 0.03; 0.58 ± 0.05; 0.96 ± 0.02) while derelict *Eucalyptus* plantations and untransformed sand thicket vegetation was least similar (0.50 ± 0.04; 0.49 ± 0.05; 0.65 ± 0.07) (Table 3). It should be noted that the majority of reptile species were only captured once during the survey (19 species of the 28).

Table 3. Similarity between herpetofaunal, reptile and amphibian communities and three habitat categories.

		Cleared plantation woodlots	Derelict *Eucalyptus* plantations	Untransformed sand thicket vegetation
Herpetofauna	Cleared plantation woodlots	1	0.75 ± 0.03	0.57 ± 0.04
	Derelict *Eucalyptus* plantations		1	0.51 ± 0.04
	Untransformed sand thicket vegetation			1
Reptile	Cleared Plantation Woodlots	1	0.58 ± 0.05	0.51 ± 0.04
	Derelict *Eucalyptus* Plantations		1	0.49 ± 0.05
	Untransformed Sand Thicket Vegetation			1
Amphibian	Cleared Plantation Woodlots	1	0.96 ± 0.02	0.71 ± 0.07
	Derelict *Eucalyptus* Plantations		1	0.65 ± 0.07
	Untransformed Sand Thicket Vegetation			1

Discussion

Species richness and its retention may function as a broad indicator of ecosystem integrity, and has also been linked to functional stability and resilience in communities (e.g. Avenant 2011). Higher herpetofaunal species richness was recorded in untransformed sand thicket vegetation and cleared plantation woodlots compared to derelict *Eucalyptus* plantations, suggesting an adverse impact of exotic plantations on herpetofauna of the area.

As most reptile species were only captured once during the survey, additional surveying measures at different times of the year may be required to better illustrate the impacts of exotic afforestation. This is evident when reviewing the reptile species accumulation curve for the entire survey which did not reach an asymptote. This would suggest that the species list is not comprehensive and that the documented species richness underestimates the actual richness for the survey area (Cross et al. 2012). Reptile species accumulation only reached an asymptote for the derelict *Eucalyptus* plantation component (Figure 2A). This would indicate that the reptile species richness available to be surveyed at the time of the survey was sufficiently represented within derelict *Eucalyptus* plantation sites at day 16, whilst additional species were likely to be encountered in cleared plantation blocks and untransformed sand thicket vegetation with increased survey effort. Conversely, the amphibian accumulation curve across the survey suggests that amphibian species were already adequately represented at day eight (Figure 2B). Habitat specific amphibian species accumulation however only reached a peak between day 14 (untransformed sand thicket vegetation) and day 22 (derelict *Eucalyptus* plantations).

To better assess the likely effect of exotic plantations on herpetofauna, it is necessary to evaluate the similarity in species composition (based on relative abundance) quantitatively, to classify communities based on this similarity (Dodd 2016). During this survey, the two most similar communities estimated were amphibians in cleared plantation woodlots and derelict *Eucalyptus* plantations (0.96 ± 0.02), while reptiles in derelict *Eucalyptus* plantations and untransformed sand thicket vegetation were least similar (0.49 ± 0.05). This may suggest that exotic plantations have a much greater deleterious effect on the reptiles compared to the area's terrestrial amphibians. It should however be acknowledged that this assumption is based on incomplete sampling of the reptile assemblages as indicated by the accumulation curves. As this survey was not conducted during the height of summer when amphibians are deemed most active, it is likely that additional species may be encountered when surveys are conducted during December–March. Similarly, higher reptile species richness may be detected during surveys conducted during the summer months due to the increased surface movement in response to higher temperatures and rainfall (Dodd 2016). The current study relies exclusively on the results of a PFT survey. Other survey techniques such as active searches, i.e., turning over natural cover, or night-time searches for arboreal herpetofauna, were not conducted due to the lack of natural cover features and the presence of potentially dangerous wildlife (elephants and hippopotamus) in the area respectively.

Whilst herpetofaunal captures in PFT arrays are taken as a proxy for diversity and relative abundance, results depend on surface movement and can consequently be subject to various environmental and species-specific biases (Shield 1985; Driscoll et al. 2012; Jordaan et al. 2023). Arboreal and soil living herpetofauna are also likely not adequately represented by our PFT survey. Half of all the reptile species (14 of 28) and all four of the amphibian species captured during the survey exhibit various degrees of fossoriality (Maritz and Alexander 2008). Due to the infrequent surface activity of many of these species, the efficacy of PFT arrays to reliably quantify soil dwelling herpetofaunal assemblages may have limited use and may require specific quantitative techniques to adequately quantify densities (e.g. Maritz and Alexander 2008). Evidently, many of these species are captured in PFT arrays during surface and shallow sub-surface movements (Henderson et al. 2016) however, captures are generally low especially for species that are largely sedentary or live deeper down the soil column.

For instance, *Acontias plumbeus* Bianconi 1849, *Amblyodipsas m. microphthalma* (Bianconi 1850), *Prosymna stuhhlmanii* (Pfeffer 1893), *Scelotes arenicolus* (Peters 1854), and *Xenocalamus bicolor lineatus* Roux 1907, all considered obligate or "strictly fossorial" by Maritz and Alexander (2008) were all represented by single captures. This is in stark contrast with *B.*cf *mossambicus*, also considered an obligate fossorial species (Maritz and Alexander 2008), which was the most captured amphibian during the survey with the majority of specimens recorded in derelict *Eucalyptus* plantations.

Increased captures during PFT surveys may however not directly relate to higher occupancy of a species for an area, but may be due to increased rates of movement in response to suboptimal habitat in conjunction with environmental conditions (e.g. Driscoll et al. 2012; Chiaverano et al. 2014). Anomalies in the capture rate of *B.* cf *mossambicus,* such as our current results (Table 2), have been reported in the region (Jordaan et al. 2023) and requires further investigation and discussions to describe these possible biases and behavioural responses to exotic afforestation and other environmental factors (Jordaan in prep.).

Although some datasets exist tracking the impact of active plantations on herpetofauna, which are conducted to comply with environmental or regulatory legislation and/or policies, the majority of these data are never published due to contractual or non-disclosure agreements. This may stifle attempts to gauge the long-term impact of exotic plantation forestry practices on regional herpetofaunal diversity. The unchecked proliferation of exotic plantations has resulted in the extinction of at least one reptile in southern Africa, *Tetradactylus eastwoodae* Hewitt and Metheun 1913 Eastwood's Long-tailed Seps (Bates and Jacobsen 2014) and is considered a threat to several herpetofaunal species (Minter et al. 2004, Branch et al. 2014). There are however instances where the management practices of exotic plantations have been altered to accommodate herpetofaunal conservation objectives (e.g. Tolley 2014).

As with previous published studies, we documented a lower herpetofaunal diversity in abandoned exotic plantations compared to surrounding untransformed vegetation based on the PFT survey data. The quantified impact of these plantations on the behaviour of *B.* cf *mossambicus* may make the species an indicator in its geographic range' to monitor rehabilitation efforts and faunal responses to those activities using PFT surveys, however this requires confirmation through further investigations.

The positive influence of rehabilitation through increased herpetofaunal diversity of cleared plantation woodlots compared to derelict *Eucalyptus* plantations sites indicate the importance of active rehabilitation efforts through clearing woodlots to re-establish especially reptile assemblages when abandoned plantations are incorporated into protected areas. Future assessments documenting the responses of herpetofaunal species assemblages to plantations under active management should be conducted to better inform regional biodiversity assessments and conservation policies pertaining to commercial as well as small scale exotic timber plantations.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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