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The Potential of Foraging Chacma Baboons (*Papio ursinus*) to Disperse Seeds of Alien and Invasive Plant Species in the Amathole Forest in Hogsback in the Eastern Cape Province, South Africa

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Abstract: The invasion of alien and invasive plants into the threatened Amathole Forest in Hogsback, Eastern Cape Province (South Africa) is an emerging priority conservation issue. The objective of this pilot study was to document and compare the foraging visits of two chacma baboon (*Papio ursinus*) troops in their natural and human habitats and their foraging behavioural activities to understand their potential to disperse ingested alien seeds in Hogsback. We also estimated the number of seeds per faecal sample collected from the foraging trails of the two troops of baboons, and determined potential dispersal distances using allometric equations. Since the focal troops used preferred sleeping and foraging sites, we predicted that these sites would have a high concentration of propagules. We applied the normalised difference vegetation index (NDVI) to discern possible vegetation cover changes. Overall, the two chacma baboon troops showed a similar number of daily foraging visits, although they preferred to forage more in human-modified than natural habitats. Their feeding and moving activities were significantly greater than other activities recorded during the study. There were significant differences in the numbers of seeds of six different fruiting plant species: 82.2 ± 13.3% (n = 284) for *Acacia mearnsii*; 78.9 ± 12.1% (n = 231) for *Pinus patula*, and 64.0 ± 20.0% (n = 108) for *Solanum mauritianum*. The two baboon troops could transport about 445 536 seeds from the six focal fruiting plant species considered in this study. Baboons' seed dispersal distances were long at > 5 km per daily foraging activity. The NVDI vegetation cover analysis (i.e., 1978–2023) shows that the dense vegetation cover expanded by 80.9 ha, while the moderate and sparse vegetation cover collectively decreased by 10.3 ha. Although the seed dispersal pattern was neither clumped nor displayed any recognisable pattern, against our prediction, the number of faecal samples containing alien seeds and the observed foraging movement patterns suggest that chacma baboons disperse alien plant seeds that may establish and facilitate the deterioration of the natural forest. Further quantitative studies investigating the diversity of the plant species dispersed, their germination rates after ingestion by baboons, and their seasonal patterns are required to understand the baboon seed dispersal systems in the Amathole forests of Hogsback.

Keywords: invasion; habitat fragmentation; conservation and seed predation

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1. Introduction

It is estimated that more than 95% of tropical seeds are dispersed by animals [1] and that between 30% and 50% of temperate tree species [2] are dispersed largely by birds [3–5] and primates [6]. The role of primates in seed dispersal is well documented [6,7]. Globally, more than 380 primate species feed on fruits and disperse seeds [8,9], and they represent 25–40% of the frugivore biomass in tropical forests [10–12]. For example, baboons are omnivorous and opportunistic feeders with diverse dietary material, depending on the nature of the prevailing environment [13,14]. They may eat large quantities of fruit, and either defecate or spit out large numbers of viable seeds [15–20] while a certain portion can be destroyed [21]. Owing to their mobility, baboons may contribute to long-distance seed dispersal [22–24], and thus potentially influence local vegetation population and community dynamics. Several studies have investigated primate frugivory and seed dispersal in Africa [6,15,18,20,25–28], but seed dispersal by baboons in South Africa and its ecological implications for natural vegetation (e.g., indigenous forest) dynamics have received little attention [23,29,30]. Animal-mediated seed dispersal processes are essential in maintaining plant communities [4,31,32] as well as the associated ecosystem goods and services.

Studies have revealed that fruiting invasive alien plants may out-compete indigenous plant species for pollination and seed dispersal services [33–36]. Thus, recently introduced fruiting plants may exploit the baboons' dispersal services to the detriment of the indigenous plant species that have co-existed over long periods, thereby creating an ecological imbalance. Much as alien fruits are important food resources for many native animals, there is indeed evidence that invasive alien plants disrupt the animal–plant dispersal mutualisms [34,36,37], thus negatively impacting local vegetation dynamics. However, undisturbed continental tropical areas with the highest abundance (e.g., 80%) of fleshy fruits [5] reportedly experience relatively lower alien plant invasion threats than extra-tropical habitats owing to the absence of empty and colonisable niches [38,39]. For example, it has been argued that a counter-competition by 65 native plant species bearing fleshy fruits for vertebrate seed dispersal agents may have prevented the spread of the recognised 19 alien fleshy-fruited species in Montpellier, France [40]. Preliminary field observations of the black wattle's (*Acacia mearnsii*) invasion patterns show that the indigenous forest fringes pose some natural resistance [38,41], which is, however, continually weakened by anthropogenic physical disturbance that facilitates colonisation by alien plants. Indeed, the introduction of alien invasive plants has profoundly altered the state of natural habitats worldwide [42]. We speculate that, with the increasing number of alien species, the negative impacts may also increase, since management efforts are also limited.

Habitat fragmentation is another major conservation threat to vertebrate dispersal mutualisms [43]. The fragmented habitats are impoverished of natural resources and animal movements are restricted [44]. Mucina and Rutherford [45] indicated that indigenous forests support a large proportion of South Africa's biodiversity, although the forest biome is the smallest and most severely fragmented by anthropogenic developments in South Africa, particularly in the Eastern Cape Province [46–50]. Therefore, the fragmented state of the patches of Amathole indigenous forests in the Eastern Cape Province may increase certain species' vulnerability to extinction [45,51]. In addition, the invasion of alien and invasive plant species is an emerging conservation issue, and needs urgent attention, since invasive plants alter the structure and functionality of the habitat [52,53]. Consequently, understanding the role of baboons in the seed dispersal of alien and invasive plants is important for the conservation of the threatened indigenous Amathole Southern Mistbelt forest fragments in Hogsback in the Eastern Cape Province of South Africa. For example, alien and invasive plants will potentially pose a threat to indigenous keystone plant species such as yellowwood (*Podocarpus latifolius*), white stinkwood (*Celtis africana*), cape chestnut (*Calodendrum capense*), and forest knobwood (*Zanthozylum davyi*) [54].

While the main study was centred around the human–wildlife conflict phenomenon in the Hogsback village, the foraging range of the studied chacma baboon troops also covered human-modified habitats in Hogsback (e.g., orchards and gardens) [55], which are deemed to be a major source of alien plant propagules [50,56–58]. We therefore predicted that foraging by the chacma baboons in the human-modified habitat would increase the transfer of seeds from alien and invasive plants into the natural forest, thereby compounding the forest's vulnerability to the reported extinction threat. The objective of this pilot study was to document and compare the foraging visits of two baboon troops in the natural and human-modified habitats and to determine their foraging behavioural activities (i.e., feeding and moving) related to the spread of the ingested alien seeds. We also estimated the number of intact seeds per faecal sample collected from the foraging trails of the two troops of baboons in Hogsback, and generated seed dispersal distances using allometric equations. Since the troops used preferred sleeping and foraging sites, we also predicted that these sites would have a high concentration of propagules. Finally, we applied the normalised difference vegetation index (NDVI) to discern possible vegetation cover changes owing to the invasion of alien plants.

2. Material and Methods

2.1. Study Site

The study was conducted in Hogsback (GPS location: 32.5833° S, 26.9500° E), located in the Amathole Mountains of the Eastern Cape Province, South Africa (Figure 1). The area comprises human-modified and natural habitats dominated by indigenous Afromontane forest (i.e., Southern Mistbelt) vegetation, including the alpine grasslands of the Maputaland–Pondoland–Albany key biodiversity conservation area [45,59], and covers a total area of 13.78 km^2 at an altitude of 1200–1300 m. Hogsback village is situated about 40 km from the town of Alice, and was established in the 19th century as a hill station for the families of British soldiers [60]. The village has many large gardens and farms that cover extensive areas [55]. Hogsback residents often favour woody alien plants bearing fruit and berries, which are visited by the primates, causing the animals to be regarded as pests. Hogsback also has relatively high levels of human disturbance, as it attracts tourists [45]. Furthermore, Hogsback has been one of the centres of the South African timber industry for more than 100 years, and the area hosts several commercial pine plantations. Alien timber plantations cover 1.2% of the total area of South Africa [61,62], comprising 50% pine (pine plantations including other conifers such as *Cedrus*, *Widdringtonia*, and *Cupressus* species), 43% *Eucalyptus* (eucalypt, poplar, oak, and other hardwood plantations), and 7% wattle (commercial plantations of *Acacia mearnsii* with small areas of other *Acacia* species) [61,63]. A serious threat is posed by alien tree plantations, where herbicides and fertilisers are used to the detriment of indigenous species [64] and contaminate the forest ground cover [65,66].

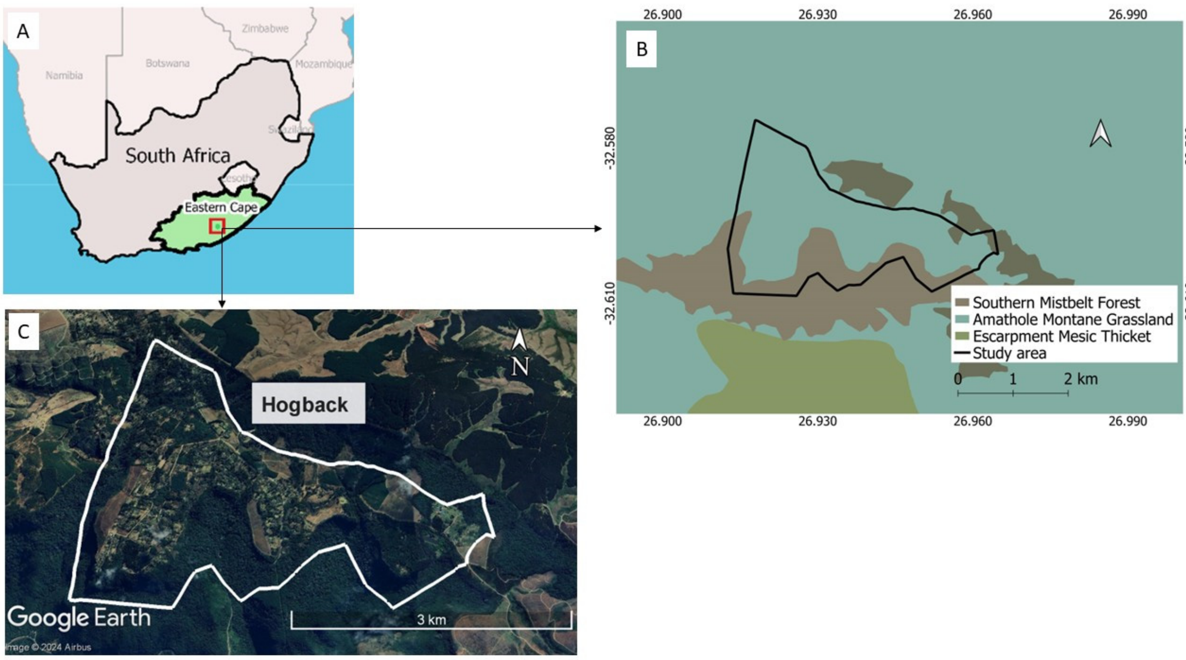

Figure 1. Map of Hogsback study site (red box) in Eastern Cape, South Africa (**A**). (**B**) shows the vegetation types, and (**C**) shows the natural and human environments within the study site.

Ambient temperatures in Hogsback range from below freezing between June and August to more than 30 °C on hot summer days in February [45]. The area receives an average annual rainfall of 974 mm, with most of the rain falling in summer, often accompanied by thunderstorms. Temperature and rainfall have a pervasive effect on animals, not only directly but also indirectly by affecting food production, which, if reduced, can lead to increased intraspecific and interspecific competition [67]. The availability of food and water influences home range size, and thus lower levels of food resources in the local forest mean that the wild animals must be more adventurous to meet their nutritional needs [67].

2.2. Study Species

The Hogsback baboons have been around for a long time; long enough, according to [68], at least to have already impacted the distribution of the plants they disperse. Chacma baboons live in various habitats, and can survive under difficult environmental conditions [69]. Slater [70] has described baboons as some of the most flexible, opportunistic, and adaptable animals on earth (Figure 2). They are also among the primate taxa that exhibit the greatest degree of spatial overlap with humans [71]. Baboons are a highly mobile species, enhancing their value to ecosystem seed dispersal [24]. Home range, troop size, and travel patterns are influenced mainly by the distribution of food resources, water sources, and suitable sleeping sites [14,70,72]. The daily travel distances of chacma baboons ranges from 1.7 to 11.7 km [73,74].

Figure 2. Male chacma baboon on the edge of the mountain, Hogsback in Eastern Cape Province, South Africa (picture: Ken Harvey).

2.3. Data Collection: Foraging Visits, Occurrence of Alien Plant Species, and Faecal Sampling

The two troops of Hogsback baboons were tracked on foot over six months [55]; we monitored troop sizes, composition, and foraging behaviour, using both scan and focal animal sampling ([75]; Figure 2). The troops were followed weekly from October 2014 to May 2015 (i.e., the optimal growing season) from 6:30 a.m. until either the troop was settled in its sleeping site at the end of the day or tracking was no longer possible. Data collection was not conducted on days of heavy rain because of poor global positioning system (GPS) functioning and low visibility. A total of 306 scans were collected for Nola's troop and 228 scans for Evie's troop, yielding 15 and 13 days of data, respectively, owing to human–primates conflict. The shooting of baboons by humans made locating the troops on a daily basis difficult. The home range sizes of the troops were determined by recording GPS data points at 15 min intervals using a handheld device (Garmin eTrex 10, New York, NY, USA). The type of habitat used by each troop was also recorded (e.g., whether it occupied a natural habitat or a human-modified habitat), and whether the baboons were feeding or moving, among other activities. Since the foraging visits frequency of vertebrate frugivores is proportional to fruit removal and subsequent seed dispersal [76–78], we determined the number of visits and their distribution at each site (Figure 3).

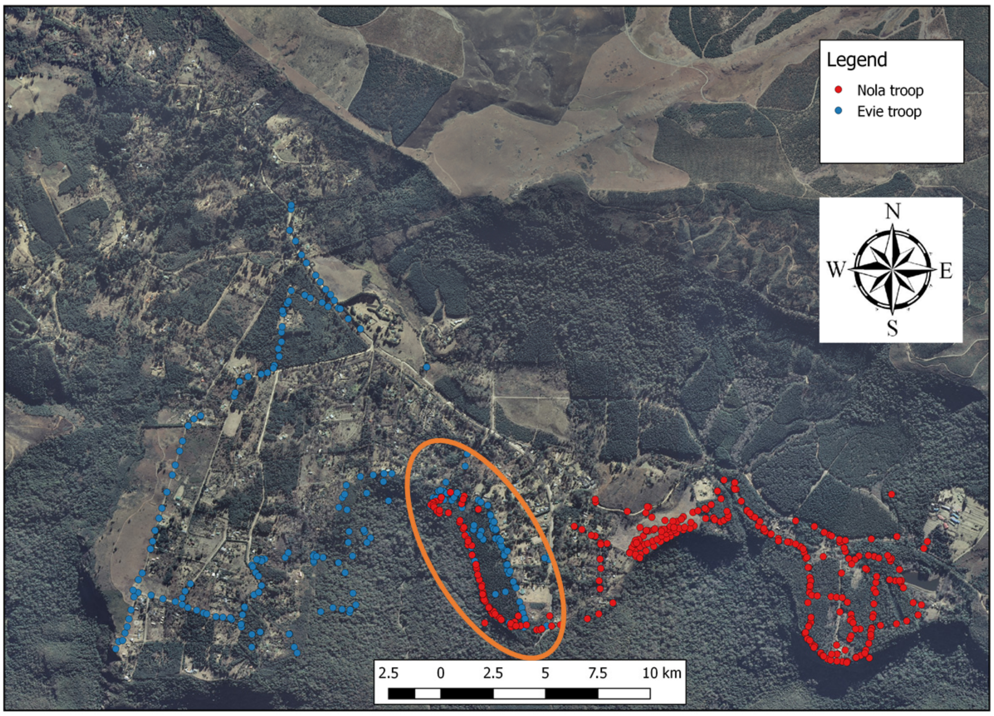

Figure 3. Foraging paths of the focal baboon troops. The red colour shows Nola's troop's range, and the blue colour shows Evie's troop's range. The orange polygon shows the overlap between the foraging home ranges of the two troops.

To determine which alien plant species are potentially dispersed by the chacma baboons in Hogback, we also recorded the fruiting alien plant species in their preferred foraging sites for both troops, which was the area in which their home ranges overlapped. We walked transects of varying lengths through the major foraging area, and recorded each fruiting plant species at 10 m intervals [79]. Because of limited accessibility in the Hogsback landscape owing to the fencing of private properties, a limited number of transects were sampled.

To assess seed dispersal patterns, faecal samples containing seeds were collected in the most preferred sleeping and foraging sites [80,81]. We also followed the baboon troops' paths to and from the foraging sites, as documented by Pamla [5]. Any faecal samples encountered were processed on the spot (see Figure 4 below). Each faecal sample, either fresh or dry, was carefully crushed with a wooden rod to expose the components of the ingested material. This allowed for the separation of masticated seeds (identified by their coats) from those that were intact. Only intact seeds were counted and recorded for each faecal sample; the intact seed load represented a conglomerate of different plant species consumed during foraging.

To determine potential seed dispersal distances, we used allometric (i.e., as a function of animal body mass [BM]) mechanistic models to predict gut retention time (GRT) in hours for ingested seeds, and movement capacity (MC) in kilometres (km) for potential dispersal range of the chacma baboons that might influence plant recruitment processes.

Figure 4. Chacma baboon faecal sample that is not crushed (**above**) and crushed with a stick (**below**) containing seeds processed during foraging.

Since the selected mammals were non-ruminant species (hindgut fermenters), we estimated the GRT (in hours), using the allometric equation from Steuer et al. [82], as follows:

$$\text{GRT} = 31.0\ \{\text{BM}\}^{0.01}\ (31.0 \text{ and } 0.01 \text{ are allometric constants}) \quad (1)$$

Although the MC is not consistent because of seasonality, age and sexual dimorphism, dietary type, body mass, and local availability of survival resources [83–85], the MC (in km) was estimated using appropriate equations that were derived and modified from Du Toit [86]:

$$\text{MC} = 0.024\ \{\text{BM}\}^{0.18}\ (0.024 \text{ and } 0.18 \text{ are allometric constants}) \quad (2)$$

To differentiate the land use in the habitats that the two troops targeted for their foraging movements, we applied NDVI measurements to determine the vegetation types and level of environmental disturbance in such patches. High-resolution images were generated for the area of interest—the study site—over 45 years (1978–2023); the year 1978 was used as a baseline. The pre-processed satellite images—Landsat Collection 2 Level-2 imagery for Landsat 4/5 TM (1978), Landsat 7 ETM (2002), and Landsat 8–9 OLI/TIRS (2023)—of the study area (path 171/row 80) were acquired using the United States Geological Survey (USGS) Earth Explorer (http://earthexplorer.usgs.gov). The USGS platform provides ready-to-use surface reflectance Landsat data processed by the Earth Resources Observation and Science (EROS) Science Processing Architecture's (ESPA) on-demand interface, the Landsat Surface Reflectance Code (LaSRC) [87]. Extra care was taken in selecting the images in the same season/month–date range (February to March, i.e., growing season) to increase the accuracy of the research results and the vegetation reflection data with a cloud cover of less than 10%. The shapefile was imported to ArcGIS Pro software. To scale the data to reflectance, the data were processed using Modelbuilder and iterators raster tools in ArcGIS Pro, and each raster image was multiplied by the scaling factor of 0.0000275 + −0.2 using the raster calculator.

The NDVI image set was used to classify the Landsat satellite pattern and to determine the change in the vegetation cover distribution of the study area. The NDVI remote sensing method displays the health and greenness (relative biomass) of the vegetation and measures the state of the plants' health based on the plants' reflection of light at certain frequencies. The band combination of channels that are used to obtain coverage of the vegetation indices' characteristics was selected. The NDVI is calculated as the ratio of the difference between the red and near-infrared signal of the electrometric spectrum divided by the sum of both, which refers to the spectral bands 4 and 5. The NDVI value ranges between −1.0 and +1.0, and reflects the health of plants (greens). An NDVI value of 0.6 to 1 represents dense vegetation cover, 0.4 to 0.6 represents moderate vegetation cover, 0.2 to 0.4 represents sparse vegetation cover, 0.1 to 0.2 shows grass cover with bare space, and −1 to 0.1 represents no vegetation, i.e., water cover [88].

3. Statistical Analysis

We derived the numbers of foraging visits of the two troops from the total observations of the troops in the field, as seen either in the natural or the human-modified habitat. A count data statistical model, the generalised linear model (GLM) with Poisson errors, was used to compare the overall number of foraging visits to human-modified and natural habitats by the two baboon troops. All statistical analyses were conducted in SPSS v. 28 (IBM, New York, NY, USA). The number of foraging visits in each environment was fitted as the response variable, while the troop names and types of habitats were the categorical variables.

Another GLM was run to compare the frequency of observations in which the baboon troops were seen feeding and moving. The predictor variables entailed baboon activities (i.e., feeding and moving) while their frequencies were fitted as the response variable. Because of high data variance, negative binomial errors were used.

For the six dominant fruiting plant species, we compared the number of intact seeds obtained from the faecal samples using GLM. The plant species were fitted as the predictor variables, while the numbers of seeds were the response variables.

The potential seed dispersal distances for the baboons were determined using allometry equations (after [78]) in combination with the actual distances measured from the sleeping sites of each baboon troop to the furthest location reached during foraging. The average distance was calculated from the above two values.

The number of seeds likely to be transported by the baboons was estimated as a product of the average seed load per faecal sample, the total number of adult baboons, and the number of monitoring days in which the troops foraged at the site during the study.

To analyse the NDVI trends during the study period (1978–2023), different proportions of vegetation cover class in hectares and converted to percentages were used to quantify the potential vegetation cover change in the study site.

4. Results

The two troops of baboons showed significantly a greater foraging frequency in human-modified than in natural habitats (Wald χ^2 = 70.0; df = 1; $p < 0.001$), and the pattern was similar for both of the baboon troops: Evie (Wald χ^2 = 19.7; df = 1; $p < 0.0001$; Nola (Wald χ^2 = 49.0; df = 1; $p < 0.0001$). Overall, the two chacma baboon troops were not significantly different in their number of daily foraging visits (Wald χ^2 = 0.27; df = 1; $p = 0.603$; Figure 5).

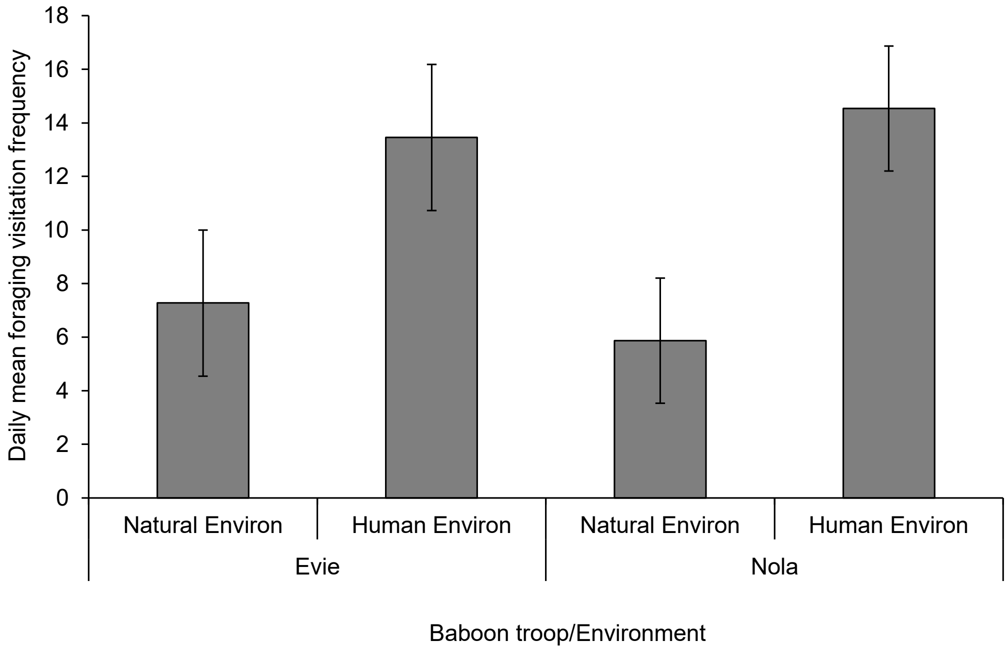

Figure 5. Daily mean foraging visits frequency of Evie's and Nola's troops in the human-modified and natural habitats. The standard error is represented by the bars.

Both baboon troops displayed a significantly greater frequency of feeding activity (Person χ^2 = 29.6; df = 1; p < 0.0001; 330 out of 534) and moving activity than other activities recorded during the study (Person χ^2 = 287.7; df = 1; p < 0.0001; 474 out of 534).

Overall, eighteen fruiting shrubs/trees were observed in the study area. There were significant differences in the numbers of intact seeds among the six different fruiting plant species recorded in the areas visited by the baboon troops (Wald χ^2 = 217.4; df = 5; p < 0.0001; Table 1). They entailed five alien shrubs and one indigenous shrub species. The estimated number of seeds of fruiting species exploited by the baboons in Hogsback were 82.2 ± 13.3% (n = 284) for *Acacia mearnsii*; 78.9 ± 12.1% (n = 231) for *Pinus patula*, and 64.0 ± 20.0% (n = 108) for *Solanum mauritianum*.

Table 1. Significant differences between the number of intact seeds of fruiting alien plants preferentially consumed by the chacma baboons in Hogsback shown by the generalised linear models (GLMs). Superscript "a" represents a parameter that was selected as a reference for comparison of the significance. *** native plant species.

Plant Species			Hypothesis Test		
			χ^2	Df	*p*-Value
Overall test model			217.328	5	0.000
	B	Std. Error			
Rubus cuneifolius	−0.920	0.1089	71.358	1	0.000
Cotoneaster pannosus	−1.008	0.1124	80.436	1	0.000
Sersia trilobata ***	−1.224	0.1220	100.808	1	0.000
Pine patula	−0.041	0.0831	0.248	1	0.618
Solanum mauratianum	−0.248	0.0878	7.976	1	0.005
Acacia mearnsii	0 [a]	-	-	-	-

Based on the total troop size and the number of observation days, it was estimated that the two baboon troops could transport 445,536 seeds of the six focal fruiting plant species documented during the study period.

It was also estimated that the baboons could disperse seeds over an average distance >5 km for each daily foraging activity (Table 2).

Table 2. Potential seed dispersal distances for chacma baboons in Hogsback: Predicted distances were generated using allometry equations, while actual distances were measured over the foraging trails from sleeping sites to the furthest location reached by each troop during foraging.

Troop	Predicted Distance in km [78]	Actual Distance (km)	Average (km)
Evie	4.4	7.14	5.8
Nola	4.4	6.33	5.4

The overall NDVI shows that the change in vegetation cover is the result of bush encroachment in the study areas between 1978 and 2023. The predominant vegetation in the forest biome's 'dense vegetation cover' has expanded by 80.9 ha over 45 years (88.8 to 97.4%; Figure 6). Conversely, the moderate vegetation and sparse vegetation covers have collectively decreased by 10.3 ha (Figure 6).

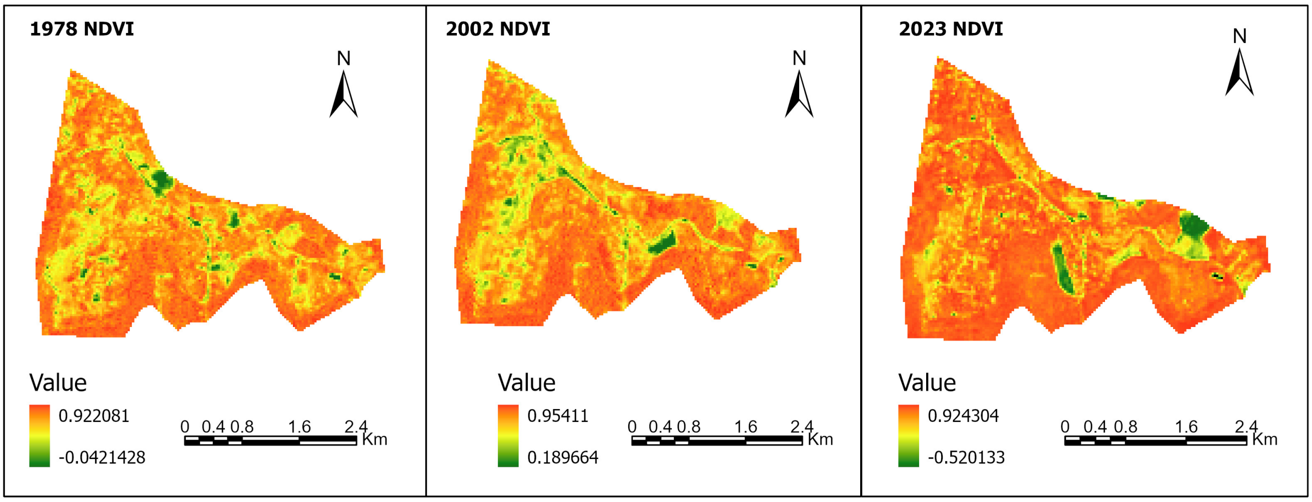

Figure 6. Variation in the normalised difference vegetation index for Hogsback areas (the study site) between 1978 and 2023.

5. Discussion

The baboons' foraging preference for domestic gardens creates human–wildlife conflict and accounts for a significant decline in species that were once abundant [55]. In this study, we show that chacma baboons also have the potential to spread the ingested seeds of fleshy-fruited alien and invasive plant species consumed in domestic gardens, although alien plant resources are important food supplements [76]. This may deprive indigenous plant species of reproductive ecological services (i.e., pollination and seed dispersal [50]) that are essential for plant recruitment and the maintenance of the threatened Amathole forest in Hogsback, Eastern Cape Province.

Because the foraging visits frequencies of vertebrates on fruit resources influence seed dispersal effectiveness [76,77], the significantly high foraging preference of chacma baboons towards the human-modified habitats of Hogsback supports the prediction that baboons may transport the seeds of invasive alien plant species. The orchards and gardens are reportedly a major source of alien plant propagules [55–57,89,90], and are indeed a major resource for native animals where indigenous forests have been cleared [76]. In the absence of the rare and large indigenous fruits preferred by large mammal frugivores [57,91–94], the baboons may opt for the large fruit crops of the alien plant species in gardens [35], which deprives the natural vegetation of seed dispersal services. This is concerning, since invasive plant species are known to alter habitat functionality and damage biodiversity [52,53].

Primates (e.g., *Papio* species) are known to be effective dispersal vectors, transporting huge seed loads in Africa [23,94–96]. Our consistent finding that the chacma baboon troops may transport many intact seeds from the six fruiting plant species is likely a result of the prevalence of these species in the human-modified habitat of Hogsback and on forest edges where they become established over time. We argue that baboons might effectively disperse seeds from the fleshy-fruited *S. mauritianum* and *Rubus cuneifolius* in Hogsback, as suggested by Kunz and Linsenmair [21], since they often eat the ripe and colourful fruits in the forest [94,97,98]. Lotter et al. [99] also associated the infestation of the invasive *Opuntia stricta* in Kruger National Park, South Africa with seed dispersal due to the foraging of chacma baboons. In contrast, chacma baboons are partly seed predators that depend on the nature of the fruits [14,25,96], and Kunz and Linsenmair [21] reported that predation effects are suffered by dry seeds while fleshy fruits with smaller seeds can be effectively dispersed. Since the foraging site was mainly dominated by invasive *A. mernsii* and *P. patula* (i.e., having dry seeds), we suggest that significant proportions of their seeds were likely to be masticated by the baboons, which could suppress their dispersal as soft-coated seeds and their establishment, leading to the further invasion of hard-coated seeds. In addition, the asynchronous fruiting pattern of *S. mauritianum*, which concurrently keeps many unripe and immature and a few ripe fruits/berries in the infructescence for foraging frugivores [34,58], can reduce seed dispersal effectiveness, since immature seeds will not geminate [58,98,100]. A similar phenomenon has been previously reported for baboons feeding on the fruits of the Baobab (*Adansonia digitata*) in South Africa [99].

It has been proposed that large mammal vectors are likely to produce clumped dispersal patterns [81] because of their constant daily foraging movement patterns in combination with the use of permanent sleeping sites in a particular landscape [101]. We argue that an absence of clumped seed dispersal, against the study's prediction and the report by Kunz [28], is likely to be physiologically driven by laxative alkaloids in the foliage and the fruits of alien plant species, especially *S. mauritianum* [102–104]. This finding was unexpected, since, during the study, the baboons spent 38% of their time eating and because the fruit resources were abundant. It seems that the baboons intermittently defecate as they traverse the habitat. Also, we speculate that the rugged terrain of the study site allows floods to wash away some dispersed/defecated seeds during the rainy season, and thus conceal clear patterns, although this may provide secondary dispersal services. Nevertheless, the seeds that are retained in the gut are likely dispersed over long distances (>5 km), and this is known to facilitate the establishment of new alien plant populations [105]. In combination with biophysical disturbance and the arrival of new alien plant propagules [106], there is a high possibility of alien plant invasion occurring in the Amathole forest, and infiltration by alien and invasive plant species may result in the deterioration of forest resilience. We consistently observed an increase in woody vegetation cover and a decrease in sparse vegetation spatial coverages, which supports our proposal that new-recruiting alien plant species are likely to drive change in the forest's integrity. In addition, the observed change may be expedited by the local timber plantations that have transformed the native forest's ecological supporting vegetation units that reportedly bolster the resilience of critical biodiversity areas in South Africa [88,107].

In conclusion, we have shown that the foraging of chacma baboons in domestic gardens encourages the spread of alien and invasive plants' seeds in Hogback, and that this is a conservation threat to the protection of the Amathole forest in South Africa. We recommend eradicating the alien and invasive plants and rehabilitating the areas that will be cleared to allow for the regrowth of indigenous species. Alternatively, baboons in the African savanna and forest habitats masticate dry seeds [93,97,108,109], and the foraging of partially ripe fruits of *S. mauritianum* may result in the dispersal of immature seeds that do not germinate, which would thwart the effective seed dispersal. Since fruit resource distribution influences foraging movement patterns [109], we suggest that the observed foraging movement patterns of the chacma baboons during this study were skewed by the availability of food resources in the human-modified habitat, which may greatly reduce seed dispersal services for indigenous plants in the threatened Amathole forest. While the contribution of the baboons to the seed dispersal of alien and invasive plants was not known in Hogsback, we acknowledge that the prevalence of the invasive *A. mernsii*, *P. patula*, and

S. mauritianum in the local habitat could be partly driven by the bird-mediated dispersal of highly viable seeds (i.e., greater than 80% [110–113]). According to the South African National Regulations for Biological Invasions (the National Environmental Management: Biodiversity Act [NEM:BA, Act 10 of 2004] and the Alien and Invasive Species Regulation of 2014 revised in 2020), *S. mauritianum* and *R. cuneifolius* are habitat transformers, and thus must be controlled and, where possible, removed and destroyed; trade or planting is also strictly prohibited. Lesica and Shelly [113] reported that the continuous removal of the invasive *Arabis fecunda* improved the survival and population performance of the native fruiting species in the northwestern USA. Further, quantitative studies investigating the diversity of the plant species dispersed, their germination rates after ingestion by baboons, and their seasonal patterns are required to understand the baboon seed dispersal systems in the Amathole forests of Hogsback.

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