The role of man, hand-raised black rhinos and elephants on woody vegetation, Matusadona National Park, Zimbabwe

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Abstract

The impact of man, hand-raised black rhinos and elephants (referred to as 'agents') on woody vegetation around the Tashinga rhino hand-raising site in Matusadona National Park (MNP), Zimbabwe, were assessed in April–May 2004 while the programme was running and in June 2012 after the programme was suspended. A combination of direct and indirect observation methods were used to assess the damage caused by the three agents. Each individual plant was identified and assessed to determine the extent of damage inflicted by each agent under study. Results indicate that degradation intensity and impact on woody vegetation varied among man, black rhinos and elephants and also differed significantly along a distance gradient. Density was high for some plant species, but diversity was not significantly different ($P > 0.05$) between the three segments. It can be concluded that the three agents had different roles in transforming a once thick vegetation area into open woodland. For future management of hand-raising *Pachyderm* programmes under similar circumstances, it is recommended that rotational browsing is adopted, as the benefits outweigh the disadvantages especially when faced with increasing levels of rhino poaching. Also since the area of degradation is usually relatively small, reforestation measures using native plant species could be included in future project management designs.

Additional key words: boma, degradation, hand-raising site, poaching, woody plants

Résumé

L'impact de l'homme, des rhinocéros noirs élevés avec l'alimentation à la main et des éléphants (appelés agents) sur la végétation ligneuse autour du site de Tashinga réservé à l'élevage de rhinocéros nourris à la main au Parc National Matusadona (PNM), au Zimbabwe, ont été évalués en avril–mai 2004, alors que le programme était en cours et en juin 2012 après la fin du programme. L'observation directe des animaux ciblait les rhinocéros noirs élevés à la main et l'homme et l'observation indirecte des animaux, adaptée aux éléphants et aussi à l'homme, ont été adoptées comme des méthodes d'évaluation. Chaque plante a été identifiée et examinée afin de déterminer l'ampleur des dégâts infligés par chaque facteur à l'étude. Les résultats indiquent que l'intensité de la dégradation et l'impact sur la végétation ligneuse variaient parmi les hommes, les rhinocéros noirs nourris à la main et les éléphants et différaient aussi considérablement le long d'un gradient de distance. La densité était élevée pour certaines espèces de plantes, mais la diversité n'était pas significativement différente ($P > 0,05$) dans les trois segments. On peut conclure que les trois agents avaient des rôles différents dans la transformation d'une zone de végétation dense en une forêt claire ouverte. Pour la gestion à l'avenir des programmes de *Pachydermes* élevés à la main dans des circonstances semblables, il est recommandé que le broutage rotationnel et un suivi de la végétation soient adoptés car les avantages l'emportent sur les inconvénients, surtout lors qu'on est confronté à l'augmentation des niveaux de braconnage de rhinocéros. En outre, puisque la zone de dégradation est souvent relativement petite, on pourrait inclure des mesures de reboisement en utilisant des espèces de plantes indigènes dans les stratégies de gestion de projets futurs.

Mots clés supplementaires: enclos, dégradation, site d'élevage à la main, braconnage, plantes ligneuses

Introduction

The construction of the Lake Kariba dam wall between 1957 and 1960 influenced the eventual establishment of Matusadona National Park (MNP), Zimbabwe. In 1958 Matusadona was first proclaimed a conservation area for non-hunting activities, then gazetted a game reserve in 1963 and finally declared a National Park in 1975 (Parks and Wildlife Act [Chapter 20:14] of 1996). Regardless of the establishment of protected areas, wild animals continue to be poached. For instance, black rhino (*Diceros bicornis*) poaching intensified during the 1980s throughout Africa (Reid et al. 2007). By 1995 the African black rhino population had plunged to about 2,410 individuals from an estimated continental population of 100,000 in 1960 (Milliken and Shaw 2012). In Zimbabwe numbers declined to about 250 by 1993 from an estimated population of 1,400 in 1991 (Zimbabwe National Parks 1997; Gandiwa 2013). The magnitude of this onslaught prompted the formulation of conservation strategies like the Zimbabwe Black Rhino Conservation Strategy (Zimbabwe National Parks 1992), the Black Rhino Project Emergency Plan (Zimbabwe National Parks 1993) and the establishment of black Rhino Intensive Protection Zones (IPZs) on state land and the black rhino conservancies on private land. In order to save the black rhino in Zimbabwe from escalating poaching, four IPZs were established in 1993 including MNP, Sinamatella National Park, Matopos National Park and Chipinge Safari Area. In addition, a black rhino hand-raising programme, involving MNP, was established. These strategies resulted in Zimbabwe currently holding approximately 700 rhinos, of which about 400 are black rhinos (Gandiwa 2013), making it the fourth largest stronghold for the species after South Africa, Namibia and Kenya.

The translocation of rhino calves for hand-raising at MNP was suspended by the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) around 2002/3 following incidences of poaching, but protection and monitoring of the existing animals under hand raising intensified. Although there is no consensus among stakeholders on the current black rhino size in MNP, the majority are concerned and agree that the numbers have declined considerably based on the small number of sightings and encounters.

The elephant (*Loxodonta africana*) population of MNP was estimated at 2,150 in 2000, and the 2006 aerial census estimated the population to be about 1,925 (Blanc et al. 2007). This exceeds the threshold of potential ecological concern of around 700 and is above the recommended elephant density of 0.5 animals/km2 in Zimbabwe's protected areas (Zimbabwe National Parks 1997; Cumming et al. 1997). However, a survey recently carried out in 2014 estimated a reduction of elephants in the Sebungwe region, which includes MNP, by an estimated 75% (P. Kuwaoga pers comm., October 2014), suggesting that the MNP elephant population could be on the decline.

Before its suspension, the black rhino hand-raising and release programme was blamed by stakeholders for causing woody vegetation degradation. Impacts of elephants on woody vegetation are well documented (Chafota 2007; Mukwashi et al. 2012) and where they co-exist with other large herbivores, such as rhinos, woody vegetation is subjected to intense utilization and damage (Pradhan et al. 2008). Man's role in such situations is directly associated with rhino feeding, as rhino handlers cut preferred leafy tree branches to provide supplementary feed. Between October 1994 and March 2002, eight hand-raised black rhino calves, one sub-adult and two adults were received at MNP from different sources for further raising or release (Matipano 2004a). Seven of the calves were received from a private game ranch (Imire) located in Mashonaland East Province of Zimbabwe and one was received from Chewore Safari Area, a state protected area (Table 1). These rhinos complemented an estimated 43 wild and released black rhinos resident in MNP (Matipano 2004a).

Table 1. Details of black rhinos that went through the Tashinga rhino hand-raising site (1994–2003). HRP: hand raising programme; Chewore safari area; Imire game ranch. Dates are shown as (dd/)mm/yy; *month of birth not known
Source: Modified from Matipano (2004b)

Entry No	Rhino name	Sex	Date of Birth	Origin	Date rec'd at Tashinga	Status on arrival	Release date from HRP
1	Chewore	F	4/94	Chewore safari area	8/94	Calf	10/3/98
2	Mgofu	M	2/95	Imire game ranch	12/96	Calf	18/12/99
3	Mbizhi	F	6/97	MNP	9/97	Adult	22/6/01
4	Kiplings	M	2/96	Imire game ranch	12/97	Calf	12/00
5	Cleopatra	F	5/97	Imire game ranch	12/97	Calf	1/01
6	Cuckoo	F	early 1987*	Mana Pools via Imire game ranch	30/5/98	Adult	6/98
7	Pfumbe	M	early 1987*	Mana Pools via Imire game ranch	30/5/98	Adult	6/98
8	Shungu	M	22/2/98	Imire game ranch	1/4/99	Calf	8/01
9	Madonna	F	22/12/97	Imire game ranch	9/4/99	Sub-adult	8/8/01
10	Mvura	F	1/99	Imire game ranch	6/6/00	Calf	2/1/03
11	Boma	F	28/11/99	Imire game ranch	11/5/01	Calf	2/1/03
12	Chibage	M	29/8/99	Imire game ranch	28/3/02	Calf	Poached while sill under HRP
Key:	HRP= hand-raising programme; MNP= Matusadona National Park; * Actual date/month not known						

The hand-raising programme at MNP saw rhinos alternating between being 'hand fed' and herded like domestic livestock every day within a 2–3 km radius from a focal point at the *boma* (kraal/enclosure) at Tashinga camp, reaching a maximum range of 4 km (Matipano 2003). While the ecology and behavioural aspects of black rhinos are well documented (Artkinson 1995; Hutchins and Kreger 2006), the impact created by a combination of rhino, elephant and man on woody vegetation, is poorly documented. The objectives of this study were (i) to assess woody vegetation density and diversity and woody vegetation degradation by man, elephant and rhino (collectively referred to as 'agents' in this study) across different segments at Tashinga black rhino hand-raising site, and (ii) to establish the relationship between woody vegetation damage and distance from the study centre.

Materials and methods

Study area

MNP stretches from 28°23'–28°51'E and 16°41'–17°13'S (Fig. 1). The park covers about 1,407 km² and is divided into two major geomorphologic landscapes: the wet, dystrophic, rugged highland section with altitudes ranging from 600 to 1,200 m, where *Brachystegia–Julbernadia* woodlands dominate (Matipano 2004a); and the semi-arid eutrophic valley floor at an altitude of between 485 and 600 m, dominated by *Colophospermum mopane* mixed with *Combretum* spp. and *Terminalia* spp. On the valley floor, annual rainfall varies between 400 and 800 mm per year (mean: 730 mm), with the main rainy season occurring between November and April.

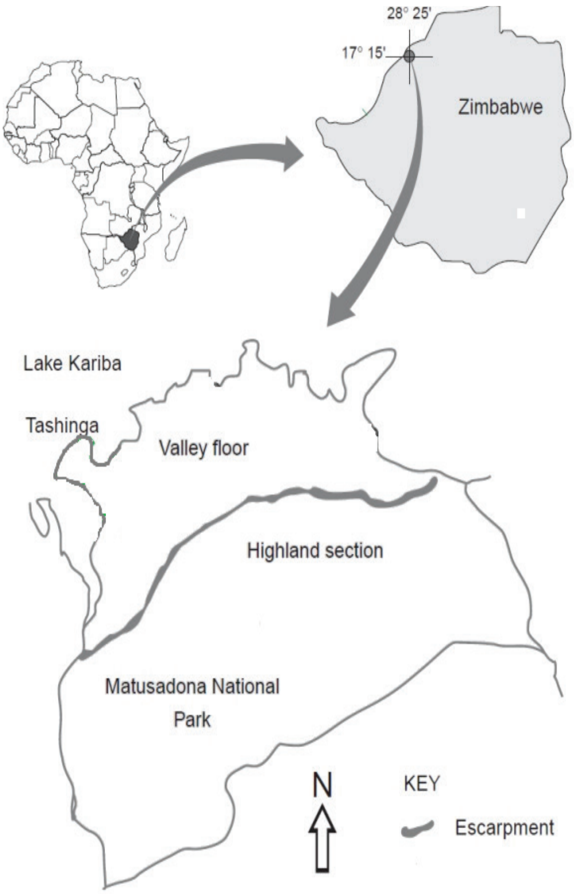
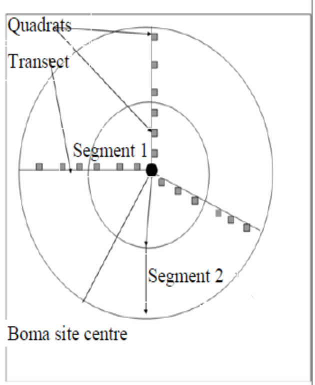


Figure 1. Matusadona National Park, indicating study site (Tashinga). Source: Modified from Matipano (2004b)

Damage category	Class
Uprooted and dead	9
Main trunk pushed over and broken	8
Main trunk pushed over, but not broken	7
>50 % branches broken/cut	6
<50 % branches broken/cut	5
Scarred on main trunk	4
>50 % branches dead	3
<50 % branches dead	2
Shoots/twigs cut	1
Plant with no damage	0

a



b

Figure 2. (a) Plant damage categories and (b) Arrangement of transects and quadrats where woody vegetation damage variables were assessed

Experimental design and data collection

The vegetation assessment design located a focal point at the boma, selected purposively as a reference point. Three 2 km long line transects running in different directions, about 120° from each other, were established and the area was divided into two concentric segments (Segments 1 and 2), with radii of 1,000 m and 2,000 m respectively (Figure 2b). On each transect, six 25 × 20 m quadrats (3 in each segment) were established using systematic sampling, at 300 m intervals. The size of the quadrats did not strictly follow the Braun-Blanquet method due to homogeneity of the vegetation community. Four further quadrats of the same size were established in another segment (Segment 3), located 3 km away from the focal point and with similar vegetation. These quadrats were used to compare vegetation damage in the absence of heavy utilization by the three agents considered in this study.

The study was carried out between April and May 2004 soon after the rainy season and in June 2012 well after the black rhino hand-raising programme had been suspended. The impact of hand-raised black rhino (hereafter 'rhino') was assessed by means of direct observation of animal–vegetation interaction. One selected animal would be followed each day on its feeding trail, where targeted tree/shrub species and the girth of individual plants were recorded together with all damages inflicted on the woody plants. Assessment followed methods described by of Matipano (2003) and Sarma et al. (2012).

For elephants, an indirect observation method was adopted; this involved tracking an animal's feeding trail and recording its feeding patterns

Table 2. Woody vegetation species density (plants/ha) in the three segments (2004)

No.	Plant species	Segment 1 (9 quadrats)	Segment 2 (9 quadrats)	Segment 3 (4 quadrats)
1	*Adansonia digitata*	0	2	0
2	*Baphia massaensis*	2	36	10
3	*Bauhinia petersiana*	0	4	0
4	*Boscia angustifolia*	2	0	5
5	*Canhtium randii*	0	0	20
6	*Canthium huillense*	0	9	0
7	*Cassia abbreviate*	0	4	10
8	*Colophospermum mopane*	193	29	60
9	*Combretum apiculatum*	44	127	425
10	*Combretum collinum*	36	173	165
11	*Combretum eleagnoides*	231	273	115
12	*Combretum zeyheri*	18	111	130
13	*Commifora africana*	0	4	0
14	*Commiphora mossambicensis*	2	0	0
15	*Dichrostachys cinerea*	20	16	0
16	*Diospyros quiloensis*	120	240	665
17	*Elephantorrhiza goetzei*	2	11	0
18	*Erythroxylum zambesiacum*	0	11	35
19	*Friesodielsia obovata*	0	9	0
20	*Gardenia resinifera*	0	0	10
21	*Grewia bicolour*	7	2	0
22	*Grewia flavescens*	0	2	0
23	*Grewia monticola*	4	2	0
24	*Holarrhena pubescens*	0	0	5
25	*Karomia tettensis*	549	1251	970
26	*Kirkia acuminate*	2	0	0
27	*Lannea stuhlmannii*	2	0	0
28	*Lonchocarpus capassa*	0	4	0
29	*Margaritaria discoidea*	0	2	0
30	*Ormocarpum kirkii*	7	0	0
31	*Pteleopsis myrtifolia*	31	153	60
32	*Pterocarpus rotundifolius*	0	0	10
33	*Schrebera alata*	0	9	20
34	*Sclerocarya caffra*	2	0	0
35	*Strychnos madagascariensis*	40	96	135
36	*Terminalia mollis*	16	38	5
37	*Terminalia prunioides*	0	0	5
38	*Terminalia sericea*	0	22	0
39	*Terminalia stuhlmannii*	2	0	0
40	*Vanguelia infausta*	16	40	35
41	*Xemenia caffra*	0	0	5
42	*Xerodoris stuhlmanii*	13	11	10
Total plants/ha		1361	2691	3030
Total no. of recorded species		26	29	24

hours after the animal had gone (Kotze and Zacharias 1993; Basha et al. 2009). Tracking was done early in the morning between 05:00 and 07:00 GMT following elephants' visits at the study site the previous night. For man direct observation focused on freshly cut branches either by a hand-held axe or machete, while indirect observation assessed old damage inflicted a month or more previously and identified by a darkened cut surface due to the action of environmental agents over time.

Woody vegetation was recorded as trees, i.e. woody plants ≥3 m in height and shrubs, i.e. plants of <10 cm girth and <3 m in height. Woody vegetation composition variables calculated were density and diversity. For the purposes of this study, 'damage' referred to signs of visible breakage on the trunk or branches caused by plant utilization or browsing (Ssali et al. 2012) that had the potential to incapacitate further growth or development of the woody plant or plant part affected. Following Conybeare (1991) and Ndlovu and Mundy (2009), categories of woody vegetation damage recorded included; breaking of main trunk, breaking of branches, pushing over of trunks, scarring, uprooting of woody plants and cutting of shoots or twigs. Further subdivisions results in a total of 10 classes of damage (Figure 2a).

Data analysis

Woody vegetation densities for each quadrat were converted into per hectare quantities. The Shannon's diversity index (H) was used to determine the differences in species composition in the study site (Shannon and Weaver 1949). The Chi-square goodness of fit test was used to test for differences between vegetation damage by elephants and rhinos in two segments. Pearson's r was used to measure the linear correlation between plant damage by each agent and distance from the focal point. Kruskal–Wallis ANOVA by ranks was used to determine relationships between recorded woody vegetation damage categories in the 22 sample quadrats, and principal component analysis (PCA) was performed to establish the extent to which sample quadrats across the segments were associated based on damage patterns. Statistical analyses were done in STATISTICA for Windows version 7 (Stat Soft 2004).

Results and discussion

Density, diversity and impact of man, elephant and rhino on woody vegetation

In 2004, Segments 1, 2 and 3 contained totals of 1,361, 2,691 and 3,030 woody vegetation plants/ha, respectively (Table 2), with a total of 42 woody vegetation species recorded in the study area, representing 33 genera and 20 families. Using Shannon's Diversity index, species diversity between the same segments was not significantly different ($P > 0.05$) between 2004 and 2012, with indices of similarity of 0.64, 0.60 and 0.62 for Segments 1, 2 and 3 respectively. The diversity value (H) ranges between 0–5, where 0 indicates that the number of species in the sample are similar and a value near 5 indicates high species complexity in the sample. The non-significant

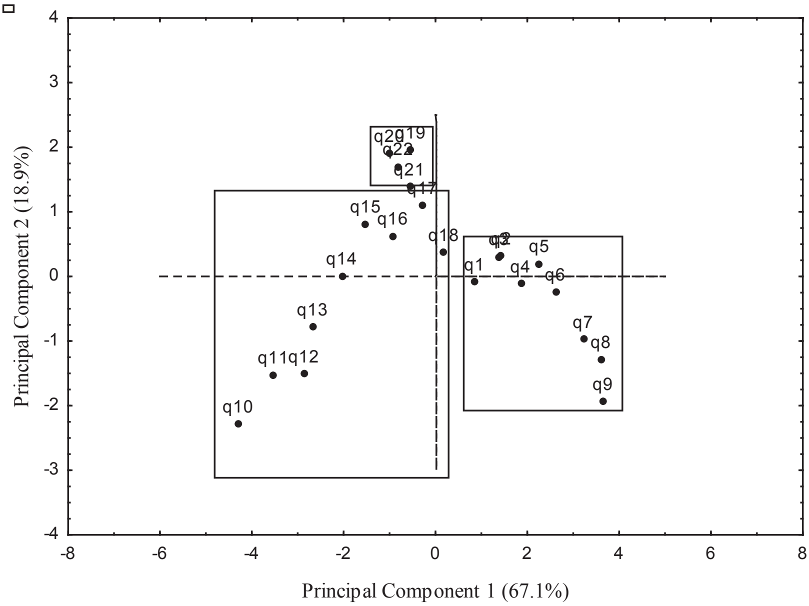


Figure 3. Principal component analysis biplot of 22 sample quadrats based on woody vegetation damage variables drawn from all quadrats across the three study segments. Notes: Box indicates quadrats with similar characteristics.

difference in woody vegetation composition between 2004 and 2012 could indicate that the suspended black rhino hand-raising programme had little impact on vegetation composition across the study site.

In 2004, the impact on woody vegetation by elephants and hand-raised black rhinos varied across the segments. A greater proportion of rhino damage was to shrubs ($P < 0.05$); while elephants caused relatively more damage to trees. The rhinos exploited 28 woody vegetation species but were observed to prefer *Karomia tettensis, Diospyros quiloensis, Combretum apiculatum, C. zeyheri* and *Strychnos madagascariensis*. Elephants also concentrated on the above species, with the exception of *D. quiloensis*, but also favoured *C. collinum*. Overall, there was significant difference in woody vegetation damage between elephants and rhinos ($\chi^2 = 118.44$, df = 1, $P < 0.0001$) across the quadrats, with rhinos damaging more woody plants than elephants.

Trees with broken trunks ranged between 3 cm to 48 cm in girth (mean: 34 cm), but the bulk of this class of damage occurred in the 5 cm to 25 cm girth classes. Those that had trunks pushed over ranged from 7 cm to 59 cm in girth (mean: 24 cm) and the largest recorded tree pushed over by rhinos had a girth of 46 cm. A negative relationship was observed between trunk pushing-over and tree girth, as trunk pushing-over displayed a decreasing trend with increasing tree girth. There was low trunk breaking in woody plants of girth <5cm, while trunk breaking also decreased with increasing girth. Elephants uprooted and broke trunks more than rhinos in the larger girth sizes and concentrated their damage in the 40–70 cm girth classes. Trunk breaking by elephants increased with increasing girth while the pushing-over of tree trunks by elephants decreased with decreasing tree size. Trees of >200 cm girth rarely had their trunks broken or were ever pushed over. With respect to damage by humans, observation revealed that branches were cut selectively. Damage to trees covered a wider girth class but no observations of woody plant trunk pushing over or uprooting by man were recorded.

Table 3. Summary of recorded woody vegetation damage by category across the three segments using the eight classes of damage in 2004. Data are expressed as percentage damaged of the total number of woody plants (n) recorded per segment. For branches, the percentage damaged of the total number of branches stemming from the main trunk (in brackets) is shown. The results of Kruskal–Wallis ANOVA by ranks of the 22 sample quadrats (H and P values) are also given. H-values indicate the ranking of the means of recorded woody vegetation damage by category across the sample segments, P-values indicate the relationship of recorded woody vegetation damage categories across all segments; all values are significant with the exception of the P-value in bold, which indicates no significant difference for the 'plant scarred on main trunk' damage category across all segments. Woody plants with the damage classes of >50% branches broken/cut and >50% branches dead were not observed

Damage class	Segment 1 (*n = 633*)	Segment 2 (*n = 1213*)	Segment 3 (*n = 610*)	*H*-value	*P*-value
Plants with no damage	5.9	7.0	6.2	10.5	0.005
Shoot/twigs cut	42.2	56.7	57.4	13.8	0.001
< 50 % branches dead	37.5 (*2532*)	86.5 (*4852*)	51.4 (*2440*)	18.0	0.000
Scarred on main trunk	10.1	3.9	2.1	6.6	0.036
< 50 % branches broken/cut	72.2 (*2532*)	94.2 (*4852*)	89.0 (*2440*)	16.9	0.000
Main trunk pushed-over but not broken	15.2	26.4	2.1	17.4	0.000
Main trunk pushed over and broken	68.9	61.9	54.6	11.0	0.001
Uprooted and dead	8.1	14.0	2.6	13.3	0.001

The observed damage patterns (trunk breaking, branch breaking, plant uprooting and plant pushing over of targeted tree sizes) are consistent with observations by other authors (Mapaure and Mhlanga 2000; Birkett 2002; Vanak et al. 2012) who observed that rhino damage and tree removal were confined mostly to shrubs while there was an almost even impact across all girth sizes by elephants. Further, an element of incremental damage was observed where woody vegetation that had already been damaged by elephants was subjected to further damage by rhinos. According to Anderson and Walker (1974), elephants preferentially browse on woody vegetation previously utilized. Black rhinos and other browsers were observed to have the same behaviour, taking advantage of woody plants that had been pushed over or broken by elephants (Valeix et al. 2011). Bell and MacShane (1985) and Kohi et al. (2011) also observed that the elephant feeding strategy of pushing over trees made available forage for other browsers and this could also apply for rhinos.

Some trees were observed to be dead. The natural causes involved remain speculative but could include natural diebacks, droughts, soil acidity and water logging. However, these were present in very low numbers. In Segments 1 and 2, 51.8% of trees and 15.3% of shrubs damaged were left as stumps; while in Segment 3 only 22.8% of trees and 0 % of shrubs were left as stumps. A greater amount of coppice re-growth was recorded in Segments 1 and 2 compared to Segments 3.

Woody vegetation damage patterns and distance from the study centre

An assessment of vegetation damage patterns across quadrats using the PCA indicated two principal components with eigenvalues .>1, accounting for 86.04% of the patterns in the vegetation matrix. Figure 3 presents a PCA-biplot with 22 sampled quadrats from the three segments in the study site. Principal component 1 (eigenvalue = 5.4) explains 67.10% of the woody vegetation damage, defining a gradient from an area where woody plants were more scarred on main tracks to areas where less plants were uprooted/dead and plants with trunks pushed over but not broken. Principal component 2 (eigenvalue = 1.5) explains 18.94% of the woody vegetation damage with gradient indicating a movement from an area with less uprooted and dead plants, trunks pushed over but not broken to an area with woody plants with more main trunks broken, <50% total branches dead and <50% total branches broken and twig cuts. There were similarities between patterns of woody vegetation damage and association with distance in sampled quadrats in Segments 1 and 2. Specifically, in Segments 1 and 2 there were decreases in all woody vegetation damage classes with increasing distance from the focal point, while Segment 3 showed no correlation between woody vegetation damage and distance from the focal point among the sampled quadrats.

With respect to the three agents, plotting woody vegetation damage against distance from the focal point showed significant strong negative linear relationships, i.e. damage decreased with increasing distance from the focal point, for man (adjusted R2 = –0.23, $P < 0.05$), rhino (adjusted R2 = –0.89, $P < 0.05$) and elephant (adjusted R2 = –0.09, $P < 0.05$). Man accounted for the largest percentage of tree trunk breaking (59.8%, n = 379) in Segment 1 (0–1 km). In Segment 2 (1–2 km) rhinos accounted for the largest percentage of tree trunk breaking (68.5%, n = 831), followed by elephants (27.6%, n = 335) and lastly man (3.9%, n = 47). Elephant damage to woody vegetation showed a significant increase in impact with decreasing distance from the focal point. In Segment 3, man's activity was negligible, with only one tree observed cut during the 2004 study period. Across all segments, the overall damage for all recorded variables/categories showed significant differences in the amount of damage observed between segments (Table 3).

The concentration of rhino plant damage in Segments 1 and 2 concurs with the fact that rhinos were herded mostly within a 2 km radius. The confinement of hand-raised black rhinos could have resulted in an artificially created, localized high density of rhinos, exceeding the recommended density of about 1 per 10 km2 (du Toit 1994) in Zimbabwe's low veld areas. Although man's impact was less than that of hand-raised black rhinos and the elephants, it was intense between 0.6 km and 1 km, indicating that man was most active in utilizing woody plants within that distance.

Conclusions

With respect to the objectives of this study several conclusions can be drawn: 1) variations existed in woody plant damage by man, elephant and hand-raised black rhino with increasing distance from the focal point; 2) a competitive effect existed among the three agents on woody vegetation damage around the rhino hand-raising site; 3) coppicing of most of the damaged plants supported the idea that herbivores, especially elephants, do not prevent regeneration of many species, but may prevent recruitment into taller size classes (Anderson and Walker 1974), and 4) the establishment of this black rhino hand-raising programme had no significant contribution to woody vegetation degradation at the study site. However, unregulated anthropogenic activities could threaten the survival of biodiversity (Milliken and Shaw 2012). For management purposes it is recommended that where such similar programmes are run, rotational browsing and management regimes should be established to allow regeneration and recruitment of plants into taller canopy trees and that for elephants, the recommended density of 0.5 animals/km² (Cumming et al. 1997) should be maintained if a balance between animal and vegetation conservation is to be achieved. Strategies for maintaining the balance can be through establishing linking corridors to adjacent protected areas and further promotion of the concept of trans-frontier conservation areas (TFCAs). Also given that the area of degradation is usually relatively small, re-forestation measures using native plant species could be adopted in future programmes.

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