ECOLOGICAL IMPACT OF LARGE HERBIVORES ON WOODY VEGETATION AT SELECTED WATERING POINTS IN THE KRUGER NATIONAL PARK

by

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SUMMARY

The Kruger National Park is situated in the Lowveld of Mpumalanga and the Northern Province, along the north-eastern boundary of South-Africa. It measures approximately 350 km from north to south and 65 km from east to west and covers an area of 1 948 528 ha.

The lack of quantitative data, on the impact of large herbivores on woody vegetation structure around watering points in the KNP, necessitated an in depth study of this aspect. The purpose of the study was firstly, to serve as an inventory study and secondly, to model the impact of large herbivores on the woody vegetation around artificial permanent watering points.

A diverse assemblage of igneous, sedimentary and metamorphic rocks, which covers a timescale of more than 3 000 million years, occurs within the borders of the KNP.

Sampling sites were selected to represent four combinations of high and low rainfall and two rock types. These areas constitute the largest land systems of the KNP.

By means of the BECVOL computer programme, certain structural variables related to woody structure were calculated. The structural variables chosen were total density (all woody individuals), tree density (woody individuals > 2 m), shrub density (woody individuals ≤ 2 m) and ETTE (Evapotranspiration Tree Equivalents).

The logistic curve and a third order polynomial curve were fitted to the data using non-linear regression analysis. The aim of fitting these curves was to find a model to describe impact of large herbivores on the structure of the woody vegetation around artificial watering points. In general, the logistic equation described the relationships between structural variables and distance from water better than the polynomial equation.

The logistic equation satisfactory models the impact of large indigenous herbivores on parameters of woody vegetation structure as a function of distance from water in the KNP. The shape of the curve varies with utilization pressure and soil types and depends on the dominant woody species of the area.

A browsing intensity gradient was hypothesised for woody vegetation around artificial watering points in the KNP. At most watering points on all land systems the biomass (ETTE) in areas close to watering points was negatively influenced. The zone of influence extended between 500 m and 2 300 m. This means that at a mean impact distance of 800 m, 3 % of the KNP is impacted by large herbivores around watering points.

On the eastern basaltic soils of the Satara and Letaba Land Systems the impact caused by large indigenous herbivores was one of low shrub density close to the watering point with increasing density away from the watering point. This trend modelled for shrub density at watering points was consistent at all the points, except one.

The impact of large herbivores on the woody vegetation of the granitic soils on the western side of the KNP showed differing trends. On the crestal areas of the Skukuza and Phalaborwa Land Systems shrub encroachment occurred close to the watering point. When the granitic area as a whole is assessed, it was clear that a zone of higher utilization occurred around all watering points. The effect depended mainly on species and soil differences between crestal and footslope areas.

From the results, it can not be concluded that the provision of artificial water and the accompanying grazing and browsing gradients, play a major role in the decline of large trees in the KNP.

Monitoring the woody vegetation around the closed points is of essence, the study should be repeated in 10 years time. This would enable one to keep the effect of fire and herbivory (elephants) constant and the effect of the watering point itself, if any, should come to the fore.

EKOLOGIESE IMPAK VAN GROOT HERBIVORE OP DIE HOUTAGTIGE PLANTEGROEI BY GESELEKTEERDE WATERPUNTE IN DIE NASIONALE KRUGERWILDTUIN

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OPSOMMING

Die Nasionale Krugerwildtuin (NKW) is in die Laeveld van Mpumalanga en die Noordelike Provinsie geleë en vorm die noord-oostelike grens van Suid-Afrika. Die wildtuin is bykans 350 km van noord na suid en 65 km van oos na wes en beslaan 'n oppervlakte van 1 948 528 ha.

Die gebrek aan kwantitatiewe inligting aangaande die impak van groot herbivore op die houtagtige plantegroei van die NKW, het 'n studie oor hierdie aspek nodig gemaak. Die doel van die studie was eerstens, om as 'n inventaris te dien en tweedens, om die impak van groot herbivore op die houtagtige plantegroei rondom kunsmatige waterpunte te modelleer.

Binne die grense van die NKW kom 'n diverse samestelling van stollings, sedimentêre en metamorfiese gesteentes voor. Monsterpersele is geselekteer dat die grootste

landsisteme van die NKW verteenwoordig is. Persele is uitgeplaas in vier kombinasies van hoë en lae reënval en twee geologiese gesteentes.

Die BECVOL rekenaarprogram is gebruik om sekere strukturele veranderlikes van die houtagtige plantegroei te bereken. Die strukturele veranderlikes wat in ag geneem is, was totale digtheid (alle houtagtige individue), boomdigtheid (houtagtige individue > 2 m), struikdigtheid (houtagtige individue ≤ 2 m) en ETTE (Evapotranspirasie Boomekwivalente).

Die logistiese kromme en 'n derdegraadse polinomiese kromme is gepas deur middel van nie-lineêre regressie-analise. Die doel met die passing van hierdie krommes was om 'n model te vind wat die impak van groot herbivore op die struktuur van die houtagtige plantegroei om waterpunte kon beskryf. Oor die algemeen het die logistiese vergelyking die verhoudings tussen strukturele veranderlikes en afstand vanaf water beter as die polinomiese vergelyking beskryf.

Die impak van groot herbivore op veranderlikes van die houtagtige plantegroei in die NKW, as 'n funksie van afstand vanaf water, word bevredigend deur die logistiese vergelyking beskryf. Die vorm van die kromme varieer met die benuttingsdruk, grondtipes en die dominante houtagtige spesie van die gebied.

'n Gradiënt in die blaarbenuttingsintensitiet is gehipotiseer vir die houtagtige plantegroei rondom waterpunte in die NKW. Die biomassa (ETTE) op alle landsisteme is negatief beïnvloed in die gebied naby die waterpunt. Die gebied wat beïnvloed is, strek tussen 500 m en 2 300 m vanaf die waterpunt. Dit beteken dat 3 % van die NKW deur groot herbivore, wat saamdrom rondom kunsmatige waterpunte, beïnvloed word.

Die impak van groot herbivore op struikdigtheid rondom waterpunte op die basaltgronde van die Satara- en Letaba-landsisteme was een van lae struikdigtheid naby die waterpunt met 'n toename verder weg van die waterpunt. Met die uitsondering van een punt was hierdie tendens konstant by alle waterpunte.

Die impak van groot herbivore op die houtagtige plantegroei van die granietgronde van die westelike deel van die NKW het verskillende tendense getoon. Struikverdigting het naby die waterpunte op die kruingedeeltes van die Skukuza- en Phalaborwa-landsisteme plaasgevind. Wanneer die westelike granietgedeelte as geheel ondersoek word, is dit duidelik dat 'n gebied van hoër benutting rondom alle waterpunte voorkom. Die effek van die hoër benutting hang van die plantspesiesamestelling af en grondverskille tussen die kruin- en voethanggedeeltes.

Uit die resultate van die huidige studie, kan nie bewys word dat die afname in groot bome in die NKW veroorsaak is deur die teenwoordigheid van kunsmatige waterpunte en die bewiedings- en blaarbenuttingsgradiënte wat dit veroorsaak nie.

Monitering van die houtagtige plantegroei rondom waterpunte is van absolute belang, die studie behoort oor 10 jaar herhaal te word. Die effek van vuur en herbivoor benutting sal dan konstant bly en die impak van die teenwoordigheid van die waterpunt self sal dan na vore kom.

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APPENDIX

Appendix: Table 1.1

Mananga Species list

Number of individuals per 100 m interval

Acacia nigrescens	1	1	23	6	1	2	2	8	4	1	4	8	9	2	8	17	4	7	7	1	10	8	5	2	6	16	8	11	4	4	31	6	6	22	13	18	9	7	9	12	3	6
Cordia monoica	2	2	2	1	5	8	8	3	9	15	3	3	8	3	0	2	12	16	7	12	13	10	3	7	9	9	2	2	6	6	11	22	28	31	10	6	5	0	11	3	0	1
Dichrostachys cinerea	1	10	1	2	5	1	2	3	5	2	0	1	3	0	0	4	1	1	0	0	4	0	1	1	2	0	0	5	3	7	10	23	18	9	3	0	5	46	3	23	0	1
Flueggea virosa	2	0	1	1	0	0	3	5	0	0	0	0	0	4	1	0	4	2	2	4	2	0	5	1	1	1	0	0	0	1	0	0	3	0	2	2	2	0	2	0	1	0
Sclerocarya birrea	2	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	1	0
Boscia foetida	1	0	0	2	0	3	3	0	0	0	0	1	0	2	0	0	0	0	2	0	0	0	0	4	0	3	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Acacia tortilis	1	1	0	1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Combretum imberbe	0	2	0	3	0	1	0	2	0	0	0	1	3	2	5	4	2	0	1	1	2	4	1	5	6	2	1	0	3	3	1	2	0	0	1	1	3	3	2	15	2	8
Commiphora africana	0	12	2	1	2	0	0	0	0	0	4	11	4	0	0	0	7	4	1	3	0	3	1	0	0	0	1	0	6	0	0	0	2	0	0	0	0	0	0	1	0	0
Grewia bicolor	0	2	1	4	1	4	1	1	1	2	2	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	3	0	0	0	0	0	0	0
Ximenia caffra	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albizia harveyi	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ormocarpum trichocarpum	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	1	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	31	3
Lonchocarpus capassa	0	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Combretum mossambicense	0	0	0	0	2	3	0	0	0	1	2	0	0	3	0	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	11	1	1	0	0	1	0	1	0	1	0
Olax dissitifolia	0	0	0	0	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0	0	0	0
Gymnosporia buxifolia	0	0	0	0	0	5	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Acacia exuvialis	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	2	0	0	1	3	3	7	0	0	0	4	2	0	0	0	2	1	2	0	0	1	1	1	2
Dalbergia melanoxylon	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Combretum collinum	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhus queinzii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0

Appendix: Table 1.2
Sibotwane Species list

	Number of individuals per 100 m interval																													
Acacia tortilis	1	0	2	1	1	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grewia bicolor	1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Acacia welwitschii	1	3	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	0	0	1	1	3	3	3	9	6	8	4	6	1	3	7	6	4	3	8	10	8	1	4	6	5	8	20	66		
Dichrostachys cinerea	0	0	0	3	2	2	2	4	1	9	3	16	4	9	1	13	17	12	3	0	2	1	1	16	0	26	1	6		
Combretum imberbe	0	0	0	3	0	0	2	3	0	2	5	8	0	1	1	3	2	2	2	0	3	0	4	2	4	5	3	2		
Cordia monoica	0	0	0	3	0	1	0	0	0	2	2	1	0	1	2	1	0	0	2	1	5	3	18	6	2	3	5	3		
Lonchocarpus capassa	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	4	3	0	0	0	1	0	0	0	0	0	0		
Commiphora africana	0	0	0	0	5	0	0	0	3	1	0	0	6	11	17	0	0	0	0	9	2	0	1	0	0	0	0	0		
Combretum mossambicense	0	0	0	0	7	0	0	7	0	0	0	0	0	0	0	0	1	1	0	0	2	0	2	0	1	0	0	0		
Acacia exuvialis	0	0	0	0	0	3	0	0	0	0	1	1	0	2	3	2	5	9	13	1	0	0	0	0	1	0	0	0		
Villoniguea virosa	0	0	0	0	0	5	0	0	1	0	1	0	2	0	2	0	1	1	0	0	0	0	0	0	1	1	0	3		
Cissus cornifolia	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0		
Combretum hereroense	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1		
Combretum apiculatum	0	0	0	0	0	0	0	0	1	0	0	0	6	1	1	3	8	3	2	7	1	8	0	0	4	0	0	0		
Combretum apiculatum	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		
Diospyros mespiliformes	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
Ximenia caffra	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1		
Ormocarpum trichocarpum	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0		
Lannea schweinfurthii	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Terminalia prunoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	2	0	0	0	0	0	0		
Cassia abbreviata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0		
Ziziphus mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0		
Acacia grandicornuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		

Appendix: Table 1.3
Tihongonyen Species list

	Number of individuals per 100 m interval																												
Colophospermum mopane	18	35	17	31	25	41	39	14	13	37	11	45	25	27	18	26	12	41	30	19	50	23	32	22	22	17	14	27	25
Combretum imberbe	0	0	1	1	0	1	0	2	1	0	1	3	0	0	1	1	0	0	0	1	2	0	0	0	0	0	0	0	1
Commiphora pyracanthoides	0	0	0	11	16	0	1	1	9	0	20	0	2	0	2	0	0	0	0	8	0	0	0	0	0	0	0	0	0
Dichrostachys cinerea	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1
Cordia monoica	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	2	2
Lonchocarpus capassa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Grewia bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ozoroa paniculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Appendix: Table 1.4
Hartbeesbult Species list

	Number of individuals per 100 m interval																								
Colophospermum mopane	33	26	30	37	38	34	24	30	34	59	57	59	17	37	34	31	24	37	29	22	22	26	27	33	35
Combretum mossambicense	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	0	1	0	1	4	0	10	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	1	1
Combretum imberbe	0	4	0	2	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0
Dalbergia melanoxylon	0	1	0	0	6	0	0	0	0	0	3	4	17	0	0	0	0	0	0	0	0	0	0	0	0
Dichrostachys cinerea	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Albizia harveyi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Grewia bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0
Commiphora pyracanthoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	8	5	0	0	0	0
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0
Ozoroa paniculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Cordia monoica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Sclerocarya birrea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0

Appendix: Table 1.5
Nkolobeni-south Species list

	Number of individuals per 100 m interval																		
Colophospermum mopane	11	18	5	13	30	16	17	18	14	38	49	49	33	31	28	58	53	49	41
Combretum mossambicense	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichrostachys cinerea	0	2	0	0	4	0	11	0	0	0	0	0	0	0	0	3	0	1	0
Lonchocarpus capassa	0	2	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0
Acacia nigrescens	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Combretum hereroense	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boscia foetida	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sclerocarya birrea	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0
Combretum imberbe	0	0	0	0	0	1	0	0	0	0	1	0	2	1	1	0	1	0	1
Commiphora pyracanthoides	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	10	1
Grewia bicolor	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	4	1	2	0
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Acacia karroo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Cissus cornifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Appendix: Table 1.6
Timbiten Crest Species list

	Number of individuals per 100 m interval																								
Combretum zeyheri	31	4	26	26	7	21	20	13	9	13	9	11	4	4	9	5	13	4	5	6	3	2	10	19	4
Combretum apiculatum	1	22	2	2	7	3	4	5	1	0	7	4	10	2	21	21	8	11	7	3	0	1	21	9	9
Terminalia sericea	2	1	4	5	0	1	3	1	1	12	0	6	0	1	1	2	11	2	6	5	2	0	1	3	0
Pterocarpus rotundifolia	1	0	0	1	0	0	0	0	30	0	13	7	4	0	16	12	1	0	0	0	0	4	11	0	5
Dichrostachys cinerea	1	1	0	1	2	0	3	3	0	1	0	0	1	0	0	1	0	0	0	2	3	1	0	4	4
Dalbergia melanoxylon	1	1	0	0	1	5	0	5	2	1	0	0	0	0	3	3	0	1	2	0	0	0	1	1	0
Strychnos madagascariensis	8	0	0	0	0	0	27	29	13	0	0	0	2	0	6	0	7	3	3	1	0	7	0	0	0
Cordia monoica	3	0	1	1	0	6	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lonchocarpus capassa	2	0	1	1	2	1	3	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1
Boscia foetida	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Combretum hereroense	0	2	0	1	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnosporia buxifolia	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diospyros mespiliformis	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Sclerocarya birrea	0	0	0	2	0	1	2	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Ozoroa paniculosa	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ximenia caffra	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cassia abbreviata	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albizia harveyi	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Cissus cornifolia	0	0	0	0	0	0	0	0	0	0	1	2	2	4	2	5	0	3	2	1	0	3	2	0	0
Grewia bicolor	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	1
Lannea schweinfurthii	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	2	1	6	0	12	5	3	0	3	2
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	1	0	0	0	0	0
Acacia exuvialis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	1
Ziziphus mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Acacia grandicornuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Euclea crispa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Appendix: Table 1.7
Shiteve-teve crest Species list

	Number of individuals per 100 m interval																														
Combretum apiculatum	22	7	19	3	11	12	23	19	11	14	12	18	35	24	19	12	17	14	13	20	11	13	14	12	24	11	26	18	17	20	17
Combretum zeyheri	3	12	7	21	14	7	7	2	3	4	2	12	8	5	3	3	1	1	1	2	2	11	0	13	1	1	3	5	3	4	0
Pterocarpus rotundifolia	0	8	5	4	10	0	12	16	9	19	6	1	0	14	9	4	16	4	0	2	6	1	3	20	3	2	5	8	3	7	7
Dalbergia melanoxylon	1	3	8	3	0	1	0	1	2	0	0	1	3	0	0	0	0	0	0	0	1	1	0	0	0	0	1	6	0	0	0
Cissus cornifolia	1	2	0	0	0	1	0	0	0	2	0	0	0	1	0	1	2	0	1	6	2	1	1	1	2	0	1	2	1	1	2
Albizia harveyi	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0
Acacia exuvialis	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Peltophorum africanum	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sclerocarya birrea	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	1	1	0	3	1	0	2	1	0	1	0	0
Lannea schweinfurthii	0	10	5	1	0	0	0	2	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lonchocarpus capassa	0	3	0	1	0	0	0	0	0	2	0	0	1	0	0	1	1	1	1	1	1	0	1	0	0	1	2	1	1	0	1
Strychnos madagascariensis	0	0	3	1	6	1	0	0	0	0	0	0	0	0	0	0	0	4	6	3	0	0	0	0	0	1	0	4	1	0	2
Terminalia sericea	0	0	0	2	0	0	0	0	0	1	2	2	2	1	3	0	0	1	0	0	1	3	1	0	3	3	3	5	5	1	2
Gymnosporia buxifolia	0	0	0	1	0	2	0	0	2	0	0	0	4	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0
Balanites maughamii	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Grewia bicolor	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Cordia monoica	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	0	0	1
Ziziphus mucronata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commiphora africana	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
Acacia grandicornuta	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ximenia caffra	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ormocarpum trichocarpum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Acacia nigrescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Flueggea virosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Ozoroa paniculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Dichrostachys cinerea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0
Cassia abbreviata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Combretum collinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix: Table 1.8
Timbiten Footslope Species List

	Number of individuals per 100 m interval																			
Combretum hereroense	12	1	12	12	10	16	0	17	17	4	8	18	5	1	0	5	1	0	29	22
Acacia grandicornuta	1	3	4	6	3	5	6	8	5	1	8	2	0	6	3	10	4	7	3	0
Combretum apiculatum	2	2	2	0	1	2	0	4	3	2	15	7	7	4	0	0	3	2	0	0
Dalbergia melanoxylon	5	1	12	2	3	5	3	1	2	13	17	12	5	0	0	0	0	0	0	0
Combretum imberbe	2	4	3	0	0	0	3	3	0	1	14	10	0	1	0	0	1	0	2	4
Terminalia sericea	5	0	0	0	3	0	3	5	0	1	1	1	12	1	1	1	2	14	0	12
Dichrostachys cinerea	2	0	0	1	0	0	1	4	0	2	1	2	0	11	2	0	0	4	2	3
Flueggea virosa	7	3	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cordia monoica	3	1	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Combretum zeyheri	1	1	1	0	5	4	0	0	2	0	0	0	0	0	0	0	0	0	0	1
Euclea divinorum	2	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	4	4	0	0	8	3	1	0	1	0	0	0	0	5	0	0	0	0	2	0
Lonchocarpus capassa	1	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	1	0	0	0
Acacia exuvialis	0	3	15	3	2	2	0	11	9	8	0	1	1	1	0	8	0	5	5	0
Albizia harveyi	0	3	0	0	0	0	12	4	1	5	7	8	2	4	26	8	11	20	4	12
Cissus cornifolia	0	2	5	0	1	0	0	0	2	1	1	0	0	0	0	1	0	0	0	0
Boscia foetida	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manilkara mochisia	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ozoroa paniculosa	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia welwitschii	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Spirostachys africana	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
Ziziphus mucronata	0	0	0	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Pterocarpus rotundifolia	0	0	0	0	2	4	0	0	0	0	0	0	13	0	0	0	0	0	0	0
Cassia abbreviata	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnosporia buxifolia	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bolusanthus speciosus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ximenia caffra	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia tortilis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Ormocarpum trichocarpum	0	0	0	0	0	0	0	4	1	5	0	3	0	1	0	0	1	0	1	0
Grewia bicolor	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0
Sclerocarya birrea	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Combretum collinum	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Euclea crispa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0

Appendix: Table 1.9
Shiteve-teve Footslope Species list

	Number of individuals per 100 m interval																								
Albizia harveyi	7	7	3	15	11	10	60	29	40	1	3	3	5	0	1	0	13	15	2	3	18	6	16	38	0
Combretum hereroense	8	2	4	0	0	0	0	5	3	6	21	0	3	1	3	1	2	0	5	3	6	3	3	0	0
Dalbergia melanoxylon	5	2	0	2	0	0	0	6	0	6	0	9	20	13	32	12	12	8	5	3	0	15	6	0	3
Combretum imberbe	2	2	0	2	4	0	0	1	8	4	0	7	3	7	1	4	0	3	0	0	0	3	0	0	1
Acacia nigrescens	2	5	2	3	0	0	0	0	0	16	20	18	0	0	0	0	0	0	1	1	0	1	1	11	1
Lonchocarpus capassa	1	0	0	0	0	0	0	0	0	6	1	1	0	1	1	1	2	1	3	2	3	4	0	0	4
Euclea crispa	1	1	3	2	1	5	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	3	2	5
Gymnosporia buxifolia	0	13	32	3	0	1	0	3	0	2	3	0	1	10	8	5	11	10	7	13	2	5	0	0	9
Acacia exuvialis	0	5	0	0	0	0	0	0	1	1	0	0	0	1	2	1	0	0	0	7	1	0	2	0	0
Flueggea virosa	0	2	1	0	0	0	0	0	0	3	2	0	3	0	0	0	0	0	0	1	1	1	0	0	0
Sclerocarya birrea	0	1	0	1	0	0	0	0	0	0	0	1	0	3	1	1	0	0	0	0	0	0	0	0	0
Euclea divinorum	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bolusanthus speciosus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peltophorum africanum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	3	0	0	0	0	1
Lannea schweinfurthii	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5
Ormocarpum trichocarpum	0	0	0	2	2	0	4	17	0	1	5	20	0	0	0	0	0	0	0	0	0	0	9	0	1
Acacia grandicornuta	0	0	0	0	0	0	1	1	0	1	2	2	1	0	0	1	0	0	0	1	1	2	0	5	5
Ziziphus mucronata	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	1	1	2	0	1	0
Terminalia sericea	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cissus cornifolia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Cassia abbreviata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pterocarpus rotundifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Rhus queinzii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Combretum apiculatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Combretum collinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Spirostachys africana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0

Appendix: Table 1.10
Shivulani Crest Species list

	Number of individuals per 100 m interval																				
Colophospermum mopane	18	25	10	8	16	18	12	11	28	22	13	23	37	38	28	59	51	29	44	3	2
Combretum apiculatum	7	4	10	14	13	7	10	8	4	11	7	7	9	8	9	7	5	7	2	9	9
Commiphora africana	5	3	3	3	0	0	0	4	1	0	1	1	0	0	0	1	0	0	0	0	1
Dichrostachys cinerea	4	0	1	4	1	1	0	3	0	3	0	0	0	1	1	0	0	0	0	0	8
Acacia exuvialis	6	0	0	0	0	0	3	0	1	0	0	0	0	2	5	0	14	9	12	0	0
Boscia foetida	1	0	3	0	0	0	0	0	0	4	3	0	0	0	0	2	1	0	4	0	0
Sclerocarya birrea	0	1	1	0	1	3	7	3	1	3	3	2	0	2	0	1	1	1	0	3	5
Albizia harveyi	0	1	2	0	0	1	0	3	1	1	0	0	0	0	0	0	0	2	0	1	1
Cissus cornifolia	0	1	0	0	0	0	4	3	0	1	0	1	0	1	2	0	0	1	0	1	2
Commiphora pyracanthoides	0	3	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Lannea schweinfurthii	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Grewia bicolor	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Ormocarpum trichocarpum	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Lonchocarpus capassa	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Euclea divinorum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0
Ziziphus mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Ozoroa paniculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Dalbergia melanoxylon	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	1	4	0
Terminalia sericea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5
Cassia abbreviata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Appendix: Table 1.11
Ledeboer Crest Species list

	Number of individuals per 100 m interval																			
Colophospermum mopane	23	20	22	42	35	36	18	19	19	33	19	26	23	30	7	20	22	9	4	9
Combretum apiculatum	9	13	7	9	2	3	5	7	13	7	7	12	5	6	10	12	14	6	16	12
Cissus cornifolia	2	0	2	2	1	3	4	3	0	1	1	1	2	1	0	1	1	2	3	1
Combretum mossambicense	4	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Boscia foetida	6	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
Albizia harveyi	0	2	0	2	1	0	0	1	1	1	0	0	0	0	0	0	3	0	0	3
Lonchocarpus capassa	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sclerocarya birrea	0	0	0	0	1	0	0	2	0	0	2	0	0	0	0	1	0	0	0	0
Commiphora africana	0	0	0	0	0	0	1	2	2	0	0	0	1	0	0	0	0	0	0	0
Acacia nigrescens	0	0	0	0	0	0	3	0	0	0	0	0	1	2	1	4	0	0	0	0
Ormocarpum trichocarpum	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Lannea schweinfurthii	0	0	0	0	0	0	0	1	1	0	6	0	0	0	0	4	2	7	10	0
Dichrostachys cinerea	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	1	1	2
Grewia bicolor	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0
Cassia abbreviata	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Appendix: Table 1.12
Shivulani Footslope Species list

	Number of individuals per 100 m interval																			
Colophospermum mopane	25	88	78	77	32	29	36	31	112	11	30	20	28	26	53	63	56	53	51	43
Combretum apiculatum	4	3	1	6	10	7	4	5	0	15	6	8	10	0	10	6	1	4	1	7
Cissus cornifolia	2	1	2	0	0	0	0	1	1	0	2	0	1	0	1	0	0	0	0	0
Commiphora africana	4	0	0	0	2	0	1	0	0	0	1	0	0	0	0	2	0	1	0	1
Sclerocarya birrea	2	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0	1
Ozoroa paniculosa	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commiphora pyracanthoides	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Combretum mossambicense	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia exuvialis	0	8	0	1	0	3	1	7	0	2	1	0	0	1	0	5	1	7	2	10
Boscia foetida	0	2	0	0	0	0	0	0	2	3	1	1	0	0	0	0	1	0	4	0
Flueggea virosa	0	1	0	0	1	0	0	2	0	0	0	4	0	1	1	1	0	0	0	0
Albizia harveyi	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	2
Acacia nigrescens	0	0	1	0	0	5	4	1	0	2	0	0	4	51	7	2	4	1	3	4
Grewia bicolor	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	3	0
Lannea schweinfurthii	0	0	0	0	2	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0
Dichrostachys cinerea	0	0	0	0	0	1	0	0	0	0	1	0	0	7	0	0	0	0	0	0
Ximenia caffra	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euclea divinorum	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Combretum imberbe	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	0
Combretum hereroense	0	0	0	0	0	0	0	0	0	0	1	1	0	5	0	2	1	0	0	0
Lonchocarpus capassa	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0

Appendix: Table 1.13
Ledeboer Footslope Species list

	Number of individuals per 100 m interval																		
Colophospermum mopane	49	35	66	33	23	19	17	53	28	26	45	26	26	33	37	23	42	28	44
Boscia foetida	1	5	0	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0	0
Combretum apiculatum	0	3	3	13	22	14	13	11	6	15	5	9	14	9	3	15	9	12	15
Cissus cornifolia	0	3	0	2	1	3	1	0	0	1	1	1	1	2	1	1	1	1	1
Lannea schweinfurthii	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
Combretum hereroense	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Albizia harveyi	0	0	3	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Acacia exuvialis	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Lonchocarpus capassa	0	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0
Grewia bicolor	0	0	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	2	0
Acacia tortilis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Acacia nigrescens	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0
Sclerocarya birrea	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
Dichrostachys cinerea	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Commiphora africana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	4
Ozoroa paniculosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ziziphus mucronata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0