CHAPTER 7

A SPECIES LEVEL ANALYSIS OF THE EFFECT OF HERBIVORES AND MAN ON THE STRUCTURE, AND DYNAMICS OF WOODLAND VEGETATION OF MAPUTALAND, NORTHERN KWAZULU-NATAL, SOUTH AFRICA

Abstract

The woodlands of Maputaland are under utilisation pressure in both conserved and non-conserved areas, due to the mounting densities of mammals in the former areas, and the increasing human utilisation of natural vegetation in the rural areas. The conservation of this biodiversity rich region requires a better understanding of the vegetation dynamics. To fill this gap in knowledge, the structure of the woodland vegetation is evaluated on three sites through a classical size class distribution analysis, reinforced by the determination of species centroids, the comparisons of size class distributions between sites, and the determination of community grain, a forestry concept here provisionally applied to woodlands. One site had animals as the main disturbance agent; humans filled this role in a second site, while the third site was not disturbed by either since 1992. The three sites have been under their respective disturbance regimes for comparable periods. The results show a pattern of utilisation similar to those described for other areas in Southern, Eastern, and Central Africa where woodlands are over-utilised by man in rural areas, and woodland are destroyed by elephants in the confined conserved areas. The grain model performed successfully for the woodlands of the region and the results obtained are coherent with grain theory. The woodlands of Maputaland are mostly fine-grained forest-like vegetation units, and they follow the dynamics of fine-grained forests closely. The implications of grain for conservation are discussed.

Keywords

Elephant, fine-grain, forest grain, human utilisation, Maputaland, rural community, size class distribution, vegetation dynamics, woodlands

Introduction

Savanna woodlands are a dominant feature of the African landscape (Bond and Keeley 2005; Pote *et al.* 2006). The woodlands have evolved under a delicate balance of fire, animal and people-related disturbance in association with climate variations (Bond *et al.* 2005). As such, woodlands form an important resource base for rural African people (Perrings and Lovett 1999; Naughton-Treves *et al.* 2007; Shackleton *et* *al.* 2007), and are the most represented landscapes in famous conservation areas of central, east and southern Africa (Leuthold 1996; Eckhardt *et al.* 2000; Dudley *et al.* 2001; Mosugelo *et al.* 2002; Walpole *et al.* 2004; Van Aarde and Jackson 2007; Western In Press). Under low human demographic pressure, where wildlife populations roam freely, woodlands are resilient (Perrings and Lovett 1999; Walpole *et al.* 2004; Western In Press), and able to support large but temporary surges of utilisation. In systems where demographic pressure is high, such as in conserved areas where animal densities have increased to levels that threaten the ecological capacity of the reserves, human – wildlife conflicts are rife, and woodland landscapes tend to change (Leuthold 1996; Naughton-Treves 1998; Gillson *et al.* 2003; Walpole *et al.* 2004; Western In Press).

Under intense wildlife utilisation, especially linked to high African elephant *Loxodonta africana* (Blumenbach 1797) densities, woodlands have been documented to change into grasslands (Leuthold 1996; Western In Press), while under low densities, woodlands become denser, the canopy level becomes continuous, and potentially evolve into forests (Walpole *et al.* 2004; Western and Maitumo 2004). Effects from human utilisation are more complex and varied. Where people are few, and agriculture limited to shifting cultivation, but where hunting removes wildlife from the landscape, woodlands have changed into forests (Ickowitz 2006). Where human density is high, wildlife is usually hunted to local extinction, and and when harvesting is limited to lying dead wood and standing pole-sized trees, gradients of plant utilisation are observed away from villages (Schwartz and Caro 2003; Banda *et al.* 2006a; Banda *et al.* 2006b). In these areas there is usually a wealth of seedlings and saplings but large trees contain a gap in the pole-sized classes. While the gap in size classes may become a sustainability issue, there is often sufficient regeneration to perpetuate the woodland type albeit with a changed structure (Luoga *et al.* 2002). Problems occur when pressure from commercial harvesting is added, as is the case for charcoal and precious timber species (Luoga *et al.* 2002; Schwartz *et al.* 2002; Schwartz and Caro 2003; Caro *et al.* 2005). In those instances, selective harvest of species for precious timber can lead to local extirpation of all commercially valuable woody species, thus changing species composition (Luoga *et al.* 2002; Schwartz *et al.* 2002; Ticktin 2004). Charcoal production, which is especially pronounced along easily accessible routes (Kirubi *et al.* 2000; Okello *et al.* 2001) leads to the harvesting of a wide range of species, to such an extent that it results in severe changes in the woodland's structure (Naughton-Treves *et al.* 2007).

As a whole it is widely acknowledged that woodlands in Africa are a valuable, if not essential, resource for rural people in Africa (Shackleton *et al.* 2007). In South Africa this importance has remained unchanged by development programmes. Despite the recent implementation of a free electrical supply to rural areas by the government, it appears that at least 80% of rural households utilise firewood for cooking and heating as they did before the electrification programme (Madubansi and Shackleton 2006; Madubansi and Shackleton 2007). In rural areas where demographic growth is high, the sustainability of the natural woodland vegetation utilisation becomes questionable (Shackleton 1993; Shackleton 1998; Shackleton *et al.* 2005).

Woodlands and forests of Maputaland are intricately interwoven, diverse vegetation units. They share many species, and it is often not clear whether some woodlands are the result of Sand Forest deterioration or whether they are the precursor to Sand Forest (Van Rensburg *et al.* 2000; Gaugris 2004; Botes *et al.* 2006; Matthews 2006). In protected areas, it is documented that both Sand Forest and woodlands are deteriorating due to high animal densities (Matthews 2006; Guldemond and Van Aarde In Press), while outside conserved areas, numerous questions have been raised with regards to the potential destruction of these ecosystems by people (Tarr *et al.* 2004; Peteers 2005; Smith *et al.* 2006; Gaugris *et al.* 2007). In order to avoid further woodland destruction, the conservation authorities in KwaZulu-Natal, South Africa are encouraging rural communities to protect parts of their land and to practice sustainable resource utilisation (KwaZulu-Natal Nature Conservation Services 1997; Gaugris 2004; Peteers 2005; Matthews 2006).

In northern Maputaland the problem is exacerbated by the rapid demographic growth rate (Kloppers 2001; Matthews 2006; Peteers 2005; Jones 2006) and while resource utilisation until present was limited (Brookes 2004; Gaugris *et al.* 2004; Gaugris *et al.* 2007), land clearing for the creation of new households and fields is increasing. Reasons are twofold, on the one hand modernisation of rural society leads to a lower number of residents per households, while the arrival of new people by immigration increases and fuels the preponderance of this phenomenon (Peteers 2005). In addition, since 2000, Maputaland has become a favourite tourism destination in South Africa and southern Mozambique, which recently provoked the migration of people towards economic hubs of Maputaland as tourism-related activities and businesses have flourished (Peteers 2005; Matthews 2006).

Because of the demographic growth observed in the Maputaland region, and the recent debates that animal populations in formally protected areas have reached saturation and begun to damage the ecosystems that sustain them, information is needed on the current state of vegetation structure and to understand the underlying dynamics. The aims of the present study were therefore to investigate the effect of two different landscape shaping agents: large herbivores (especially elephants) and man on the population structure and dynamics of woody species. The study area encompassed three sites in the remote, rural, and poor northern Maputaland region of KwaZulu-Natal, South Africa (-26.85 º to -27.15 º South and 032.35 º to 032.60 º East) which have been under differing utilisation regimes during the past 15 years. Site one was located in Tembe Elephant Park (Tembe), sites two and three in the neighbouring Manqakulane rural community (6 km south of the southern fence of Tembe), where one site was located within the Manqakulane Rural Community village rule area (Manqakulane) and the other site in the Tshanini Community Conservation Area (Tshanini). Utilisation by either agents was low to nil in the Tshanini Community Conservation Area (Gaugris *et al.* 2004) and it could therefore be used as a control to compare the other sites.

The woody species resource base on the three sites was evaluated by using a range of techniques. These techniques range from a species level size class distribution regression analysis (Poorter *et al.* 1996; Lykke 1998; Lawes and Obiri 2003; Niklas *et al.* 2003), evaluating the position of the mean stem diameter of populations (Niklas *et al.* 2003), to determining the grain of species (Midgley *et al.* 1990; Everard *et al.* 1994; Everard *et al.* 1995; Obiri *et al.* 2002; Lawes and Obiri 2003). Although these methods do not replace long-term studies, the combination of these methods allows forestry practitioners to make some inferences on population dynamics (Obiri *et al.* 2002; Lawes and Obiri 2003; Niklas *et al.* 2003; Boudreau *et al.* 2005).

Study area

The study area is situated in the Maputaland coastal plain nearly midway from the sea to the east and the Lebombo Mountain Range to the west. This plain is intersected by ancient littoral dune cordons aligned in a north – south direction, and it is vegetated by open to closed woodlands, with patches of Sand Forest. The Muzi Swamp, underlain by clay soils, runs along the eastern side of the study area (Matthews *et al.* 2001; Gaugris *et al.* 2004). The region is hot, wet, and humid in summer, but winters are cool and dry. The region is relatively arid with a mean annual rainfall of 721 mm from 1981 to 2003 (Matthews 2006).

Tembe Elephant Park was created in 1983 to conserve the region's remaining wildlife and protect the diverse Sand Forest vegetation from utilisation by people. The park covers 30 000 ha and while the South African sides were fenced by 1983, full closure of the northern border with Mozambique occurred in 1989. The main purpose of Tembe was not to attract mass tourism (KwaZulu-Natal Nature Conservation Services 1997; Browning 2000) and therefore Tembe received few tourists between 1983 and 2001, which has elicited resentment from neighbouring communities as few economic returns accrued to them. A thorough description of Tembe appears in Matthews *et al.* (2001).

Tshanini Community Conservation Area is a remarkable achievement of the Manqakulane rural community. Already in 1992, the people from this community set aside the 2 420 ha section of tribal land that was launched as Tshanini Game Reserve in 2000, renamed and gazetted as Tshanini Community Conservation Area by end of 2005. Before the 1992 decision, people used the land to collect building material, firewood, fruit and honey, but also for cattle grazing and some hunting, while some areas on the eastern side were cultivated. In 1992, following the installation of a safe water supply along the Muzi Swamp, the people moved eastwards (Gaugris 2004). Tshanini has been protected by tribal rules since that date and therefore little human utilisation has taken place (Gaugris *et al.* 2004). Tshanini is described in Gaugris *et al.* (2004).

Manqakulane represents the land east of Tshanini (*ca.* 2 500 ha in total), comprised of the village zone where people are now living, but also the portion of free land between the village itself and Tshanini (Gaugris 2004; Gaugris *et al.* 2007). Both sections fall under tribal rule authority for the use of land and natural resources. Tribal rules can be likened to utilisation pressure within a restricted area. Tribal rules preclude harvesting in a neighbouring community's land, which would be considered trespass and may call for compensation (Kloppers 2001; Gaugris 2004). A total of 778 permanent residents lived in 124 households in the Manqakulane sector in 2004 (Peteers 2005) scattered along a broad north-south axis, parallel and to the west of the Muzi Swamp. The Manqakulane population has remained relatively stable over the past 10 years, in stark contrast to the regional population (Peteers 2005). However, the number of households increased considerably, thereby implying that land was cleared and natural vegetation utilised intensively for the construction of new households. A thorough description of the Manqakulane community village zone appears in Gaugris *et al.* (2007) and Peteers (2005).

Methods

A total of 6 vegetation units were sampled in the three study sites (Table 1). Rectangular plots of varying length and width, depending on the vegetation density, were used to obtain abundance and distribution data of woody species in the three sites studied. A total of 105 plots were located in the woodland units of Tembe, all plots (42) in Manqakulane were within woodland units, while the woodlands of Tshanini were represented in 30 plots from the total Tshanini sample. The data were captured in Microsoft Excel spreadsheets and then compiled into a Microsoft Access database.

A classic species based size class distribution regression analysis on the spread of stem diameter values of woody species in each vegetation unit evaluated (hereafter referred to as the SCD analysis) was conducted. The limitations of such analyses for obtaining population dynamics information are acknowledged (Condit *et al.* 1998; Niklas *et al.* 2003). However, it is expected that the range of other factors evaluated in the present study, such as centroid location, contribution of smaller size classes, subcanopy and canopy densities, frequency, and the fact that three study sites including a control area are evaluated, will contribute to a much improved insight in the species population structures and possibly dynamics. The core of the methodology followed in the present chapter is identical to that of the previous chapter and is therefore not repeated here. Only the determination of grain is presented below as it differed from the previous chapter in several important aspects.

The graphical model of Lawes and Obiri (2003) to determine the grain of species by plotting canopy density on the X-axis and subcanopy density on the Y-axis, was used to define which species are fine, coarse, or intermediate-grained species. The model appears in Figure 1, and ln-transformed values were used to facilitate reading due to high densities and large density variations observed in the study area. The same critical lower bounds for canopy, subcanopy and frequency of occurrence levels as Lawes and Obiri (2003) are used. These authors evaluated a range of forests from the Eastern Cape and KwaZulu-Natal provinces of South Africa using this model, and it was deemed judicious to use the same limits to allow comparison at the regional level. These boundaries are 10 and 30 individuals per ha for the canopy and subcanopy levels respectively, and a minimum of 50% frequency of occurrence in the sampled plots. Frequency of occurrence was not represented graphically as it was already provided in the SCD analysis. The above boundary limits were used for the Closed Woodlands units as the latter have been identified as forest-like units (Gaugris 2004). For comparative purposes, the concept was applied to the Open and Sparse

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Table 1: Vegetation units of the study area in Maputaland, northern KwaZulu-Natal, South Africa

	Code	Abreviation	Community Name	Synonym in other studies
2		CW	Closed Woodland association	
	2.1.0	CWT	Closed Woodland Thicket	Described as such in Matthews *et al.* (2001), and as Closed Woodland in Gaugris *et al.* (2004)
	2.2.0	CWC	Closed Wood' d on Clay	Described as such in Matthews *et al.* (2001), and as Woodland on Clay in Gaugris *et al.* (2004)
	2.3.0	CWS	Closed Wood d on Sand	Described as such in Matthews *et al.* (2001), and as Open Woodland on Sand in Gaugris *et al.* (2004)
3		OW	Open Woodla association	
	3.1.0	OWS	Open Woodla on Sand	Described as such in Matthews *et al.* (2001), and as Sparse Woodland on Sand in Gaugris *et al.* (2004)
	3.2.0	OWAH	Open Woodland on Abandoned Household sites	Newly described in the present study
4		SW	Sparse Woodland association	
	4.1.0	SWS	Sparse Woodland on Sand	Described as such in Matthews *et al.* (2001)

Woodlands units, but the canopy boundary was relaxed to 5 and 3 individuals per ha respectively.

Results

Closed Woodland Thicket

The Closed Woodland Thicket was not well represented in Tembe, and was therefore not sampled intensively. Only three species fulfilled the analysis minimum number of individuals' criteria employed (Table 2) and it was therefore difficult to make further comparisons between Tembe and other comparable vegetation units in Tshanini and Manqakulane. The three species were classified within Type 1 (Table 3). Mean centroid 2 was located within size class 5 in both analyses, and mean centroid 1 was located within size classes 4 and 3 in the full and limited analyses respectively.

In Tshanini, this unit appeared well represented with 44 species evaluated (Table 4). The majority of species were classified in Type 1 in the full analysis (Table 3) but the limited analysis showed a vast majority of species within Type 3 (Table 3). The mean centroid 2 positions reflected a bias to the left of the centre of the SCD range in both analyses and no major shift in size classes occurred from the positions of centroid 1 to centroid 2.

The subcanopy level was dominated by *Acacia burkei, Pteleopsis myrtifolia, Sclerocarya birrea* and *Strychnos madagascariensis* (Table 4) and the canopy was dominated by the same species found as large to very large trees (size classes 10 to 12) except for *Pteleopsis myrtifolia*, and with the addition of *Terminalia sericea*. Typical species of the subcanopy level included *Bridelia cathartica, Dichrostachys cinerea, Euclea natalensis, Grewia microthyrsa, Strychnos spinosa, Tabernaemontana elegans* and *Vangueria infausta*. The population structure of all woody species found within both subcanopy and canopy levels were pyramidal, represented by a large subcanopy component and a small canopy component. The pyramidal structure and the centroid skewed to the left reinforced the assumption that regenerative processes are strong.

In Manqakulane, this unit was represented by 24 species (Table 5), all classified within Type 1 (Table 3). The mean centroid 2 position reflected a bias to the left of the centre of the SCD range in both analyses, which was belied by a major shift in size classes that occurred between the positions of mean centroids 1 and 2 (Table 5), indicating a large influence of seedlings and saplings.

The subcanopy was dominated by A*cacia burkei, Euclea natalensis, Zanthoxylum capense* and *Commiphora neglecta. Acacia burkei* was still the dominant component at the canopy level, but shared it with *Dialium schlechteri, Euclea*

Table 2: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland Thicket in Tembe Elephant Park, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.13**	**9.54**	**0.96**	**0.56**	**229.01**	**	**10**	**12**	**117**						
Full	*Tabernaemontana elegans*	-1.35	6.41	0.49	1.45	5.77	-	6	8	30	04	05	750	167	100.00	Fine
						Mean SCD centroid location for common species:					04	05				
Limited	*Sclerocroton integerrimus*	-1.74	5.74	0.49	1.86	5.81	-	6	8	11	03	06	125	42	100.00	Fine
Limited	*Psydrax locuples*	-3.08	8.58	0.73	1.30	2.69	-	1	3	24	02	03	83	0	100.00	***NA***
						Mean SCD centroid location for common species:					03	05				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 3: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland Thicket in Tshanini Community Conservation Area, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.13**	**9.54**	**0.96**	**0.56**	**229.01**	**	**10**	**12**	**4126**						
Full	*Acacia burkei*	-1.07	5.08	0.94	0.32	146.04	**	9	11	203	05	06	283	105	100.00	Fine
Full	*Albizia adianthifolia*	-0.80	3.09	0.29	1.03	1.23	-	3	5	31	03	03	50	0	30.00	***NA***
Full	*Bridelia cathartica*	-1.86	5.71	0.76	1.03	15.69	*	5	7	150	03	04	183	8	50.00	***NA***
Full	*Catunaregam taylori*	-0.78	3.41	0.11	1.77	0.39	-	3	5	68	03	03	73	0	60.00	***NA***
Full	*Cleistanthus schlechteri*	-1.09	3.96	0.42	1.61	7.24	*	10	12	571	02	07	25	13	20.00	Intermediate (*NA*)
Full	*Clerodendrum glabrum*	-0.41	2.59	0.23	0.67	1.20	-	4	6	34	04	04	70	0	20.00	***NA***
Full	*Coddia rudis*	-2.41	5.08	0.99	0.12	187.12	*	1	3	35	01	03	10	0	70.00	***NA***
Full	*Combretum molle*	-0.83	3.44	0.40	1.07	3.96	-	6	8	67	04	04	123	5	80.00	***NA***
Full	*Deinbollia oblongifolia*	-1.50	5.66	0.72	0.65	2.55	-	1	3	118	02	03	53	0	70.00	***NA***
Full	*Dialium schlechteri*	-1.32	4.46	0.73	0.85	16.04	**	6	8	72	04	04	133	3	50.00	***NA***
Full	*Dichrostachys cinerea*	-2.39	7.10	0.92	0.64	45.95	**	4	6	270	02	04	178	0	50.00	***NA***
Full	*Euclea natalensis*	-1.65	5.74	0.89	0.64	57.87	**	7	9	174	03	05	150	23	100.00	Fine
Full	*Gardenia volkensii*	-2.13	4.84	0.95	0.36	37.70	*	2	4	32	02	03	15	0	50.00	***NA***
Full	*Grewia caffra*	-0.45	3.44	0.11	0.93	0.25	-	2	4	49	03	03	65	0	40.00	***NA***
Full	*Grewia microthyrsa*	-1.95	6.54	0.86	0.57	12.52	-	2	4	220	02	03	143	0	50.00	***NA***
Full	*Hymenocardia ulmoides*	-1.74	5.24	0.86	0.74	36.35	**	6	8	87	03	04	98	3	60.00	***NA***
Full	*Lippia javanica*	1.70	1.38	0.24	2.09	0.32	-	1	3	55	02	03	33	0	10.00	***NA***
Full	*Margaritaria discoidea*	-0.36	3.30	0.02	1.95	0.02	-	1	3	47	02	03	13	0	70.00	***NA***
Full	*Gymnosporia senegalensis*	-1.07	3.40	0.36	1.39	2.81	-	5	7	53	03	04	73	8	30.00	***NA***
Full	*Pteleopsis myrtifolia*	-1.26	5.76	0.37	1.34	1.77	-	3	5	335	03	03	465	0	50.00	***NA***
Full	*Sclerocroton integerrimus*	-0.89	3.27	0.55	0.78	6.13	-	5	7	35	04	05	50	3	50.00	***NA***
Full	*Sclerocarya birrea*	-1.26	5.18	0.88	0.58	73.88	**	10	12	174	05	05	298	43	60.00	Fine
Full	*Spirostachys africana*	-0.61	2.53	0.31	1.10	4.11	-	9	11	47	05	05	58	15	50.00	Fine
Full	*Strychnos madagascariensis*	-1.21	5.33	0.72	0.89	20.35	**	8	10	249	05	05	460	53	100.00	Fine
Full	*Strychnos spinosa*	-1.34	4.82	0.88	0.58	59.14	**	8	10	101	04	04	158	13	100.00	Fine
Full	*Tabernaemontana elegans*	-1.05	4.27	0.68	0.76	12.57	*	6	8	90	04	05	118	13	80.00	Fine
Full	*Terminalia sericea*	-0.93	3.83	0.55	1.03	10.80	**	9	11	111	05	06	135	40	70.00	Fine
Full	*Vangueria infausta*	-0.92	4.18	0.46	0.81	2.57	-	3	5	80	03	03	140	0	90.00	***NA***
Full	*Vitex ferruginea*	-1.11	3.81	0.51	1.22	7.17	*	7	9	72	03	04	83	3	50.00	***NA***
Full	*Xylotheca kraussiana*	-2.47	6.59	1.00	0.00	0.00	-	0	2	137	01	***NA***	0	0	100.00	***NA***
						Mean SCD centroid location for common species:					03	04				

Table 3:continued

Limited	*Acridocarpus natalitius*	2.69	-0.64	0.72	1.16	2.61	-	1	3	16	03	03	25	0	60.00	***NA***
Limited	*Ancylanthos monteiroi*	-1.01	4.18	1.00	0.00	0.00	-	0	2	27	01	***NA***	0	0	30.00	***NA***
Limited	*Balanites maughamii*	-0.08	0.69	0.02	0.68	0.18	-	9	11	16	06	06	25	15	40.00	Intermediate (*NA*)
Limited	*Bridelia micrantha*	0.75	-0.21	0.30	0.94	1.30	-	3	5	10	04	04	25	0	10.00	***NA***
Limited	*Canthium armatum*	-0.32	1.75	0.18	0.56	0.66	-	3	5	10	03	04	18	0	40.00	***NA***
Limited	*Commiphora neglecta*	-1.23	3.19	0.69	0.67	6.65	-	3	5	15	03	04	10	0	20.00	***NA***
Limited	*Diospyros inhacaensis*	0.94	-0.36	0.62	0.59	4.94	-	3	5	11	04	04	28	0	30.00	***NA***
Limited	*Ehretia obtusifolia*	-0.07	1.07	0.01	0.98	0.03	-	5	7	17	04	05	38	3	40.00	***NA***
Limited	*Psydrax locuples*	-1.15	3.19	0.88	0.35	21.14	*	3	5	15	03	04	15	0	70.00	***NA***
Limited	*Rhus gueinzii*	-0.10	1.45	0.00	1.61	0.01	-	3	5	20	03	04	33	0	60.00	***NA***
Limited	*Tarenna junodii*	0.06	1.90	0.00	1.71	0.00	-	1	3	14	02	03	5	0	10.00	***NA***
Limited	*Tricalysia lanceolata*	1.52	1.52	1.00	0.00	0.00	-	0	2	10	02	***NA***	0	0	10.00	***NA***
Limited	*Zanthoxylum leprieuri*	0.05	2.66	0.00	1.38	0.00	-	1	3	27	02	03	15	0	50.00	***NA***
Limited	*Ziziphus mucronata*	0.00	0.69	0.00	0.79	0.00	-	7	9	18	06	06	40	5	70.00	***NA***
								Mean SCD centroid location for common species:			03	04				

SC Size Class

** Highly significant ($p \leq 0.01$)

* Significant ($p \leq 0.05$)

- Not significant ($p > 0.05$)

NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 4: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland Thicket in the Manqakulane Rural Community Village zone, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.87**	**12.28**	**0.92**	**1.06**	**116.20**	**	**10**	**12**	**1170**						
Full	*Acacia burkei*	-1.84	7.29	0.82	1.06	40.47	**	9	11	36	03	06	331	110	78.57	Fine
Full	*Carissa tetramera*	-6.18	12.87	0.83	1.92	4.99	-	1	3	67	01	03	63	0	35.71	***NA***
Full	*Clausena anisata*	-7.77	14.60	0.93	1.45	13.78	-	1	3	176	01	03	47	0	85.71	***NA***
Full	*Coddia rudis*	-4.25	10.90	0.68	2.02	2.13	-	1	3	38	02	03	126	0	85.71	***NA***
Full	*Dialium schlechteri*	-2.19	7.99	0.72	1.72	25.57	**	10	12	64	01	07	94	63	85.71	Fine
Full	*Euclea natalensis*	-2.64	9.20	0.62	2.30	11.39	*	7	9	171	01	06	252	63	100.00	Fine
Full	*Monanthotaxis caffra*	-6.00	11.08	0.77	2.40	6.70	-	2	4	34	01	04	16	0	92.86	***NA***
Full	*Psydrax locuples*	-3.93	10.24	0.79	1.80	15.50	*	4	6	44	01	05	63	0	92.86	***NA***
Full	*Xylotheca kraussiana*	-1.94	9.91	1.00	0.00	0.00	-	0	2	37	01	***NA***	0	0	92.86	***NA***
Full	*Zantoxylum capense*	-3.59	10.47	0.94	0.79	67.71	**	4	6	60	01	04	331	0	92.86	***NA***
						Mean SCD centroid location for common species:					01	05				
Limited	*Brachylaena discolor*	-3.9	9.59	0.96	0.64	75.66	**	3	5	21	01	04	94	0	42.86	***NA***
Limited	*Canthium armatum*	-4.3	9.57	0.84	1.53	15.89	*	3	5	13	01	04	47	0	64.29	***NA***
Limited	*Carissa bispinosa*	-5.7	10.89	1.00	0.25	257.19	*	1	3	17	01	03	31	0	21.43	***NA***
Limited	*Catunaregam taylori*	-4.0	9.43	0.89	1.04	16.25	-	2	4	11	01	03	63	0	35.71	***NA***
Limited	*Commiphora neglecta*	-2.5	8.35	0.92	0.74	55.38	**	5	7	24	02	05	252	0	35.71	***NA***
Limited	*Deinbollia oblongifolia*	-3.93	9.70	0.88	1.18	22.21	*	3	5	17	02	04	79	0	71.43	***NA***
Limited	*Dovyalis longispina*	-5.03	10.35	0.61	2.80	1.55	-	1	3	14	02	03	16	0	42.86	***NA***
Limited	*Grewia caffra*	-2.21	6.07	0.44	2.46	3.87	-	5	7	19	01	04	142	0	92.86	***NA***
Limited	*Haplocoelum foliolosum*	-2.99	8.40	0.85	1.13	22.60	**	4	6	13	02	04	94	0	42.86	***NA***
Limited	*Manilkara concolor*	-5.47	10.68	0.75	2.16	3.08	-	1	3	12	01	03	16	0	42.86	***NA***
Limited	*Ochna natalitia*	-2.15	9.59	1.00	0.00	0.00	-	0	2	24	01	***NA***	0	0	71.43	***NA***
Limited	*Rhus gueinzii*	-4.19	9.54	0.79	1.75	11.47	*	3	5	16	01	04	63	0	78.57	***NA***
Limited	*Strychnos madagascariensis*	-1.88	6.48	0.61	1.56	9.51	*	6	8	12	03	06	110	16	50.00	Fine
Limited	*Strychnos spinosa*	-3.60	9.26	0.80	1.33	7.92	-	2	4	15	01	04	94	0	42.86	***NA***
						Mean SCD centroid location for common species:					01	04				

SC Size Class
** Highly significant (p ≤ 0.01)
* Significant (p ≤ 0.05)
- Not significant (p > 0.05)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 5: The percentage of species with Type 1 to 3 slopes for the Sand Forest vegetation of Tembe Elephant Park (TEP), the Manqakulane Rural Community village zone (MRC) and Tshanini Community Conservation Area (TCCA), for the full (≥ 30 individuals sampled) and limited (10 - 29 individuals sampled) analyses, northern Maputaland, KwaZulu-Natal, South Africa. The total number of species (No spp) for analyses by vegetation unit or sub-unit is indicated in the top line of each analysis

Analysis	Type	Vegetation units and sites													
		Closed Woodland Thicket			Closed Woodland on Clay		Closed Woodland on Sand			Open Woodland on Sand			Open Woodland on abandoned household site	Sparse Woodland on Sand	
		TEP	TCCA	MRC	TEP	MRC	TEP	TCCA	MRC	TEP	TCCA	MRC	MRC	TEP	MRC
	No spp →	1	30	10	25		18	26	8	27	19	1	13	6	2
Full		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
	Type 1	100.00	60.00	100.00	88.00	-	88.89	76.92	100.00	92.59	73.68	100.00	100.00	83.33	100.00
	Type 2	0.00	36.67	0.00	8.00	-	11.11	19.23	0.00	7.41	21.05	0.00	0.00	0.00	0.00
	Type 3	0.00	3.33	0.00	4.00	-	0.00	3.85	0.00	0.00	5.26	0.00	0.00	16.67	0.00
	No spp →	2	14	14	25		25	13	20	15	14	0	7	2	1
Limited		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
	Type 1	100.00	14.29	100.00	52.00	66.67	64.00	30.77	80.00	40.00	14.29	-	71.43	50.00	100.00
	Type 2	0.00	14.29	0.00	36.00	16.67	28.00	38.46	10.00	40.00	35.71	-	28.57	50.00	0.00
	Type 3	0.00	71.43	0.00	12.00	16.67	8.00	30.77	10.00	20.00	50.00	-	0.00	0.00	0.00
	No spp →	3	44	24	50	6	43	39	28	42	33	1	20	8	3
Combined		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
	Type 1	100.00	45.45	100.00	70.00	66.67	74.42	61.54	85.71	73.81	48.48	100.00	90.00	75.00	100.00
	Type 2	0.00	29.55	0.00	22.00	16.67	20.93	25.64	7.14	19.05	27.27	0.00	10.00	12.50	0.00
	Type 3	0.00	25.00	0.00	8.00	16.67	4.65	12.82	7.14	7.14	24.24	0.00	0.00	12.50	0.00

Type 1 slopes steeper or equal to half that of the vegetation unit evaluated

Type 2 slopes shallower than half that of the vegetation unit evaluated but steeper than - 0.15

Type 3 slopes shallower than - 0.15 coefficient or with positive slope coefficients *natalensis* and to a lesser degree *Strychnos madagascariensis*. The SCD range indicated that some large to very large trees were identified, but the bulk of species did not exceed size class 6 (Table 5).

A total of 16 comparisons were performed and half showed different population structures (Table 6). All Tshanini species populations had shallower slopes and lower Y-axis intercepts than their Manqakulane counterparts. Only *Psydrax locuples* was comparable between Tembe and Manqakulane, and the slopes and Y-axis intercepts were similar.

Closed Woodland on clay

This vegetation unit only occured in Manqakulane and Tembe. There is the possibility of a small area with underlying clay soils in Tshanini (Gaugris *et al.* 2004), but it was not investigated. Some 50 species were evaluated in Tembe (Table 7) but Manqakulane was only represented by five species in the limited analysis (Table 7). Most species of both sites fell within Type 1 (Table 3), and some in Type 2 and 3. The mean centroid 2 position for both sites indicated a slight skew to the left, but a large shift occured between the positions of mean centroids 1 and 2 for Manqakulane, indicating a large regeneration cohort, while no major shift was observed in Tembe.

In Manqakulane, *Dialium schlechteri* was an important species, present in subcanopy and canopy levels at fairly high densities. *Margaritaria discoidea* was an abundant subcanopy component.

In Tembe the SCD range indicated that a variety of size classes were found, including large to very large trees. The distribution of species in this vegetation unit appeared patchy or clustered with frequency of occurrences rarely exceeding 60%. The most ubiquitous species were *Euclea natalensis* (present in 91% of plots) and *Vepris lanceolata* (present in 68% of plots). *Acacia burkei, Schotia brachypetala, Spirostachys africana, Terminalia sericea, Afzelia quanzensis* and *Sclerocarya birrea* dominated the canopy level in the patches they occurred in, either alone or in co-dominance. *Combretum molle, Spirostachys africana* and *Terminalia sericea* were the most abundant subcanopy woody species in these patches. The bulk of the species sampled occurred at densities that ranged from 50 to 90 individuals per hectare at the subcanopy level.

The two species that could be compared (*Dialium schlechteri* and *Euclea natalensis)* had similar population structures in the two sites (Table 6).

Table 6: *A comparison of size class distribution (SCD) slope coefficients and Y-axis intercepts within species and analyses (F = Full analysis, L = Limited Analysis) in comparable Woodland vegetation units in the study sites Tembe Elephant Park (TEP), the Manqakulane Rural Community village zone (MRC) and Tshanini Community Conservation Area (TCCA), Maputaland, northern KwaZulu-Natal, South Africa*

Comparison levels					Slope Comparison					Intercept Comparison					Meaning	Note*
VT	Vegetation unit	Species	Sites compared	Datasets	F value	Df_n	Df_d	P value	Pooled slope	F value	Df_n	Df_d	P value	Pooled Intercept		
VT 02.1.0	Closed Woodland Thicket	*Acacia burkei*	MRC / TGR	F / F	6.42 *	1	18	0.02	-	-	-	-	-	-	Different	-
		Coddia rudis	MRC / TGR	F / F	0.40 -	1	2	0.59	-3.33	15.9 *	1	3	0.03	-	Different	-
		Dialium schlechteri	MRC / TGR	F / F	1.64 -	1	16	0.22	-1.93	6.03 *	1	17	0.03	-	Different	-
		Euclea natalensis	MRC / TGR	F / F	1.48 -	1	14	0.24	-2.15	2.99 -	1	15	0.10	7.47	Similar	-
		Tabernaemontana elegans	TEP / TGR	F / F	0.22 -	1	12	0.64	-1.20	7.69 *	1	13	0.02	-	Different	-
		Psydrax locuples	TEP / TGR	L / L	2.81 -	1	4	0.17	-1.52	28.03 **	1	5	<0.01	-	Different	-
		Commiphora neglecta	MRC / TGR	L / L	4.63 -	1	8	0.06	-1.52	40.38 **	1	9	<0.01	-	Different	-
		Rhus gueinzii	MRC / TGR	L / L	5.91 -	1	6	0.05	-2.14	3.57 -	1	7	0.10	5.50	Similar	-
		Canthium armatum	MRC / TGR	L / L	6.02 -	1	5	0.06	-1.58	0.91 -	1	6	0.38	3.92	Similar	-
		Catunaregam taylori	MRC / TGR	L / F	3.21 -	1	5	0.13	-1.92	3.03 -	1	6	0.13	5.87	Similar	X
		Deinbollia oblongifolia	MRC / TGR	L / F	2.00 -	1	4	0.23	-3.45	3.24 -	1	5	0.13	8.45	Similar	X
		Grewia caffra	MRC / TGR	L / F	0.59 -	1	7	0.47	-1.89	0.11 -	1	8	0.75	5.35	Similar	-
		Psydrax locuples	TEP / TGR / MRC	L / L / F	2.56 -	2	8	0.17	-2.89	6.00 *	2	10	0.02	-	Different	-
		1) *Psydrax locuples*	MRC / TGR	L / F	5.04 -	1	7	0.06	-2.87	8.94 *	1	8	0.02	-	Different	-
		2) *Psydrax locuples*	MRC / TEP	F / L	0.10 -	1	5	0.76	-3.82	0.45 -	1	6	0.53	9.80	Similar	-
		3) *Psydrax locuples*	TEP / TGR	L / L	2.81 -	1	4	0.17	-1.52	28 **	1	5	<0.01	-	Different	-
		Strychnos madagascariensis	MRC / TGR	L / F	1.21 -	1	14	0.29	-1.46	0.12 -	1	15	0.73	5.80	Similar	X
		Strychnos spinosa	MRC / TGR	L / F	8.12 *	1	11	0.02	-	-	-	-	-	-	Different	-
		Sclerocroton integerrimus	TEP / TGR	L / F	0.93 -	1	11	0.35	-1.38	1.46 -	1	12	0.25	4.62	Similar	X
VT 02.2.0	Closed Woodland on Clay	*Dialium schlechteri*	TEP / MRC	F / L	0.50 -	1	15	0.49	-1.20	0.00 -	1	16	0.99	4.35	Similar	-
		Euclea natalensis	TEP / MRC	F / L	1.09 -	1	8	0.33	-2.44	0.00 -	1	9	0.97	7.14	Similar	X
VT 02.3.0	Closed Woodland on Sand	*Combretum molle*	TEP / TGR	F / F	3.04 -	1	14	0.10	-1.20	0.00 -	1	15	0.95	4.52	Similar	-
		Deinbollia oblongifolia	TEP / MRC	F / F	0.00 -	1	3	0.99	-3.21	6.91 -	1	4	0.06	7.10	Similar	-
		Dialium schlechteri	TEP / TGR	F / F	0.29 -	1	17	0.60	-1.27	21.1 **	1	18	<0.01	-	Different	-
		Dichrostachys cinerea	MRC / TGR	F / F	0.00 -	1	8	0.98	-2.06	9.47 *	1	9	0.01	-	Different	-
		Euclea natalensis	TEP / MRC / TGR	F / F / F	3.21 -	2	13	0.07	-1.76	2.72 -	2	15	0.10	5.84	Similar	-
		Psydrax locuples	TEP / MRC / TGR	F / F / F	1.95 -	2	11	0.19	-2.08	1.35 -	2	13	0.29	5.55	Similar	-
		Sclerocroton integerrimus	TEP / TGR	F / F	0.25 -	1	13	0.63	-1.23	0.16 -	1	14	0.69	4.25	Similar	-
		Spirostachys africana	TEP / TGR	F / F	3.87 -	1	16	0.07	-0.93	3.42 -	1	17	0.08	3.79	Similar	-
		Strychnos madagascariensis	TEP / TGR	F / F	3.17 -	1	16	0.09	-1.19	7.70 *	1	17	0.01	-	Different	-
		Strychnos spinosa	TEP / MRC / TGR	F / F / F	1.03 -	2	18	0.38	-1.71	3.43 -	2	20	0.05	5.69	Similar	-
		Tabernaemontana elegans	TEP / TGR	F / F	0.03 -	1	13	0.86	-0.99	8.94 *	1	14	0.01	-	Different	-
		Catunaregam taylori	MRC / TGR	L / L	0.16 -	1	4	0.71	-2.23	41.22 **	1	5	<0.01	-	Different	-
		Commiphora neglecta	TEP / MRC	L / L	5.64 *	1	12	0.04	-	-	-	-	-	-	Different	-
		Coddia rudis	MRC / TGR	L / L	0.36 -	1	3	0.59	-1.04	0.05 -	1	4	0.83	3.42	Similar	-
		Ptaeroxylon obliquum	TEP / TGR	L / L	0.03 -	1	11	0.86	-1.04	0.00 -	1	12	0.99	3.01	Similar	-
		Rhus gueinzii	TEP / TGR	L / L	2.99 -	1	9	0.12	-1.10	1.15 -	1	10	0.31	3.37	Similar	-
		Sclerocarya birrea	MRC / TGR	L / L	0.92 -	1	20	0.35	-0.74	8.04 **	1	21	<0.01	-	Different	-
		Acacia burkei	MRC / TGR	F / L	0.94 -	1	20	0.34	-1.33	0.14 -	1	21	0.71	5.51	Similar	-
		Bridelia cathartica	MRC / TGR	L / F	0.10 -	1	8	0.76	-1.41	16.45 **	1	9	<0.01	-	Different	X
		Clausena anisata	TEP / MRC	L / F	0.20 -	1	2	0.70	-3.78	9.60 -	1	3	0.05	7.36	Similar	-
		Deinbollia oblongifolia	TEP / TGR / MRC	F / L / F	1.91 -	2	4	0.26	-3.19	7.75 *	2	6	0.02	-	Different	-
		1) *Deinbollia oblongifolia*	TEP / TGR	F / L	41.9 *	1	2	0.02	-	-	-	-	-	-	Different	-
		2) *Deinbollia oblongifolia*	MRC / TEP	F / F	0.95 -	1	3	0.40	-3.62	7.23 -	1	21	0.05	7.47	Similar	-

Table 6: continued

		3) Deinbollia oblongifolia	MRC / TGR	F / L	1.07	-	1	3	0.38	-2.78	12.94	*	1	4	0.02	-	Different	-
		Dalbergia obovata	MRC / TGR	L / F	0.28	-	1	3	0.64	-3.35	0.65	-	1	4	0.46	6.95	Similar	-
		Dialium schlechteri	TEP / TGR / MRC	F / F / L	6.19	**	2	21	<0.01	-	-	-	-	-	-	-	Different	-
		1) Dialium schlechteri	TEP / TGR	F / F	0.29	-	1	17	0.60	-1.27	21.15	**	1	18	<0.01	-	Different	-
		2) Dialium schlechteri	MRC / TEP	L / F	9.90	**	1	12	<0.01	-	-	-	-	-	-	-	Different	-
		3) Dialium schlechteri	MRC / TGR	L / F	8.22	*	1	13	0.01	-	-	-	-	-	-	-	Different	-
		Canthium armatum	MRC / TGR	L / F	1.91	-	1	6	0.73	-2.16	3.30	-	1	7	0.11	6.16	Similar	X
		Spirostachys africana	TEP / TGR / MRC	F / F / L	2.47	-	2	22	0.11	-1.09	1.23	-	2	24	0.31	4.20	Similar	-
		Strychnos madagascariensis	TEP / TGR / MRC	F / F / L	1.42	-	2	26	0.26	-1.19	3.99	*	2	28	0.03	-	Different	-
		1) Strychnos madagascariensis	TEP / TGR	F / F	3.17	-	1	16	0.09	-1.19	7.70	*	1	17	0.01	-	Different	-
		2) Strychnos madagascariensis	MRC / TEP	L / F	1.01	-	1	17	0.33	-1.10	0.77	-	1	18	0.39	4.52	Similar	-
		3) Strychnos madagascariensis	MRC / TGR	L / F	0.60	-	1	19	0.45	-1.27	3.54	-	1	20	0.07	5.30	Similar	-
		Terminalia sericea	MRC / TGR	L / F	5.76	*	1	15	0.03	-	-	-	-	-	-	-	Different	X
		Dichrostachys cinerea	TEP / TGR / MRC	L / F / F	2.63	-	2	13	0.11	-1.45	6.26	*	2	15	0.01	-	Different	X
		1) Dichrostachys cinerea	TEP / TGR	L / F	3.32	-	1	9	0.10	-1.20	2.18	-	1	10	0.17	3.59	Similar	X
		2) Dichrostachys cinerea	MRC / TEP	F / L	2.87	-	1	9	0.12	-1.19	10.46	**	1	10	<0.01	-	Different	X
		3) Dichrostachys cinerea	MRC / TGR	F / F	0.00	-	1	8	0.98	-2.06	9.47	*	1	9	0.01	-	Different	-
		Tabernaemontana elegans	TEP / TGR	F / F	0.03	-	1	13	0.86	-0.99	8.94	**	1	14	<0.01	-	Different	-
VT 03.1.0	en Woodland on Sand	*Acacia burkei*	TEP / TGR	F / F	0.21	-	1	20	0.65	-0.87	1.57	-	1	21	0.22	3.65	Similar	-
		Catunaregam taylori	TEP / TGR	F / F	0.12	-	1	5	0.74	-3.00	0.72	-	1	6	0.43	6.15	Similar	-
		Combretum molle	TEP / TGR	F / F	0.38	-	1	16	0.54	-1.03	0.91	-	1	17	0.35	3.66	Similar	-
		Dialium schlechteri	TEP / TGR	F / F	2.31	-	1	16	0.15	-1.06	0.16	-	1	17	0.69	3.64	Similar	-
		Sclerocroton integerrimus	TEP / TGR	F / F	0.75	-	1	14	0.40	-0.78	0.08	-	1	15	0.78	2.79	Similar	-
		Strychnos madagascariensis	TEP / TGR	F / F	0.39	-	1	18	0.54	-1.30	0.87	-	1	19	0.36	5.12	Similar	-
		Strychnos spinosa	TEP / TGR	F / F	0.82	-	1	15	0.38	-1.31	0.00	-	1	16	0.99	4.45	Similar	-
		Terminalia sericea	TEP / TGR	F / F	11.84	**	1	19	<0.01	-	-	-	-	-	-	-	Different	-
		Vangueria infausta	TEP / TGR	F / F	5.83	*	1	14	0.03	-	-	-	-	-	-	-	Different	-
		Mundulea sericea	TEP / TGR	L / L	0.00	-	1	3	0.99	0.16	6.77	-	1	4	0.06	1.29	Similar	-
		Tabernaemontana elegans	TEP / TGR	L / L	0.22	-	1	13	0.65	-0.46	0.17	-	1	14	0.68	1.53	Similar	-
		Albizia adianthifolia	TEP / TGR	L / F	6.96	*	1	20	0.02	-	-	-	-	-	-	-	Different	-
		Albizia versicolor	TEP / TGR	F / L	2.04	-	1	17	0.17	-0.27	3.66	-	1	18	0.07	1.15	Similar	-
		Dichrostachys cinerea	TEP / TGR	F / L	8.56	*	1	11	0.01	-	-	-	-	-	-	-	Different	-
		Euclea natalensis	TEP / TGR	F / L	2.55	-	1	7	0.15	-1.41	4.08	-	1	8	0.08	3.70	Similar	-
		Grewia microthyrsa	TEP / TGR	L / F	0.80	-	1	2	0.47	-1.65	5.03	-	1	3	0.11	4.48	Similar	-
		Gymnosporia senegalensis	TEP / TGR	F / L	1.97	-	1	5	0.22	-1.64	6.40	*	1	6	0.04	-	Different	-
		Hymenocardia ulmoides	TEP / TGR	L / F	2.67	-	1	9	0.14	-1.61	14.49	**	1	10	<0.01	-	Different	-
		Psydrax locuples	TEP / TGR	F / L	7.89	*	1	4	0.05	-	-	-	-	-	-	-	Different	X
		Rhus gueinzii	TEP / TGR	F / L	5.22	*	1	9	0.05	-	-	-	-	-	-	-	Different	X
		Spirostachys africana	TEP / TGR	F / L	1.37	-	1	18	0.26	-0.67	0.15	-	1	19	0.70	2.18	Similar	-
VT 04.1.0	Sparse Woodland on Sand	*Dichrostachys cinerea*	TEP / MRC	F / F	0.07	-	1	5	0.80	-3.96	1.19	-	1	6	0.32	9.36	Similar	-

** Highly significant (p ≤ 0.01)
* Significant (p ≤ 0.05)
- Not significant (p > 0.05)
Note* analyses marked with an X were conducted on regression slopes where F was not significant in at least one site

Table 7: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland on Clay in the sites: Tembe Elephant Park (TEP) and Manqakulane Rural Community Village zone (MRC); Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F	Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
<u>TEP site</u>															
Community Level	**Community SCD**	**-1.87**	**8.99**	**0.98**	**0.35**	**463.97 ****	**10**	**12**	**2015**						
Full	*Acacia burkei*	-0.96	4.33	0.82	0.57	44.25 **	10	12	84	06	08	80	107	59.09	Intermediate
Full	*Acacia gerrardii*	-1.58	4.82	0.84	0.69	25.38 **	5	7	44	03	05	54	0	27.27	***NA***
Full	*Acalypha glabrata*	-2.09	5.86	0.87	0.65	20.46 *	3	5	55	02	03	74	0	4.55	***NA***
Full	*Berchemia zeyheri*	-1.32	4.47	0.86	0.57	35.94 **	6	8	39	04	05	70	7	22.73	***NA***
Full	*Canthium armatum*	-1.99	5.44	0.90	0.54	26.55 *	3	5	40	02	04	37	0	45.45	***NA***
Full	*Catunaregam taylori*	-1.40	4.54	0.32	1.50	0.94 -	2	4	38	02	04	23	0	36.36	***NA***
Full	*Clausena anisata*	-2.90	6.44	0.95	0.49	37.64 *	2	4	58	02	03	40	0	40.91	***NA***
Full	*Coddia rudis*	-2.03	5.51	0.81	0.81	12.57 *	3	5	45	02	03	57	0	54.55	***NA***
Full	*Combretum molle*	-1.19	4.45	0.93	0.34	81.99 **	6	8	46	04	05	101	3	50.00	***NA***
Full	*Dialium schlechteri*	-1.58	5.07	0.95	0.39	109.72 **	6	8	49	03	05	67	7	54.55	***NA***
Full	*Dichrostachys cinerea*	-2.45	5.71	0.82	0.93	13.87 *	3	5	39	02	03	40	0	45.45	***NA***
Full	*Diospyros dichrophylla*	-3.08	6.77	1.00	0.00	0.00 -	0	2	59	01	***NA***	0	0	27.27	***NA***
Full	*Euclea nataler*	-2.20	6.67	0.92	0.67	71.74 **	6	8	162	02	05	84	3	90.91	***NA***
Full	*Gymnosporia s galensis*	-1.77	4.86	0.78	0.69	7.09 -	2	4	32	02	03	37	0	27.27	***NA***
Full	*Hymenocardia oides*	-1.76	4.59	0.49	1.63	3.80 -	4	6	38	02	06	20	0	4.55	***NA***
Full	*Monanthotaxis ra*	-2.81	6.17	1.00	0.00	0.00 -	0	2	37	01	***NA***	0	0	22.73	***NA***
Full	*Ochna nataliti*	-2.34	5.56	0.99	0.16	236.46 **	2	4	34	02	03	23	0	31.82	***NA***
Full	*Psydrax locupl*	-1.99	5.68	0.80	0.80	12.32 *	3	5	66	02	04	60	0	54.55	***NA***
Full	*Schotia brachy la*	-0.76	2.89	0.46	1.05	8.37 *	10	12	33	05	09	7	34	31.82	Coarse (*NA*)
Full	*Senna petersianna*	1.48	1.89	0.25	1.75	0.34 -	1	3	36	02	03	47	0	9.09	***NA***
Full	*Spirostachys africana*	-1.23	5.34	0.93	0.44	124.03 **	10	12	126	05	07	188	90	50.00	Fine
Full	*Strychnos madagascariensis*	-1.15	3.96	0.75	0.78	23.92 **	8	10	35	03	07	27	10	40.91	Intermediate (*NA*)
Full	*Strychnos spinosa*	-1.30	4.45	0.89	0.47	49.90 **	6	8	37	04	05	57	10	63.64	Fine
Full	*Terminalia sericea*	-0.81	3.66	0.85	0.42	58.81 **	10	12	54	06	07	107	50	40.91	***NA***
Full	*Vepris lanceolata*	-1.85	5.82	0.97	0.34	200.06 **	6	8	74	03	04	90	3	68.18	***NA***
						Mean SCD centroid location for common species:				03	05				
Limited	*Acacia nilotica*	-0.86	2.55	0.50	0.95	7.09 *	7	9	12	04	08	3	7	18.18	***NA***
Limited	*Acacia robusta*	-0.69	2.55	0.53	0.82	11.36 **	10	12	17	06	09	10	17	36.36	Coarse (*NA*)
Limited	*Afzelia quanzensis*	0.10	0.31	0.05	0.60	0.48 -	10	12	19	08	08	30	34	45.45	Intermediate (*NA*)
Limited	*Balanites maughamii*	-0.61	2.31	0.91	0.25	98.61 **	10	12	11	06	07	20	7	36.36	Intermediate (*NA*)
Limited	*Bridelia cathartica*	-0.62	3.28	0.41	0.61	2.06 -	3	5	26	03	04	64	0	50.00	***NA***
Limited	*Commiphora neglecta*	-2.33	4.72	0.91	0.52	21.17 *	2	4	15	01	04	7	0	22.73	***NA***
Limited	*Croton pseudopulchellus*	-1.81	4.76	0.86	0.60	18.04 *	3	5	24	02	04	27	0	13.64	***NA***
Limited	*Diospyros inhacaensis*	-1.04	3.26	0.87	0.39	34.39 **	5	7	14	04	05	30	0	13.64	***NA***
Limited	*Dovyalis longispina*	-2.18	4.28	0.66	1.13	3.95 -	2	4	10	02	04	3	0	31.82	***NA***
Limited	*Erythroxylum delagoense*	-1.12	3.57	0.84	0.52	31.25 **	6	8	18	04	05	34	3	40.91	***NA***
Limited	*Euclea divinorum*	-1.07	2.99	0.70	0.73	14.15 **	6	8	11	03	05	17	3	27.27	***NA***
Limited	*Grewia caffra*	-2.41	5.17	0.89	0.68	24.65 *	3	5	25	02	04	13	0	45.45	***NA***
Limited	*Grewia spp.*	-2.36	4.43	0.75	1.01	5.84 -	2	4	11	01	04	3	0	4.55	***NA***

Table 7: continued

Limited	*Maytenus nemorosa*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	11	01	***NA***	0	0	4.55	***NA***
Limited	*Ochna barbosae*	-0.69	2.70	0.37	0.73	1.77	-	3	5	12	03	04	23	0	13.64	***NA***
Limited	*Pavetta gardeniifolia*	9.16	-3.71	1.00	0.00	0.00	-	0	2	21	02	***NA***	0	0	13.64	***NA***
Limited	*Pteleopsis myrtifolia*	-1.17	3.51	0.85	0.51	35.11	**	6	8	15	03	05	17	3	13.64	***NA***
Limited	*Rhus gueinsii*	-1.68	4.64	0.90	0.56	42.87	**	5	7	26	03	04	34	0	59.09	***NA***
Limited	*Sclerocarya birrea*	-0.08	0.67	0.02	0.72	0.16	-	9	11	10	08	09	7	20	27.27	***NA***
Limited	*Scutia myrtina*	-1.90	4.57	0.91	0.49	29.90	*	3	5	17	02	04	13	0	22.73	***NA***
Limited	*Tabernaemontana elegans*	-0.73	2.94	0.88	0.32	56.76	**	8	10	22	06	07	40	17	54.55	Fine
Limited	*Tricalysia lanceolata*	-0.60	3.03	0.15	0.97	0.18	-	1	3	10	02	03	10	0	18.18	***NA***
Limited	*Vernonia colorata*	-1.16	3.72	0.45	1.17	3.21	-	4	6	28	03	04	47	0	22.73	***NA***
Limited	*Warburgia salutaris*	-0.45	1.81	0.18	1.01	1.35	-	6	8	11	04	05	20	3	4.55	***NA***
Limited	*Zanthoxylum capense*	-1.35	3.58	0.76	0.74	16.07	*	5	7	15	02	05	13	0	27.27	***NA***
Limited	*Ziziphus mucronata*	-0.5	2.16	0.45	0.80	8.02	*	10	12	15	06	08	17	13	45.45	***NA***
						Mean SCD centroid location for common species:					04	05				
MRC site																
Community Level	**Community SCD**	**-2.1**	**9.80**	**0.75**	**1.58**	**29.80**	**	**10**	**12**	**186**						
Limited	*Carissa tetramera*	-4.18	9.65	1.00	0.00	0.00	-	0	2	19	01	***NA***	0	0	50.00	***NA***
Limited	*Dalbergia obovata*	-2.76	5.95	0.21	3.97	0.52	-	2	4	13	01	04	83	0	50.00	***NA***
Limited	*Dialium schlechteri*	-1.02	3.90	0.25	2.13	3.03	-	9	11	10	03	08	167	83	50.00	Fine
Limited	*Euclea natalensis*	-3.90	8.81	0.49	2.91	1.93	-	2	4	15	01	04	83	0	100.00	***NA***
Limited	*Margaritaria discoidea*	-2.61	8.98	0.91	0.60	20.37	*	2	4	26	02	03	417	0	50.00	***NA***
						Mean SCD centroid location for common species:					02	05				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Closed Woodland on sand

This vegetation unit was well-represented on all sites. A total of 43, 39 and 28 species were evaluated in Tembe, Tshanini and Manqakulane respectively (Tables 8, 9 and 10). In all three sites the majority of species fell within Type 1, but the percentages were highest in Manqakulane, followed by Tembe, and then Tshanini (Table 5). In the three sites the mean centroid 2 location fell either within size classes 4 or 5 (Tables 8 – 10). In Tembe and Tshanini a minor shift between mean centroids 1 and 2 locations was observed but in Manqakulane there was a noticeable shift in size classes between the positions of mean centroids 1 and 2 (Table 10)

The subcanopy level of this unit in Tembe was dominated by *Dialium schlechteri, Canthium armatum* and *Vepris lanceolata*. The first and last of these species also formed an important part of the canopy, accompanied by *Combretum molle, Spirostachys africana, Strychnos madagascariensis, Tabernaemontana elegans, Acacia burkei* and *Afzelia quanzensis* in what appeared to be a fairly diverse canopy stratum.

In Tshanini this unit's subcanopy was dominated by *Acacia burkei, Albizia adianthifolia, Hymenocardia ulmoides, Pteleopsis myrtifolia, Strychnos madagascariensis* and *Terminalia sericea*. The canopy level was dominated by *Acacia burkei*, the ubiquitous *Strychnos madagascariensis*, and *Terminalia sericea* (Table 9). Quite a range of trees reached large to very large sizes. The fruit bearing *Sclerocarya birrea* occurred in low but equal densities at subcanopy and canopy levels, while some large forest trees (*Cleistanthus schlechteri*) were observed within this vegetation type.

The subcanopy in Manqakulane was dominated by *Acacia burkei, Dichrostachys cinerea, Strychnos spinosa, Bridelia cathartica, Strychnos madagascariensis, Tabernaemontana elegans* and *Terminalia sericea* (Table 10). The canopy level was dominated by *Acacia burkei, Strychnos spinosa, Sclerocarya birrea, Spirostachys africana* and *Strychnos madagascariensis*. Interestingly, the woody species where large individuals were sampled were either large shady trees (*Acacia burkei* and *Acacia robusta*) or edible fruit bearing trees (*Sclerocarya birrea* and *Strychnos madagascariensis*) (Pooley 1997).

A total of 28 species were compared between the sites and 14 (50%) had different population structures (Table 6). The differences at the species slope level revealed that slopes were usually steepest in Manqakulane, followed by Tembe, and then Tshanini. However most differences observed were at the Y-axis intercept level (eight of the 14 different species), where the Y-axis intercepts was usually highest in Manqakulane, then Tembe then Tshanini.

Table 8: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland on Sand in Tembe Elephant Park, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-1.90**	**9.28**	**0.99**	**0.27**	**817.51**	**	**10**	**12**	**1999**						
Full	*Canthium armatum*	-2.42	7.25	0.89	0.70	23.53	*	3	5	145	02	03	269	0	61.90	***NA***
Full	*Clausena anisata*	-4.09	6.89	1.00	0.07	1860.41	*	1	3	36	02	05	5	0	33.33	***NA***
Full	*Combretum molle*	-0.96	4.02	0.81	0.51	30.38	**	7	9	38	05	06	82	37	42.86	Fine (*NA*)
Full	*Dalbergia obovata*	-3.19	6.62	0.96	0.49	45.59	*	2	4	58	01	03	18	0	38.10	***NA***
Full	*Deinbollia oblongifolia*	-3.20	6.28	0.98	0.29	56.85	-	1	3	30	01	03	9	0	23.81	***NA***
Full	*Dialium schlechteri*	-1.3	5.54	0.96	0.32	188.66	**	8	10	100	05	06	233	50	90.48	Fine
Full	*Euclea natalensis*	-2.1	6.64	0.89	0.74	39.14	**	5	7	161	02	05	96	0	95.24	***NA***
Full	*Monanthotaxis caffra*	-4.2	6.65	0.89	1.02	8.40	-	1	3	37	01	03	5	0	33.33	***NA***
Full	*Psydrax locuples*	-1.8	5.50	0.84	0.72	21.78	**	4	6	51	03	05	68	0	57.14	***NA***
Full	*Sclerocroton integerrimus*	-1.3	4.54	0.79	0.79	30.67	**	8	10	40	03	06	46	5	61.90	***NA***
Full	*Sideroxylon inerme*	-1.39	4.85	0.90	0.50	51.36	**	6	8	41	04	05	82	14	23.81	Fine (*NA*)
Full	*Spirostachys africana*	-1.29	5.01	0.77	0.82	27.04	**	8	10	73	04	06	114	32	33.33	Fine (*NA*)
Full	*Strychnos decussata*	-0.69	3.06	0.20	1.52	1.77	-	7	9	44	04	05	169	5	38.10	***NA***
Full	*Strychnos madagascariensis*	-0.92	4.00	0.70	0.66	16.67	**	7	9	43	05	07	78	41	42.86	Fine (*NA*)
Full	*Strychnos spinosa*	-1.42	4.62	0.82	0.69	28.01	**	6	8	34	03	05	46	9	61.90	***NA***
Full	*Tabernaemontana elegans*	-0.95	4.09	0.74	0.63	19.74	**	7	9	48	05	06	110	32	66.67	Fine
Full	*Tricalysia junodii*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	30	01	***NA***	0	0	9.52	***NA***
Full	*Tricalysia lanceolata*	-2.19	5.72	0.87	0.75	27.50	**	4	6	39	02	04	37	0	38.10	***NA***
Full	*Vepris lanceolata*	-1.48	6.48	0.97	0.28	180.07	**	6	8	203	04	05	420	32	76.19	Fine
						Mean SCD centroid location for common species:					03	05				

Table 8: continued

Limited	*Acacia burkei*	-0.60	2.66	0.41	0.90	6.98	*	10	12	25	07	09	23	50	66.67	Coarse
Limited	*Afzelia quanzensis*	0.12	0.72	0.05	0.65	0.53	-	10	12	28	08	08	64	64	47.62	Fine (*NA*)
Limited	*Azima tetracantha*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	28	01	***NA***	0	0	4.76	***NA***
Limited	*Brachylaena discolor*	-3.03	4.49	0.50	2.10	1.00	-	1	3	11	01	03	5	0	23.81	***NA***
Limited	*Coddia rudis*	-0.75	3.03	0.20	1.10	0.49	-	2	4	11	03	03	18	0	28.57	***NA***
Limited	*Cola greenwayi*	-1.76	4.70	0.72	0.80	5.24	-	2	4	19	02	03	23	0	9.52	***NA***
Limited	*Commiphora neglecta*	-0.47	2.72	0.37	0.64	3.52	-	6	8	28	05	05	110	9	33.33	***NA***
Limited	*Croton pseudopulchellus*	-2.37	5.52	0.65	1.22	1.83	-	1	3	25	02	03	9	0	14.29	***NA***
Limited	*Dichrostachys cinerea*	-0.61	2.09	0.16	1.37	0.96	-	5	7	11	03	05	18	0	33.33	***NA***
Limited	*Diospyros dichrophylla*	-5.01	6.52	1.00	0.00	0.00	-	0	2	16	01	***NA***	0	0	19.05	***NA***
Limited	*Diospyros inhacaensis*	-1.37	3.96	0.81	0.66	20.81	**	5	7	15	03	04	37	0	33.33	***NA***
Limited	*Dovyalis longispina*	-2.04	5.07	0.92	0.45	21.67	*	2	4	21	02	04	18	0	52.38	***NA***
Limited	*Grewia caffra*	-2.53	5.38	0.85	0.87	16.94	*	3	5	24	02	04	9	0	52.38	***NA***
Limited	*Grewia microthyrsa*	-1.39	4.01	0.79	0.58	11.48	*	3	5	15	03	03	37	0	42.86	***NA***
Limited	*Hymenocardia ulmoides*	-1.26	3.52	0.64	0.92	8.94	*	5	7	13	03	05	18	0	23.81	***NA***
Limited	*Mundulea sericea*	-0.76	2.62	0.22	1.51	1.66	-	6	8	22	03	04	64	5	9.52	***NA***
Limited	*Ochna natalitia*	-3.69	6.47	0.98	0.39	42.46	-	1	3	27	01	03	5	0	57.14	***NA***
Limited	*Pavetta gardeniifolia*	-2.08	4.57	0.56	1.50	3.87	-	3	5	18	02	05	9	0	23.81	***NA***
Limited	*Ptaeroxylon obliquum*	-1.08	3.08	0.62	0.89	9.60	*	6	8	12	03	07	9	5	9.52	***NA***
Limited	*Rhus gueinsii*	-1.37	4.01	0.85	0.57	27.81	**	5	7	16	03	05	27	0	38.10	***NA***
Limited	*Rothmania fischerii*	0.76	-0.35	0.48	0.77	4.60	-	5	7	15	05	05	68	0	23.81	***NA***
Limited	*Suregada zanzibariensis*	-0.70	3.30	0.49	0.58	2.90	-	3	5	17	03	04	46	0	33.33	***NA***
Limited	*Tecoma capensis*	-3.21	5.48	1.00	0.00	0.00	-	0	2	13	01	***NA***	0	0	4.76	***NA***
Limited	*Terminalia sericea*	-0.26	1.52	0.15	0.77	1.79	-	10	12	17	08	08	32	37	33.33	Intermediate (*NA*)
Limited	*Tricalysia delagoensis*	-1.31	3.63	0.70	0.78	9.21	*	4	6	12	03	04	27	0	38.10	***NA***
Limited	*Zanthoxylum capense*	-1.33	4.39	0.90	0.36	27.47	*	3	5	23	03	04	46	0	28.57	***NA***
								Mean SCD centroid location for common species:			03	05				

SC Size Class
** Highly significant (p ≤ 0.01)
* Significant (p ≤ 0.05)
- Not significant (p > 0.05)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 9: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland on Sand in Tshanini Community Conservation Area, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F	Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.09**	**9.31**	**0.98**	**0.39**	**458.71 ****	**10**	**12**	**3915**						
Full	*Acacia burkei*	-1.25	5.27	0.96	0.32	248.69 **	10	12	198	05	06	151	89	77.78	Fine
Full	*Albizia adianthifolia*	-1.82	5.89	0.72	1.32	20.51 **	8	10	344	03	03	276	9	66.67	***NA***
Full	*Boscia filipes*	3.86	-0.73	0.61	2.13	1.58 -	1	3	78	03	03	80	0	11.11	***NA***
Full	*Bridelia cathartica*	-1.35	4.10	0.87	0.46	27.90 **	4	6	42	03	04	42	0	22.22	***NA***
Full	*Combretum molle*	-1.44	5.01	0.86	0.64	43.96 **	7	9	125	03	05	100	13	100.00	Fine
Full	*Dialium schlechteri*	-1.21	4.26	0.84	0.64	47.61 **	9	11	75	04	05	53	16	77.78	Fine
Full	*Dichrostachys cinerea*	-2.07	5.48	0.89	0.66	32.18 **	4	6	89	02	04	36	0	55.56	***NA***
Full	*Euclea natalensis*	-1.27	4.31	0.62	1.04	9.86 *	6	8	85	03	05	58	9	44.44	***NA***
Full	*Gardenia volkensii*	-2.1	4.77	0.70	1.02	4.66 -	2	4	40	02	03	9	0	55.56	***NA***
Full	*Grewia caffra*	-0.7	3.84	0.05	2.26	0.05 -	1	3	79	02	03	11	0	33.33	***NA***
Full	*Grewia microthyrsa*	-3.6	7.75	0.91	0.96	29.54 *	3	5	279	01	03	22	0	88.89	***NA***
Full	*Hymenocardia ulmoides*	-1.6	5.82	0.82	0.94	35.35 **	8	10	235	03	04	398	4	55.56	***NA***
Full	*Lippia javanica*	-3.0	5.80	0.50	2.09	0.99 -	1	3	72	02	03	2	0	22.22	***NA***
Full	*Margaritaria discoidea*	-1.5	4.09	0.54	1.05	2.35 -	2	4	34	02	03	11	0	66.67	***NA***
Full	*Mundulea sericea*	-3.18	7.02	0.85	1.09	17.06 *	3	5	163	02	03	56	0	44.44	***NA***
Full	*Psydrax locuples*	-1.02	3.39	0.45	0.92	2.49 -	3	5	31	03	03	36	0	44.44	***NA***
Full	*Pteleopsis myrtifolia*	-2.13	6.88	0.80	1.13	23.35 **	6	8	401	03	04	407	7	77.78	***NA***
Full	*Sclerocroton integerrimus*	-1.02	3.76	0.32	1.46	2.38 -	5	7	99	03	04	122	13	77.78	Fine
Full	*Spirostachys africana*	-0.56	2.58	0.33	0.92	4.01 -	8	10	57	05	07	49	24	11.11	Fine (*NA*)
Full	*Strychnos madagascariensis*	-1.37	5.76	0.91	0.51	96.14 **	9	11	278	05	05	369	82	100.00	Fine
Full	*Strychnos spinosa*	-1.57	5.42	0.89	0.53	41.28 **	5	7	138	03	04	131	11	100.00	Fine
Full	*Tabernaemontana elegans*	-1.03	3.11	0.55	0.98	7.37 *	6	8	31	04	05	18	7	66.67	***NA***
Full	*Terminalia sericea*	-1.63	6.01	0.88	0.69	60.30 **	8	10	298	03	05	182	36	77.78	Fine
Full	*Vangueria infausta*	-1.29	4.74	0.45	1.16	2.47 -	3	5	105	03	03	100	0	100.00	***NA***
Full	*Vitex ferruginea*	-2.15	5.48	0.76	0.89	6.27 -	2	4	78	02	03	22	0	66.67	***NA***
Full	*Xylotheca kraussiana*	-4.28	7.46	1.00	0.00	0.00 -	0	2	152	01	***NA***	0	0	88.89	***NA***
						Mean SCD centroid location for common species:				03	04				

Table 9: continued

Limited	*Albizia versicolor*	0.03	0.58	0.00	0.84	0.01	-	5	7	11	04	04	22	2	11.11	***NA***
Limited	*Ancylanthos monteiroi*	-1.63	3.88	0.54	1.05	1.17	-	1	3	20	02	03	4	0	44.44	***NA***
Limited	*Brachylaena elliptica*	-0.83	2.46	0.34	1.15	2.53	-	5	7	24	03	06	7	4	33.33	***NA***
Limited	*Catunaregam taylori*	-1.99	4.21	0.81	0.67	4.30	-	1	3	20	02	03	4	0	55.56	***NA***
Limited	*Cleistanthus schlechteri*	-0.67	2.27	0.63	0.66	16.67	**	10	12	16	05	09	4	4	11.11	***NA***
Limited	*Coddia rudis*	-1.70	4.10	0.93	0.31	14.26	-	1	3	24	02	03	11	0	55.56	***NA***
Limited	*Combretum mkuzense*	0.60	0.51	0.25	0.85	0.98	-	3	5	16	04	04	31	0	11.11	***NA***
Limited	*Deinbollia oblongifolia*	-1.7	4.08	0.95	0.28	19.22	-	1	3	20	02	03	7	0	44.44	***NA***
Limited	*Gymnosporia senegalensis*	0.5	1.51	0.07	1.46	0.077	-	1	3	16	02	03	9	0	33.33	***NA***
Limited	*Ptaeroxylon obliquum*	-0.9	2.93	0.66	0.70	9.56	*	5	7	20	03	05	13	2	22.22	***NA***
Limited	*Rhus gueinzii*	-0.6	2.55	0.60	0.51	5.90	-	4	6	19	04	05	24	0	44.44	***NA***
Limited	*Sclerocarya birrea*	-0.6	2.42	0.75	0.44	29.98	**	10	12	28	07	08	20	22	66.67	Coarse
Limited	*Strychnos henningsii*	2.2	-0.38	0.57	1.37	1.32	-	1	3	14	03	03	16	0	22.22	***NA***
										Mean SCD centroid location for common species:	03	05				

SC Size Class
** Highly significant (p ≤ 0.01)
* Significant (p ≤ 0.05)
- Not significant (p > 0.05)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 10: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Closed Woodland on Sand in the Manqakulane Rural Community Village zone, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F	Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.11**	**9.77**	**0.96**	**0.53**	**248.45** **	**10**	**12**	**819**						
Full	*Acacia burkei*	-1.41	5.74	0.91	0.56	99.15 **	10	12	33	04	06	191	38	70.00	Fine
Full	*Coddia rudis*	-3.20	8.01	0.90	0.78	18.30 -	2	4	39	02	03	76	0	50.00	***NA***
Full	*Deinbollia oblongifolia*	-3.22	7.71	0.86	0.95	12.34 -	2	4	30	02	03	38	0	60.00	***NA***
Full	*Dichrostachys cinerea*	-2.06	6.77	0.81	0.89	17.20 *	4	6	39	03	04	268	0	90.00	***NA***
Full	*Euclea natalensis*	-3.27	8.36	0.98	0.34	99.47 **	2	4	57	01	03	89	0	90.00	***NA***
Full	*Psydrax locuples*	-2.95	7.22	0.76	1.51	12.47 *	4	6	33	02	05	38	0	70.00	***NA***
Full	*Strychnos spinosa*	-2.00	6.80	0.82	1.04	32.01 **	7	9	48	03	05	217	38	90.00	Fine
Full	*Zanthoxylum capense*	-2.64	7.47	0.94	0.59	64.90 **	4	6	45	02	04	102	0	60.00	***NA***
						Mean SCD centroid location for common species:				02	04				
Limited	*Acacia robusta*	-1.39	4.74	0.62	1.36	16.65 **	10	12	20	03	06	51	13	10.00	Fine (*NA*)
Limited	*Balanites maughamii*	1.58	4.03	1.00	0.00	0.00 -	0	2	13	02	***NA***	0	0	10.00	***NA***
Limited	*Brachylaena discolor*	-2.65	6.33	1.00	0.09	380.52 *	1	3	11	01	03	25	0	30.00	***NA***
Limited	*Bridelia cathartica*	-1.48	5.50	0.83	0.60	19.47 *	4	6	20	03	04	166	0	80.00	***NA***
Limited	*Canthium armatum*	-1.90	5.08	0.42	1.83	2.17 -	3	5	11	02	05	25	0	50.00	***NA***
Limited	*Catunaregam taylori*	-2.29	6.66	0.96	0.38	71.09 **	3	5	22	02	04	102	0	20.00	***NA***
Limited	*Clausena anisata*	-3.46	7.83	0.85	0.99	5.90 -	1	3	27	01	03	25	0	50.00	***NA***
Limited	*Commiphora neglecta*	-1.76	5.72	0.69	1.25	13.13 *	6	8	25	03	05	102	13	50.00	Fine
Limited	*Dalbergia obovata*	-3.72	7.47	0.92	0.74	12.13 -	1	3	16	01	03	13	0	10.00	***NA***
Limited	*Dialium schlechteri*	-2.57	6.92	0.85	0.98	22.21 **	4	6	25	02	04	76	0	90.00	***NA***
Limited	*Diospyros dichrophylla*	-1.79	6.99	1.00	0.00	0.00 -	0	2	28	01	***NA***	0	0	30.00	***NA***
Limited	*Erythroxylum delagoense*	-2.37	6.65	0.93	0.52	40.62 **	3	5	21	02	03	102	0	50.00	***NA***
Limited	*Monanthotaxis caffra*	-4.63	7.55	1.00	0.00	***NA*** -	0	2	12	01	***NA***	0	0	50.00	***NA***
Limited	*Ochna natalitia*	-1.61	6.70	1.00	0.00	***NA*** -	0	2	23	01	***NA***	0	0	60.00	***NA***
Limited	*Sclerocarya birrea*	-0.87	4.02	0.53	1.03	11.33 **	10	12	22	06	09	89	89	60.00	Fine
Limited	*Spirostachys africana*	-1.64	5.34	0.59	1.45	8.48 *	6	8	21	03	06	89	38	50.00	Fine
Limited	*Strychnos madagascariensis*	-1.19	4.88	0.84	0.66	52.12 **	10	12	21	05	07	140	51	70.00	Fine
Limited	*Tabernaemontana elegans*	-1.66	5.24	0.60	1.34	7.41 *	5	7	18	03	04	166	0	50.00	***NA***
Limited	*Terminalia sericea*	-0.46	2.52	0.12	1.37	0.99 -	7	9	12	05	05	127	13	50.00	Fine
Limited	*Xylotheca kraussiana*	0.44	5.58	1.00	0.00	0.00 -	0	2	27	02	***NA***	0	0	80.00	***NA***
						Mean SCD centroid location for common species:				02	05				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Open Woodland on sand

This particular vegetation unit was well-represented in Tembe (42 species, Table 11) and Tshanini (33 species, Table 12), but poorly so in Manqakulane where only one species was within the full analysis from only one plot (Table 12).

In Tembe, most species were classified within Type 1 (Table 3). Mean centroid 2 was skewed to the left for the full scope analysis and in the middle of the range for the limited analysis. There was a small shift in size classes between the positions of mean centroids 1 and 2. The subcanopy level of this unit was dominated by *Strychnos madagascariensis* and *Terminalia sericea*, with some patches of dense *Vepris lanceolata* undergrowth (Table 11). In the canopy, large to very large trees of the same species occurred, with the addition of *Acacia burkei, Sclerocroton integerrimus,* and *Spirostachys africana*.

In Tembe some species had particularly obvious anomalous population structures. *Albizia adianthifolia* was absent at the subcanopy level (Table 11), and scarce at canopy level, occurring only in some places. In Tshanini this species was abundant at the subcanopy level, and was found in most plots (see Table 12). Another two such species were *Garcinia livingstonei* and *Sclerocarya birrea*, where the mean centroid 2 location was skewed to the right, inverse pyramidal population structures and low frequency of occurrence were also observed.

In Tshanini, only *Grewia caffra* was classified within Type 3 (Table 3), and the majority of species fell within Type 1 in the full analysis. Half of the species in the limited analysis fell within Type 3. Mean centroid 2 position indicated an obvious left bias in the population in both sets of analyses, and there was no major shift in size classes between the positions of mean centroids 1 and 2. The subcanopy was populated by *Pteleopsis myrtifolia, Strychnos madagascariensis* and *Terminalia sericea*, with some dense patches of *Grewia caffra*. A mix of large *Acacia burkei, Strychnos madagascariensis* and *Terminalia sericea* trees formed the canopy, while some large *Albizia adianthifolia* and *Spirostachys africana* were also found (Table 12). There were no obvious defects in population structure in this vegetation unit, species with flat or positive slope coefficients did not reach sizes that would make it obvious with the current subcanopy and canopy cut-off points.

Some 21 species were compared between Tembe and Tshanini and eight (38%) had different structures. Within the full analysis, only *Terminalia sericea* and *Vangueria infausta* had different slope coefficients (Table 6). In the cross analyses species comparisons, five species had different population structures between Tembe and Tshanini (Table 6). The most noticeable species in this group was *Albizia*

Table 11: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Open Woodland on Sand in Tembe Elephant Park, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-1.69**	**7.94**	**0.94**	**0.55**	**153.27**	**	**10**	**12**	**4202**						
Full	*Acacia burkei*	-0.91	3.89	0.78	0.61	35.48	**	10	12	198	06	08	55	66	62.00	Intermediate
Full	*Albizia versicolor*	-0.34	1.46	0.79	0.23	36.80	**	10	12	31	08	09	11	14	40.00	Coarse (*NA*)
Full	*Brachylaena discolor*	-1.54	4.32	0.77	0.61	6.84	-	2	4	75	02	03	22	0	28.00	***NA***
Full	*Carissa bispinosa*	-5.67	7.69	1.00	0.00	0.00	-	0	2	206	01	***NA***	0	0	12.00	***NA***
Full	*Catunaregam taylori*	-2.89	6.17	0.93	0.66	38.66	**	3	5	198	01	04	9	0	38.00	***NA***
Full	*Clausena anisata*	-3.49	5.81	0.93	0.66	13.41	-	1	3	77	01	03	2	0	20.00	***NA***
Full	*Combretum molle*	-0.97	3.62	0.89	0.41	76.63	**	9	11	103	05	06	40	15	66.00	Fine
Full	*Commiphora neglecta*	-1.79	3.90	0.86	0.54	12.01	-	2	4	36	02	03	6	0	24.00	***NA***
Full	*Dalbergia obovata*	-4.90	6.85	0.95	0.81	17.58	-	1	3	163	01	03	1	0	14.00	***NA***
Full	*Dialium schlechteri*	-0.96	3.34	0.82	0.56	46.82	**	10	12	74	03	05	34	3	56.00	***NA***
Full	*Dichrostachys cinerea*	-2.12	5.94	0.83	0.94	24.45	**	5	7	335	02	04	56	0	74.00	***NA***
Full	*Diospyros dichrophylla*	-3.36	6.72	1.00	0.00	0.00	-	0	2	221	01	***NA***	0	0	28.00	***NA***
Full	*Euclea natalensis*	-1.61	4.41	0.96	0.31	128.33	**	5	7	82	03	04	28	0	52.00	***NA***
Full	*Gymnosporia senegalensis*	-2.61	6.12	0.79	0.99	7.39	-	2	4	211	02	03	24	0	28.00	***NA***
Full	*Monanthotaxis caffra*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	61	01	***NA***	0	0	4.00	***NA***
Full	*Ozoroa englerii*	-1.29	3.22	0.86	0.43	17.81	*	3	5	31	03	03	14	0	38.00	***NA***
Full	*Parinari capensis*	-3.81	5.34	0.91	0.82	10.32	-	1	3	57	01	03	1	0	6.00	***NA***
Full	*Pavetta catophylla*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	57	01	***NA***	0	0	2.00	***NA***
Full	*Pavetta gardeniifolia*	-3.94	7.19	1.00	0.00	0.00	-	0	2	269	01	***NA***	0	0	20.00	***NA***
Full	*Psydrax locuples*	-1.99	4.11	0.88	0.60	21.90	*	3	5	40	02	04	4	0	34.00	***NA***
Full	*Rhus gueinsii*	-1.03	2.89	0.73	0.66	16.43	**	6	8	34	03	04	9	1	38.00	***NA***
Full	*Sclerocroton integerrimus*	-0.88	3.05	0.77	0.56	26.76	**	8	10	64	05	07	23	8	48.00	Intermediate (*NA*)
Full	*Spirostachys africana*	-0.87	2.69	0.52	0.97	8.71	*	8	10	81	03	07	4	6	18.00	Coarse (*NA*)
Full	*Strychnos madagascariensis*	-1.25	4.92	0.92	0.45	104.45	**	9	11	304	04	06	115	25	92.00	Fine
Full	*Strychnos spinosa*	-1.20	4.22	0.82	0.65	37.56	**	8	10	156	04	06	40	10	64.00	Fine
Full	*Terminalia sericea*	-0.95	4.51	0.81	0.57	44.05	**	10	12	385	06	07	158	115	90.00	Fine
Full	*Vangueria infausta*	-0.50	1.91	0.49	0.54	5.66	-	6	8	37	05	05	30	1	58.00	***NA***
Full	*Vepris lanceolata*	-1.00	2.86	0.77	0.57	20.41	**	6	8	32	03	05	750	167	24.00	Fine (*NA*)
Full	*Zanthoxylum capense*	-1.96	3.86	0.74	0.94	8.68	-	3	5	35	02	05	1	0	32.00	***NA***
						Mean SCD centroid location for common species:					03	05				

Table 11: continued

Limited	*Albizia adianthifolia*	-0.44	1.47	0.38	0.71	6.15	*	10	12	22	05	12	0	4	18.00	***NA***
Limited	*Antidesma venosum*	-0.09	0.48	0.26	0.20	3.59	-	10	12	12	07	08	6	5	16.00	Intermediate (*NA*)
Limited	*Bridelia cathartica*	-0.43	2.08	0.47	0.34	1.75	-	2	4	21	03	04	11	0	20.00	***NA***
Limited	*Canthium armatum*	-1.56	3.36	0.65	0.84	3.65	-	2	4	27	02	03	4	0	18.00	***NA***
Limited	*Deinbollia oblongifolia*	-1.62	2.95	1.00	0.00	0.00	-	0	2	11	01	***NA***	0	0	16.00	***NA***
Limited	*Garcinia livingstonei*	-0.33	1.32	0.49	0.42	9.72	*	10	12	26	07	09	4	15	34.00	Coarse (*NA*)
Limited	*Grewia microthyrsa*	-0.57	2.45	0.08	1.31	0.09	-	1	3	25	02	03	4	0	30.00	***NA***
Limited	*Grewia tenuinervis*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	15	01	***NA***	0	0	2.00	***NA***
Limited	*Hymenocardia ulmoides*	-1.03	2.51	0.84	0.36	16.25	*	3	5	17	03	04	6	0	18.00	***NA***
Limited	*Hyphaene coriacea*	-0.15	0.77	0.12	0.47	1.12	-	8	10	18	06	06	14	3	18.00	***NA***
Limited	*Mundulea sericea*	0.17	0.97	0.06	0.50	0.12	-	2	4	13	03	04	8	0	16.00	***NA***
Limited	*Ochna natalitia*	-2.75	4.22	1.00	0.00	672169.72	**	1	3	24	01	03	1	0	32.00	***NA***
Limited	*Sclerocarya birrea*	0.00	0.28	0.00	0.35	0.00	-	10	12	22	09	09	7	15	34.00	Coarse (*NA*)
Limited	*Senna petersianna*	-1.38	2.96	1.00	0.00	***NA***	-	0	2	13	01	***NA***	0	0	2.00	***NA***
Limited	*Tabernaemontana elegans*	-0.49	1.63	0.71	0.35	17.45	**	7	9	19	05	05	11	3	20.00	***NA***
Limited	*Xylotheca kraussiana*	-3.47	4.65	1.00	0.00	0.00	-	0	2	25	01	***NA***	0	0	26.00	***NA***
						Mean SCD centroid location for common species:					04	06				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 12: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Open Woodland on Sand in the sites: Tshanini Community Conservation Area (TCCA) and the Manqakulane Rural Community Village zone (MRC); Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
<u>TCCA site</u>																
Community Level	**Community SCD**	**-2.09**	**8.59**	**0.98**	**0.40**	**428.47**	**	**10**	**12**	**4663**						
Full	*Acacia burkei*	-0.83	3.42	0.88	0.38	75.57	**	10	12	138	06	07	36	41	81.82	Intermediate
Full	*Albizia adianthifolia*	-1.23	4.19	0.73	0.96	26.44	**	10	12	215	03	04	48	3	90.91	***NA***
Full	*Brachylaena elliptica*	-1.36	3.07	0.69	0.82	8.81	*	4	6	34	02	05	3	0	36.36	***NA***
Full	*Catunaregam taylori*	-3.19	6.15	0.90	0.77	18.23	-	2	4	171	01	03	5	0	63.64	***NA***
Full	*Combretum molle*	-1.1[illegible]	3.72	0.78	0.66	24.55	**	7	9	114	03	05	47	5	90.91	***NA***
Full	*Dialium schlechteri*	-1.3	4.16	0.94	0.34	96.08	**	6	8	120	03	05	35	6	63.64	Fine
Full	*Gardenia volkensii*	-1.4	3.31	0.84	0.55	21.50	**	4	6	34	02	04	5	0	63.64	***NA***
Full	*Grewia caffra*	3.0	-0.01	0.62	1.71	3.33	-	2	4	553	03	03	430	0	18.18	***NA***
Full	*Grewia microthyrsa*	-2.7	6.51	0.76	1.05	3.25	-	1	3	320	02	03	17	0	63.64	***NA***
Full	*Hymenocardia ulmoides*	-1.7	5.02	0.89	0.65	50.14	**	6	8	173	02	03	43	1	72.73	***NA***
Full	*Margaritaria discoidea*	-1.55	3.39	0.38	1.38	0.61	-	1	3	34	02	03	2	0	36.36	***NA***
Full	*Pteleopsis myrtifolia*	-1.85	5.93	0.87	0.85	52.10	**	8	10	534	02	03	136	1	72.73	***NA***
Full	*Sclerocroton integerrimus*	-0.62	2.42	0.46	0.70	5.12	-	6	8	67	04	05	49	2	81.82	***NA***
Full	*Strychnos madagascariensis*	-1.34	5.31	0.95	0.36	184.52	**	9	11	417	04	05	228	33	100.00	Fine
Full	*Strychnos spinosa*	-1.44	4.73	0.92	0.48	77.11	**	7	9	191	03	04	75	4	90.91	***NA***
Full	*Terminalia sericea*	-1.65	6.00	0.94	0.51	136.42	**	9	11	658	03	05	148	24	90.91	Fine
Full	*Tricalysia delagoensis*	-0.38	4.10	1.00	0.00	0.00	-	0	2	102	01	***NA***	0	0	9.09	***NA***
Full	*Vangueria infausta*	-1.20	4.20	0.83	0.63	39.69	**	8	10	166	04	04	96	2	100.00	***NA***
Full	*Vitex ferruginea*	-0.39	3.20	0.02	1.87	0.02	-	1	3	108	02	03	11	0	72.73	***NA***
Full	*Xylotheca kraussiana*	-4.68	6.99	0.99	0.31	112.32	-	1	3	179	01	03	1	0	100.00	***NA***
						Mean SCD centroid location for common species:					03	04				

Table 12: continued

Limited	*Albizia versicolor*	-0.14	0.70	0.10	0.45	0.81	-	7	9	16	05	06	10	4	54.55	***NA***
Limited	*Ancylanthos monteiroi*	0.65	1.95	1.00	0.00	0.00	-	0	2	22	02	***NA***	0	0	27.27	***NA***
Limited	*Brachylaena huilensis*	-1.15	2.24	0.76	0.47	6.40	-	2	4	12	02	03	3	0	36.36	***NA***
Limited	*Dichrostachys cinerea*	-0.88	2.39	0.82	0.43	28.22	**	6	8	22	03	05	4	1	63.64	***NA***
Limited	*Euclea natalensis*	-0.50	2.05	0.10	1.12	0.21	-	2	4	29	03	03	8	0	36.36	***NA***
Limited	*Hyperacanthus microphyllus*	-0.72	2.17	0.42	0.59	0.71	-	1	3	17	02	03	6	0	27.27	***NA***
Limited	*Lippia javanica*	0.93	0.22	0.15	1.52	0.18	-	1	3	13	02	03	3	0	9.09	***NA***
Limited	*Gymnosporia senegalensis*	-1.12	2.68	0.56	0.81	3.81	-	3	5	27	03	03	10	0	18.18	***NA***
Limited	*Mundulea sericea*	0.16	1.71	0.31	0.17	0.45	-	1	3	24	03	03	11	0	27.27	***NA***
Limited	*Psydrax locuples*	0.70	0.59	0.41	0.59	0.69	-	1	3	12	03	03	5	0	9.09	***NA***
Limited	*Rhus gueinzii*	0.01	0.76	0.00	0.30	0.00	-	3	5	13	04	04	10	0	54.55	***NA***
Limited	*Spirostachys africana*	-0.5	1.77	0.66	0.48	19.23	**	10	12	20	04	05	6	1	27.27	***NA***
Limited	*Tabernaemontana elegans*	-0.4	1.41	0.69	0.30	13.09	*	6	8	18	05	06	9	2	36.36	***NA***
Limited	*Vangueria esculenta*	0.4	-0.16	0.50	0.39	2.99	-	3	5	10	04	04	9	0	54.55	***NA***
						Mean SCD centroid location for common species:					03	04				
<u>MRC site</u>																
Community Level	**Community SCD**	**-3.02**	**11.38**	**0.93**	**1.07**	**126.88**	**	**10**	**12**	**149**						
Full	*Carissa bispinosa*	-3.76	11.65	1.00	0.00	0.00	-	0	2	86	01	***NA***	0	0	100.00	***NA***
						Mean SCD centroid location for common species:					01	***NA***				

Notes:

** Highly significant

* Significant

\- Not significant

NA Not applicable

SC = Size Class

adianthifolia, which had a shallower slope and a lower Y-axis intercept in Tembe, with a centroid (restricted data set) totally skewed to the right, indicating a population where only mature trees were left. The centroid position for the full data set revealed a small bias to the left, but the subcanopy density indicated a dearth of the small size classes.

Open Woodland on Abandoned Household sites

This particular unit was recognised to separate the vegetation growing on old household sites and abandoned fields from surrounding vegetation in Manqakulane. The species found in this vegetation unit were atypical for the characteristic Open Woodland surrounding vegetation. The “open” prefix is used here in the structural sense, because the mix of species ranges between Closed Woodland Thicket and Sparse Woodland on Sand. A total of 20 species were evaluated (Table 13), the majority of which were classified in Type 1 (Table 3). Mean centroid 2 was either centrally located (limited analysis) or slightly skewed to the left. However, there was a major shift in size classes (three size classes upwards) between the positions of mean centroids 1 and 2, indicating a strong influence of seedlings and saplings on the populations (Table 13).

No very large trees (size class 12) were sampled, but some were sampled in the classes immediately below (Table 13). These large trees were the fruiting species *Sclerocarya birrea, Strychnos madagascariensis* and *Strychnos spinosa*, while the other large trees were the shade providing *Dialium schlechteri* and *Trichilia emetica*. The subcanopy was dominated by *Dichrostachys cinerea*, *Strychnos spinosa* and *Acacia burkei*. This vegetation unit was unique to Manqakulane and had no equivalent in the Tshanini and Tembe.

Sparse Woodland on sand

This vegetation unit only occured in Tembe and Manqakulane. In Manqakulane only three species (Table 14) were evaluated, with *Dichrostachys cinerea* and *Gymnosporia senegalensis* in the full analysis and *Sclerocarya birrea* in the limited analysis. The first species dominated the subcanopy while the last species was prevalent at the canopy level. *Sclerocarya birrea* was found in equal densities at subcanopy and canopy levels. All three species belonged to Type 1 (Table 3) and mean centroid 2 for the full analysis was biased to the left. There were large shifts in size classes between the positions of mean centroids 1 and 2, indicating an influence of seedlings and saplings on the populations.

Table 13: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Open Woodland on Abandoned Household site in the Manqakulane Rural Community Village zone, Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F	Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
Community Level	**Community SCD**	**-2.16**	**8.91**	**0.93**	**0.77**	**125.74** **	**10**	**12**	**995**						
Full	*Acacia burkei*	-1.56	5.31	0.93	0.49	87.29 **	7	9	41	03	05	123	5	78.57	***NA***
Full	*Bridelia cathartica*	-2.37	6.28	0.91	0.68	39.57 **	4	6	42	02	04	49	0	64.29	***NA***
Full	*Canthium armatum*	-2.08	6.12	0.79	0.78	7.61 -	2	4	42	02	03	59	0	21.43	***NA***
Full	*Deinbollia oblongifolia*	-2.57	7.30	1.00	0.00	***NA*** -	0	2	71	01	***NA***	0	0	64.29	***NA***
Full	*Dichrostachys cinerea*	-2.78	7.89	0.96	0.51	95.88 **	4	6	144	02	04	137	0	85.71	***NA***
Full	*Diospyros dichrophylla*	-6.40	8.20	1.00	0.00	0.00 -	0	2	30	01	***NA***	0	0	28.57	***NA***
Full	*Gymnosporia senegalensis*	-2.33	6.26	0.96	0.39	69.79 **	3	5	39	02	04	59	0	35.71	***NA***
Full	*Margaritaria discoidea*	-2.83	7.28	0.97	0.41	92.98 **	3	5	74	02	04	59	0	78.57	***NA***
Full	*Sclerocarya birrea*	-1.32	4.86	0.81	0.78	38.43 **	9	11	41	04	07	59	29	71.43	Fine
Full	*Strychnos madagascariensis*	-1.2	4.59	0.90	0.50	84.01 **	9	11	34	04	06	69	15	57.14	Fine
Full	*Strychnos spinosa*	-1.8	6.31	0.92	0.65	89.00 **	8	10	83	03	05	127	10	92.86	Fine
Full	*Tabernaemontana elegans*	-1.9	5.66	0.92	0.48	34.82 **	3	5	30	02	04	49	0	64.29	***NA***
Full	*Terminalia sericea*	-2.1	6.15	0.89	0.78	48.13 **	6	8	55	02	05	54	5	35.71	***NA***
						Mean SCD centroid location for common species:				02	05				
Limited	*Dialium schlechteri*	-0.77	2.68	0.52	0.90	9.68 *	9	11	11	06	09	5	20	50.00	Coarse
Limited	*Euclea natalensis*	-2.27	5.41	0.79	1.06	15.04 *	4	6	21	02	05	15	0	71.43	***NA***
Limited	*Grewia caffra*	-4.51	6.47	1.00	0.00	0.00 -	0	2	12	01	***NA***	0	0	35.71	***NA***
Limited	*Ochna natalitia*	-1.34	5.09	1.00	0.00	0.00 -	0	2	15	01	***NA***	0	0	64.29	***NA***
Limited	*Trichilia emetica*	-0.68	2.88	0.56	0.73	11.32 **	9	11	19	06	08	25	39	71.43	Coarse
Limited	*Xylotheca kraussiana*	-3.21	6.42	0.63	1.72	1.67 -	1	3	24	02	03	5	0	71.43	***NA***
Limited	*Zanthoxylum capense*	-2.62	6.02	0.99	0.21	163.18 **	2	4	23	02	03	25	0	50.00	***NA***
						Mean SCD centroid location for common species:				03	06				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

Table 14: Detail of species level size class distribution (SCD) regressions, including statistical significance, the range of size classes (SC) used, number of individuals sampled, centroid 1 position (full data set) centroid 2 position (size classes 3 - 12), subcanopy and canopy density, frequency of occurrence in sample plots, and species grain. The information presented is for the common species for which 30 or more individuals were sampled (full analysis) and those for which 10 to 29 individuals were sampled (limited analysis) of the Sparse Woodland on Sand in the sites: Tembe Elephant Park (TEP) and Manqakulane Rural Community Village zone (MRC); Maputaland, northern KwaZulu-Natal, South Africa

Analysis	Species	Slope	Intercept	R^2	Standard error	F		Degrees of freedom	SC range	Number of individuals	Centroid 1 in SC	Centroid 2 in SC	Subcanopy density (individuals / ha)	Canopy density (individuals / ha)	Frequency of occurrence (%)	Species grain
<u>TEP site</u>																
Community Level	**Community SCD**	**-2.26**	**8.82**	**0.89**	**0.98**	**83.65**	**	**10**	**12**	**654**						
Full	*Catunaregam taylori*	-2.66	7.65	1.00	0.00	***NA***	-	0	2	54	01	***NA***	0	0	42.86	***NA***
Full	*Dichrostachys cinerea*	-4.11	9.15	0.79	1.71	11.50	*	3	5	143	02	04	46	0	85.71	***NA***
Full	*Parinari capensis*	0.92	6.35	1.00	0.00	0.00	-	0	2	130	02	***NA***	0	0	28.57	***NA***
Full	*Pavetta gardeniifolia*	-2.94	8.15	1.00	0.00	0.00	-	0	2	77	01	***NA***	0	0	28.57	***NA***
Full	*Strychnos madagascariensis*	-2.09	6.89	0.89	0.78	46.89	**	6	8	73	02	05	120	19	100.00	Fine
Full	*Terminalia sericea*	-1.93	6.87	0.85	0.91	39.04	**	7	9	78	03	05	333	37	100.00	Fine
					Mean SCD centroid location for common species:						02	05				
Limited	*Acacia burkei*	-1.4	4.87	0.71	1.13	22.45	**	9	11	24	03	05	74	9	57.14	Fine
Limited	*Carissa bispinosa*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	11	01	***NA***	0	0	14.29	***NA***
Limited	*Carissa tetramera*	***NA***	***NA***	***NA***	***NA***	***NA***	-	***NA***	1	20	01	***NA***	0	0	14.29	***NA***
Limited	*Combretum molle*	-0.7	4.52	0.33	0.73	0.49	-	1	3	13	02	03	46	0	71.43	***NA***
					Mean SCD centroid location for common species:						02	04				
<u>MRC site</u>																
Community Level	**Community SCD**	**-2.18**	**8.88**	**0.86**	**1.12**	**60.04**	**	**10**	**12**	**176**						
Full	*Dichrostachys cinerea*	-3.67	9.55	0.95	0.61	38.65	*	2	4	52	01	03	169	0	100.00	***NA***
Full	*Gymnosporia senegalensis*	-5.64	10.26	0.93	1.06	13.71	-	1	3	67	01	03	34	0	50.00	***NA***
					Mean SCD centroid location for common species:						01	03				
Limited	*Sclerocarya birrea*	-1.17	4.67	0.39	1.77	5.87	*	9	11	13	05	08	102	102	50.00	Fine
					Mean SCD centroid location for common species:						05	08				

SC Size Class
** Highly significant ($p \leq 0.01$)
* Significant ($p \leq 0.05$)
- Not significant ($p > 0.05$)
NA Not applicable, following the species grain, it indicates that while grain could be determined, the frequency of occurrence is too low to warrant inclusion in the model

In Tembe, ten species were evaluated (Table 14). The unit was dominated by a low stratum of *Dichrostachys cinerea, Strychnos madagascariensis, Terminalia sericea, Acacia burkei* and *Combretum molle*, while the canopy level was a mix of *Strychnos madagascariensis* and *Terminalia sericea*. Mean centroid 2 locations indicated some bias to the left, but there were large shifts in size classes between the positions of mean centroids 1 and 2. Only the populations of *Dichrostachys cinerea* could be compared between sites and they were similar (Table 6).

Grain of species and communities

The grain of species was noted for all species for which it was possible to identify grain by using the general model presented in Figure 1 (Figures 2 – 20). Most species that could be classified according to the grain model were fine-grained (Table 15), and therefore most vegetation units sampled here were considered fine-grained (Table 15). However, the Closed Woodland on Clay and Open Woodland on Sand of Tembe were intermediate-grained vegetation units, as were the Open Woodland on Abandoned Household sites unit in Manqakulane and the Closed Woodland Thicket in Tshanini. In contrast to the grain model presented by Lawes and Obiri (2002), the species for which grain could be established, but for which frequency of occurrence in the plots should have precluded their inclusion in the model, were also used to determine the woodland communities' grain.

Discussion

The woodlands of northern Maputaland are subjected to many different influences and it is obvious that man and wildlife have had a shaping influence. From the present results it appears that the main effect of both agents is an increase in the regeneration levels, and steeper species size class distribution curves, with a shortening of the range of the curves, especially with regards to the effect of man. This effect can most likely be linked to the opening of the canopies by man or large herbivores where the canopy opening stimulates the growth of lower strata, as documented in west, east and southern Africa for wildlife (Tafangenyasha 1997; Tedonkeng Pamo and Tchamba 2001; Mosugelo *et al.* 2002; Western and Maitumo 2004) and man (Lykke 1998; Schwartz and Caro 2003; Shackleton *et al.* 2005; Backeus *et al.* 2006)

In the case of Manqakulane, woody species re-growth is certainly not controlled by wildlife, as most species but the smallest antelopes have been hunted to local extinction (Guldemond and Van Aarde In Press), but also not by cattle and goats,

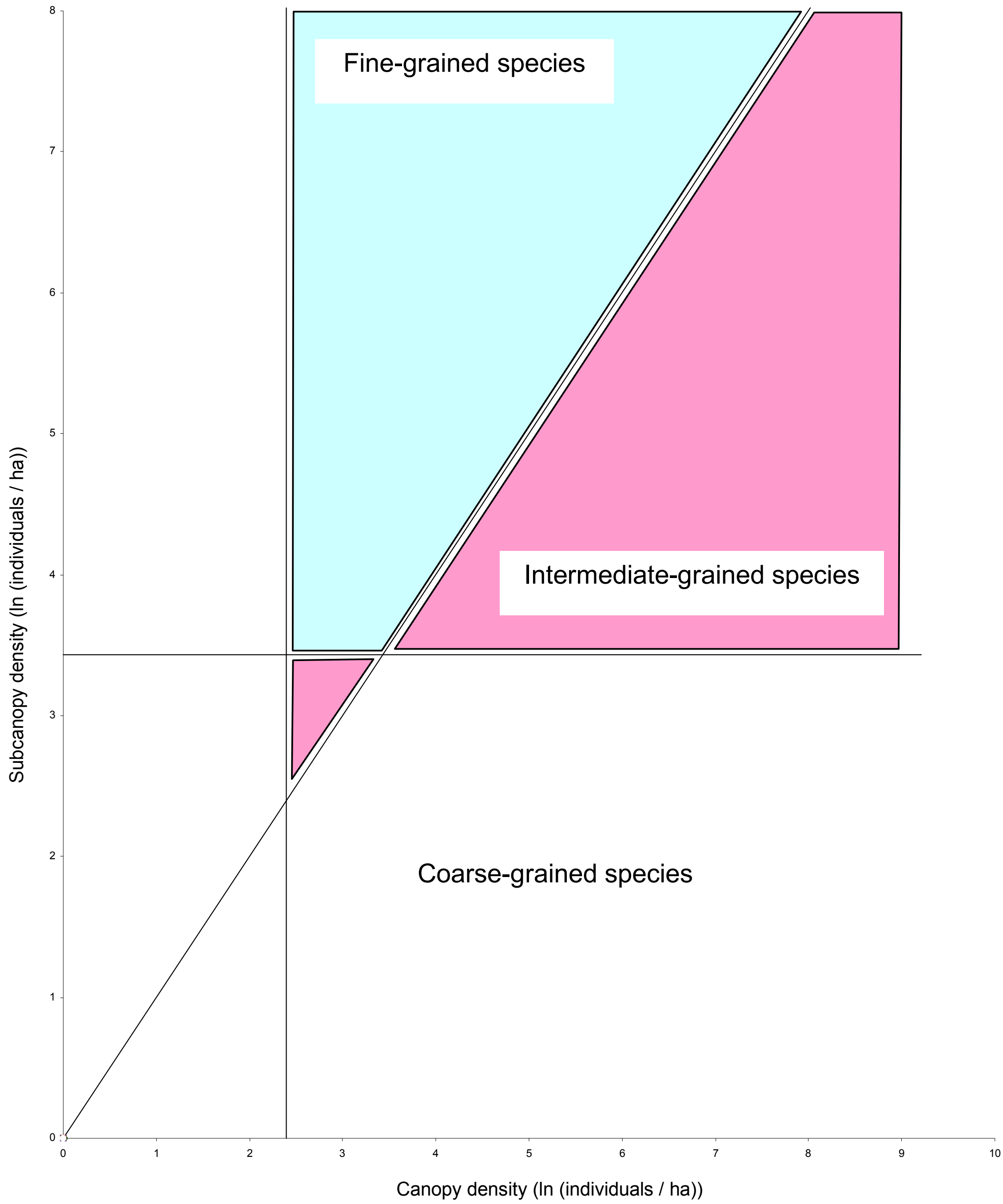

Figure 1: The graphical grain determination model based on canopy density (X-axis) and subcanopy density (Y-axis) used to evaluate tree species grain in the three study sites in KwaZulu-Natal, South Africa. Values are ln-transformed to improve readability. The model is adapted from Lawes and Obiri (2003).

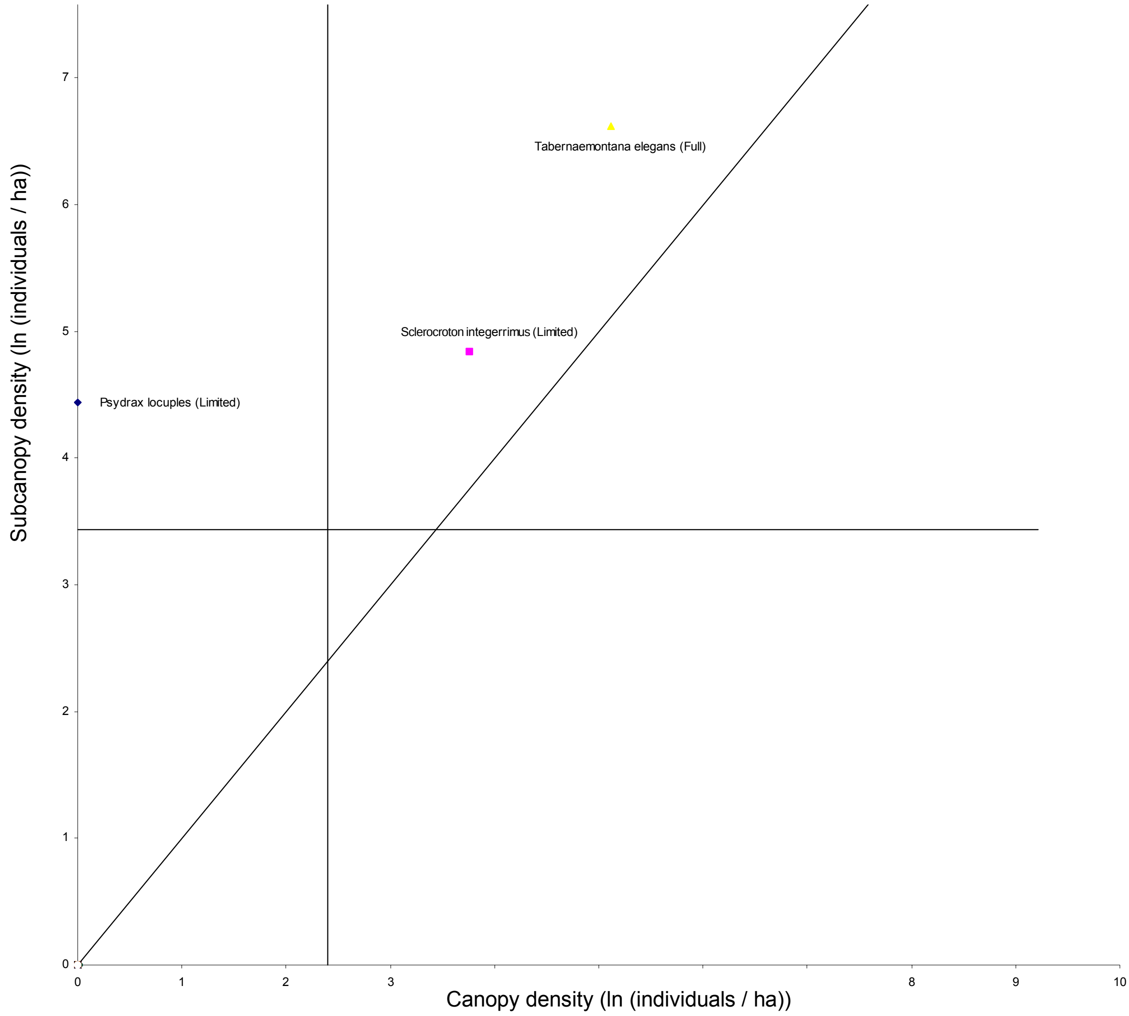

Figure 2: The grain of Closed Woodland Thicket woody species sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The full analysis represents species for which at least 30 individuals were sampled, while the limited analysis represents species for which only 10 to 29 individuals were sampled.

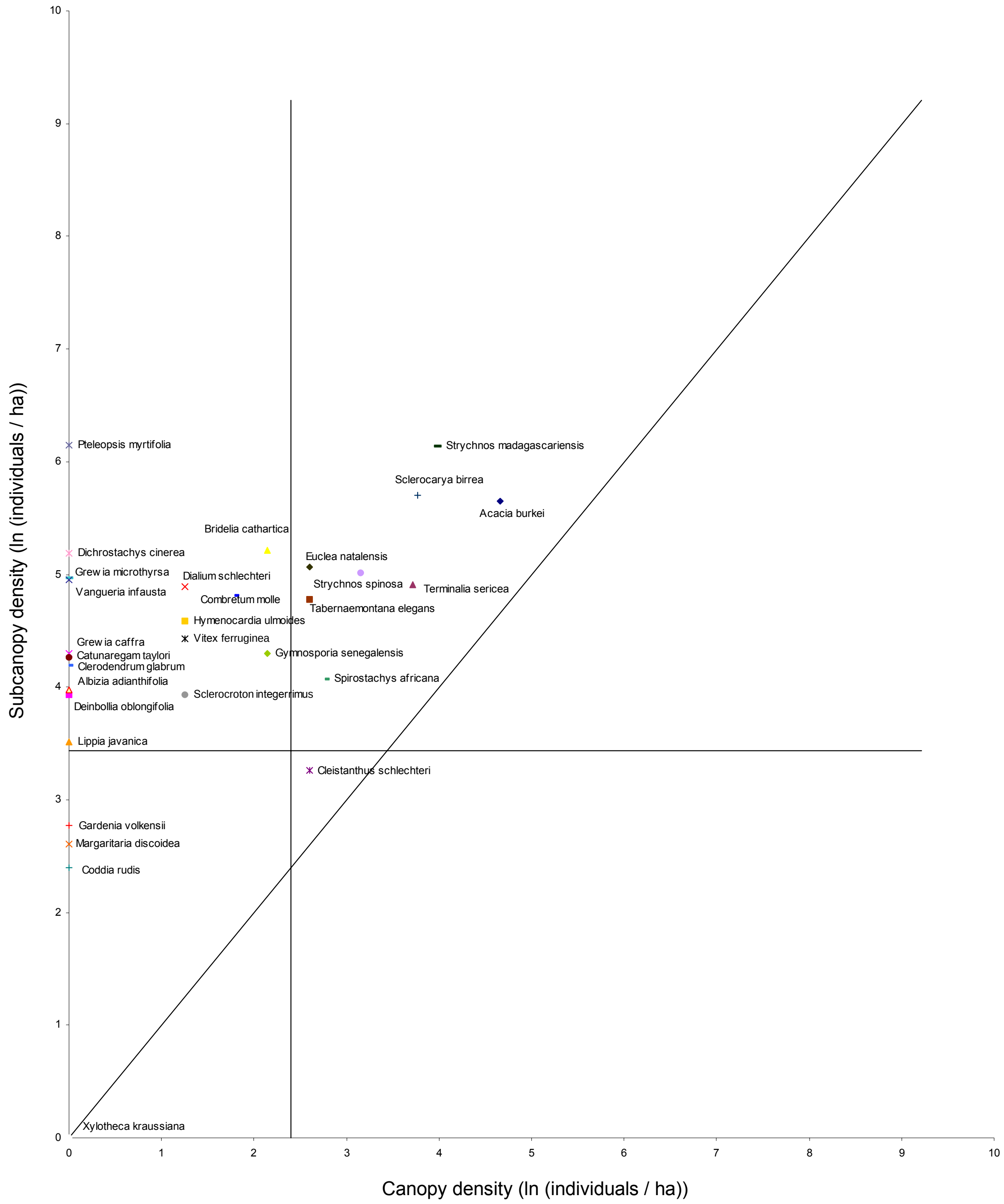

Figure 3: The grain of Closed Woodland Thicket woody species for which at least 30 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

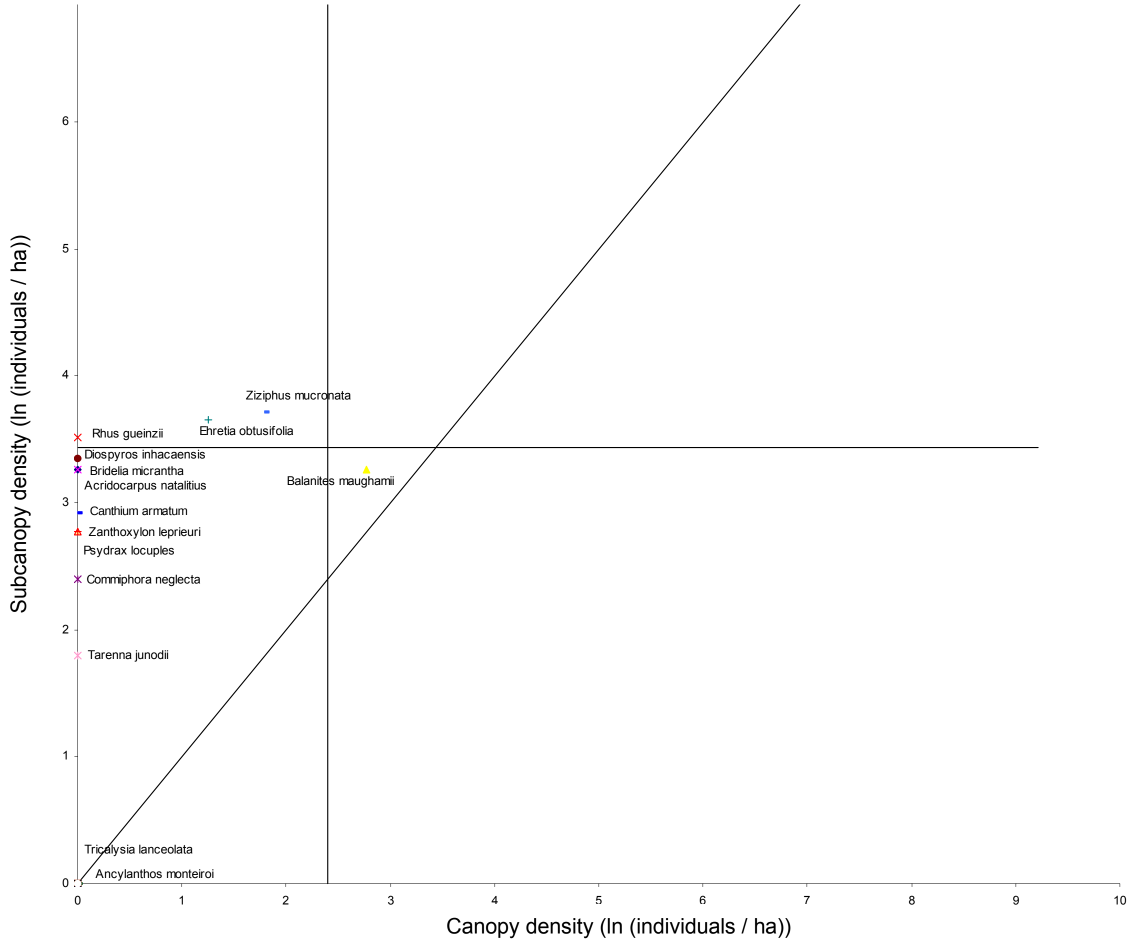

Figure 4: The grain of Closed Woodland Thicket woody species for which 10 to 29 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

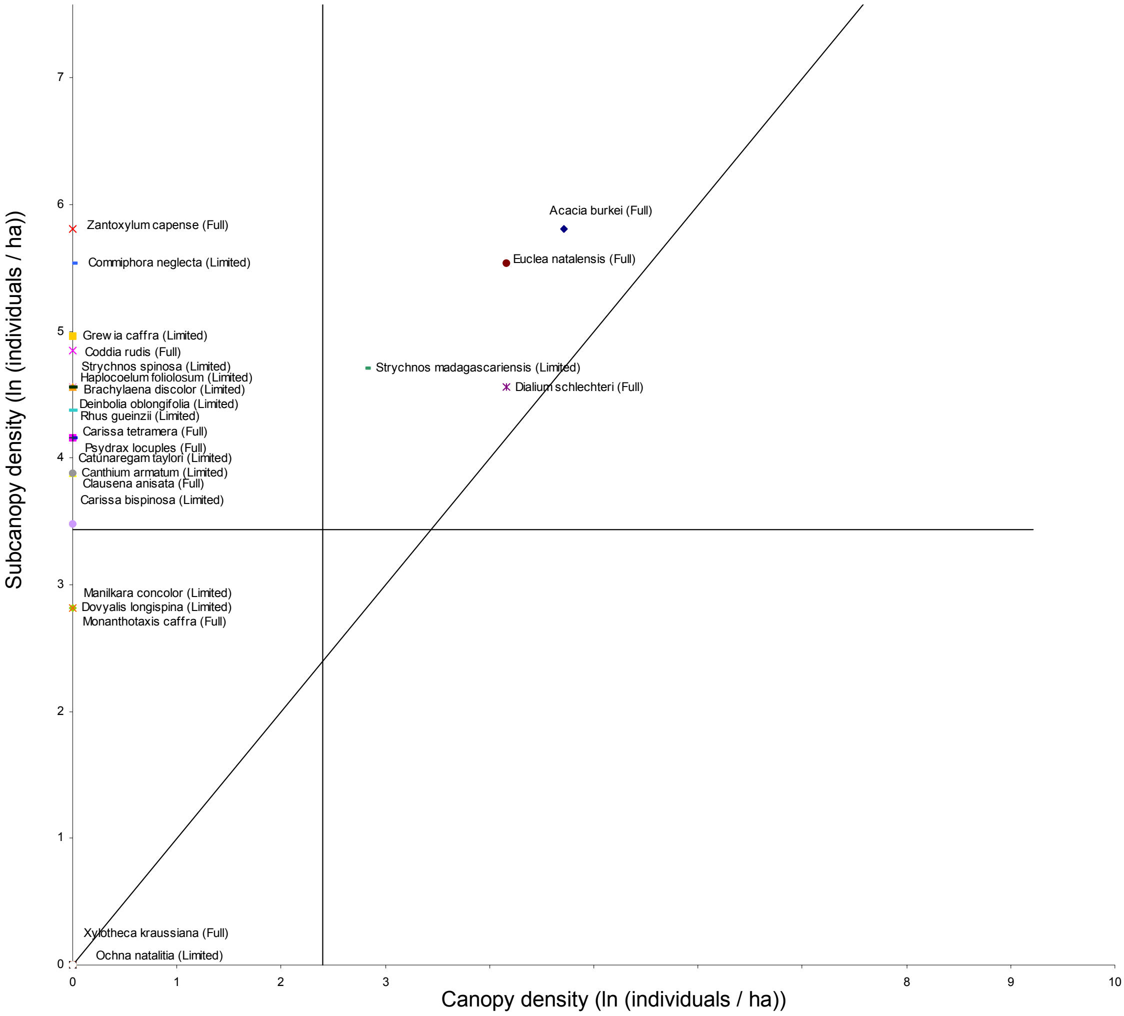

Figure 5: The grain of Closed Woodland Thicket woody species sampled in Manqakulane rural community village zone area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The full analysis represents species for which at least 30 individuals were sampled, while the limited analysis represents species for which only 10 to 29 individuals were sampled.

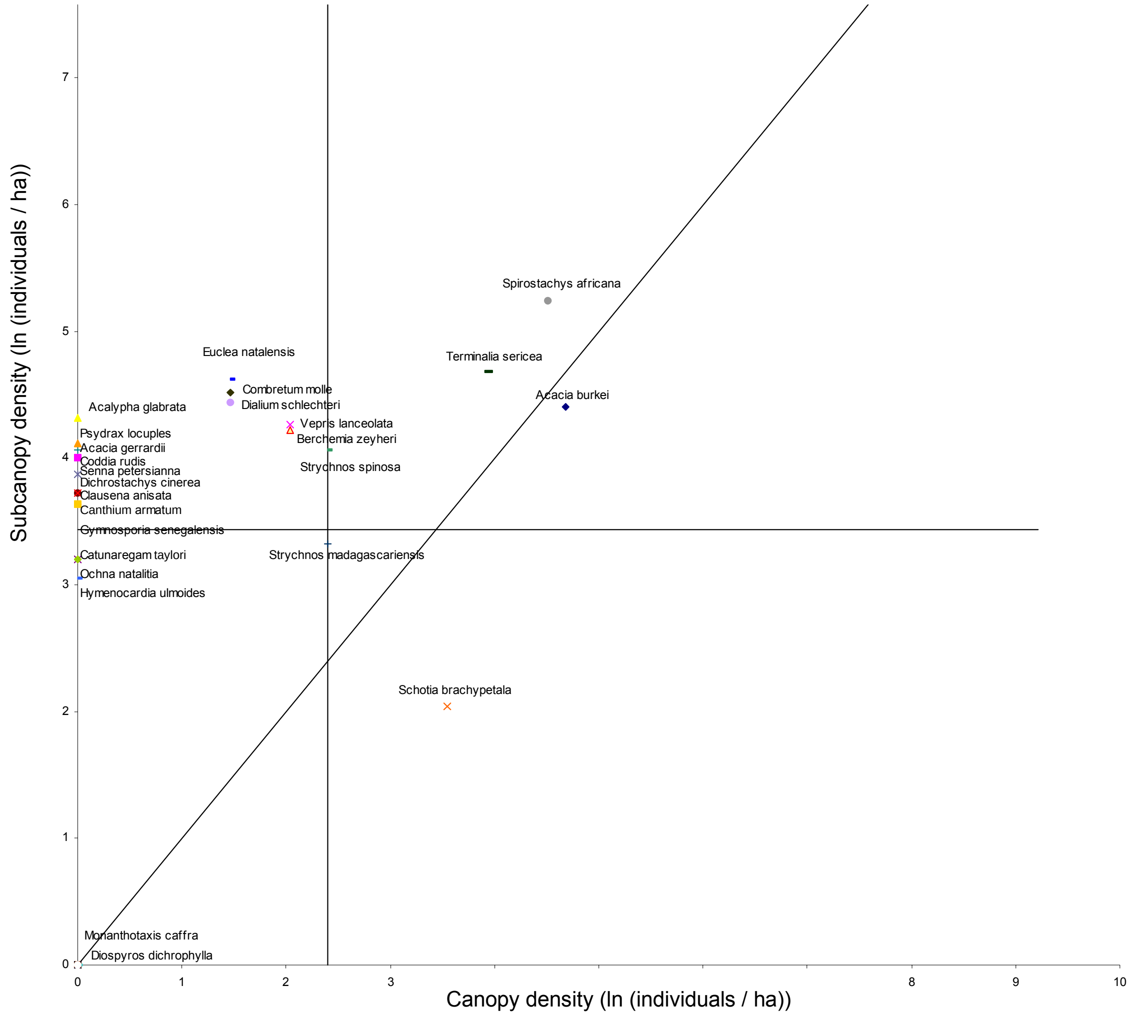

Figure 6: The grain of Closed Woodland on Clay woody species for which at least 30 individuals were sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

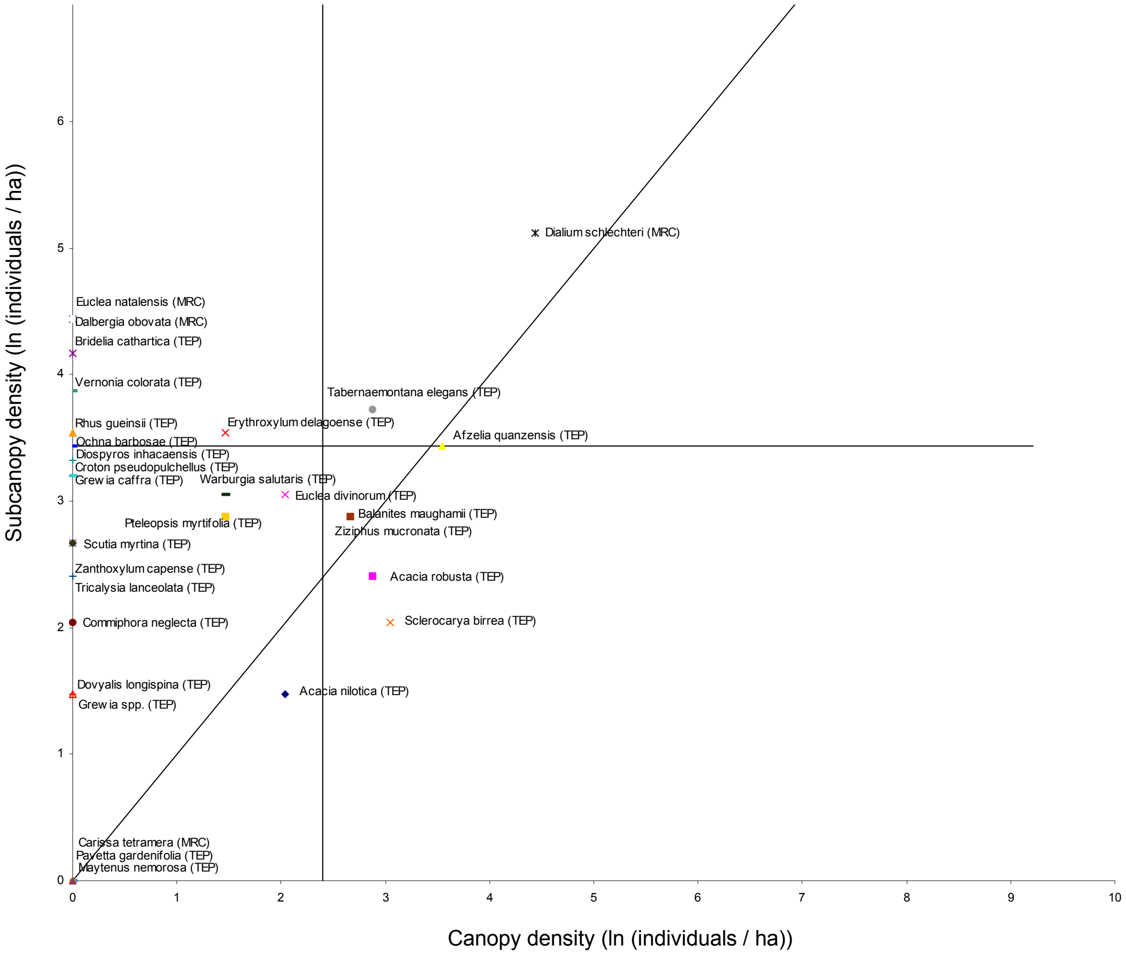

Figure 7: The grain of Closed Woodland on Clay woody species for which 10 to 29 individuals were sampled in Tembe Elephant Park (TEP) and Manqakulane Rural Community (MRC) village area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

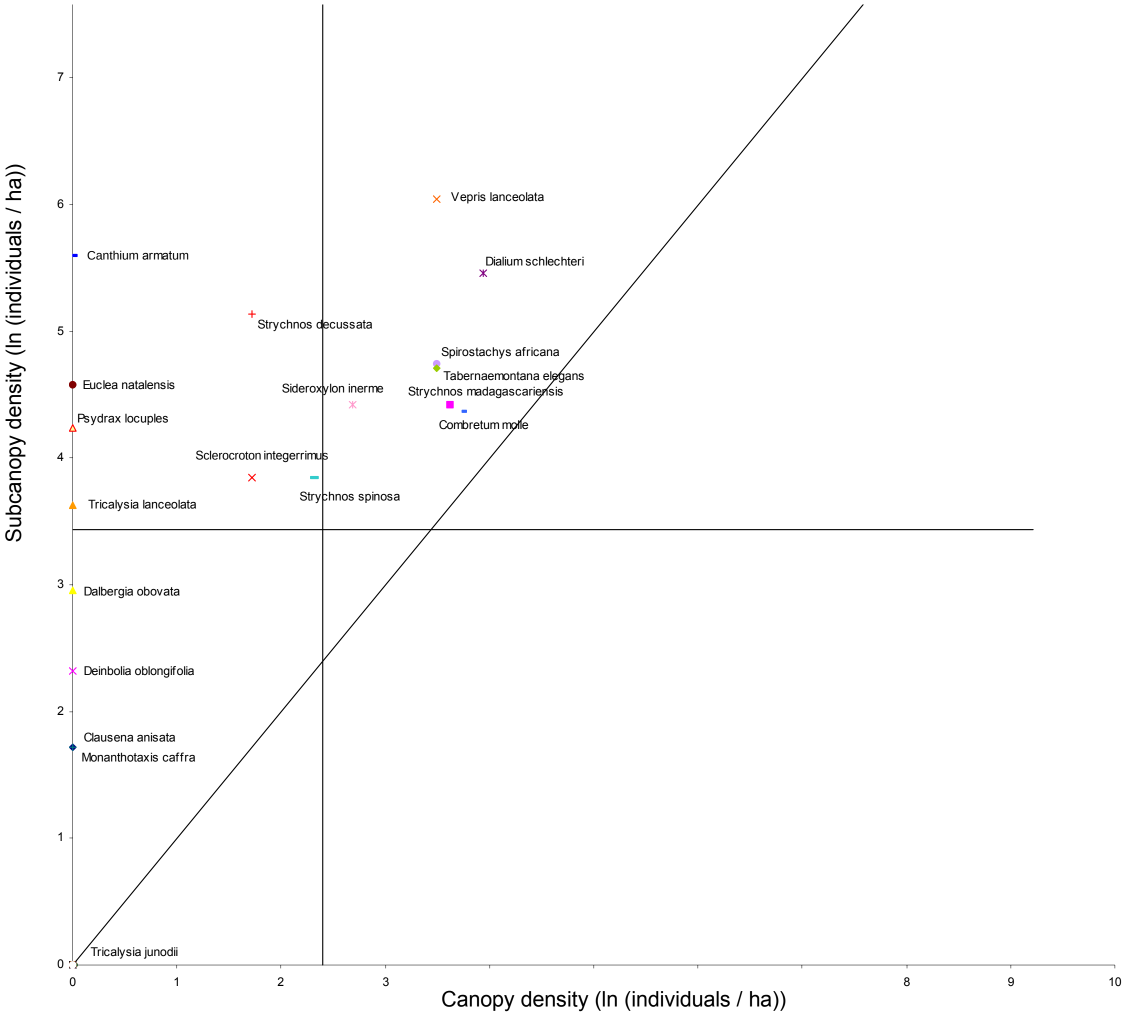

Figure 8: The grain of Closed Woodland on Sand woody species for which at least 30 individuals were sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

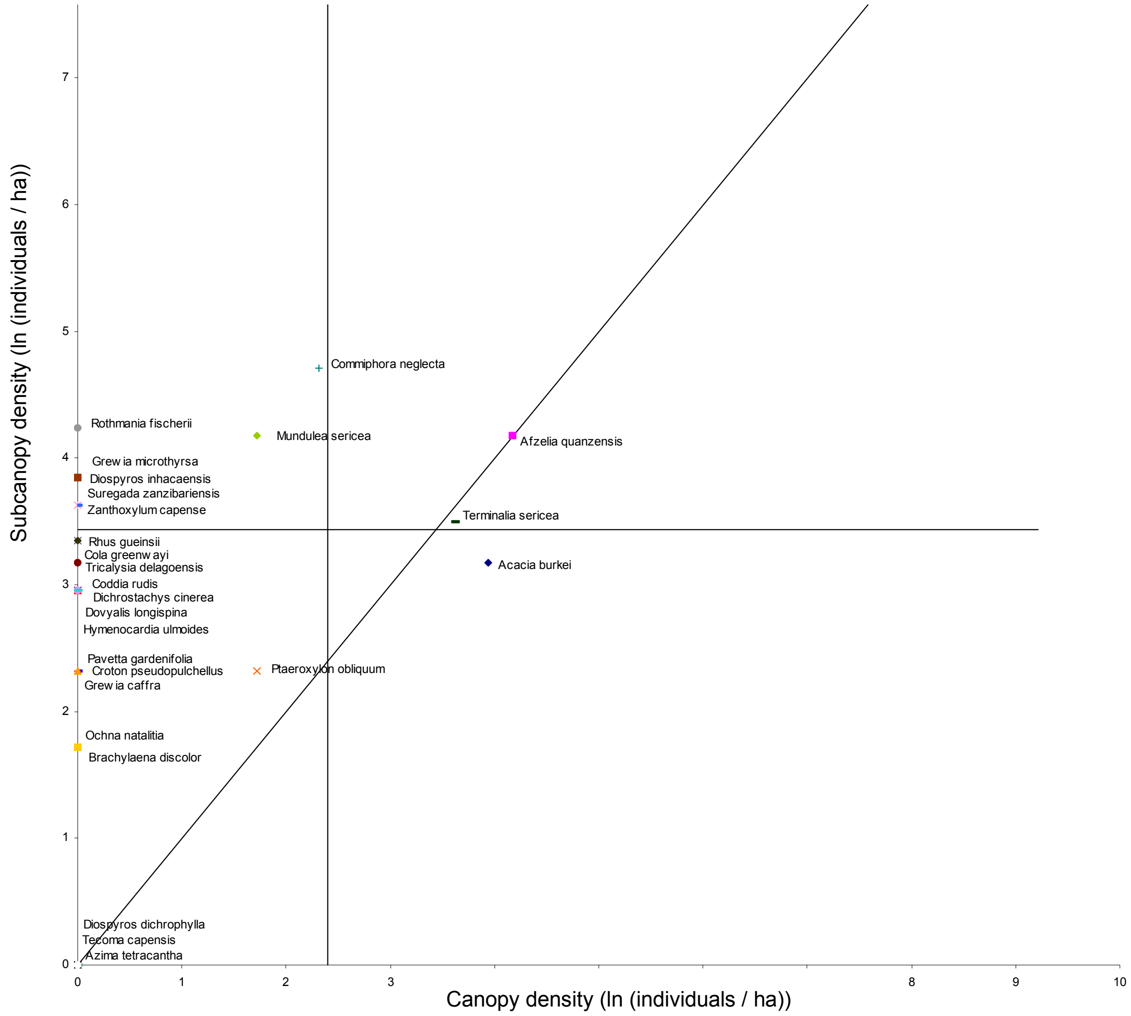

Figure 9: The grain of Closed Woodland on Sand woody species for which 10 to 29 individuals were sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

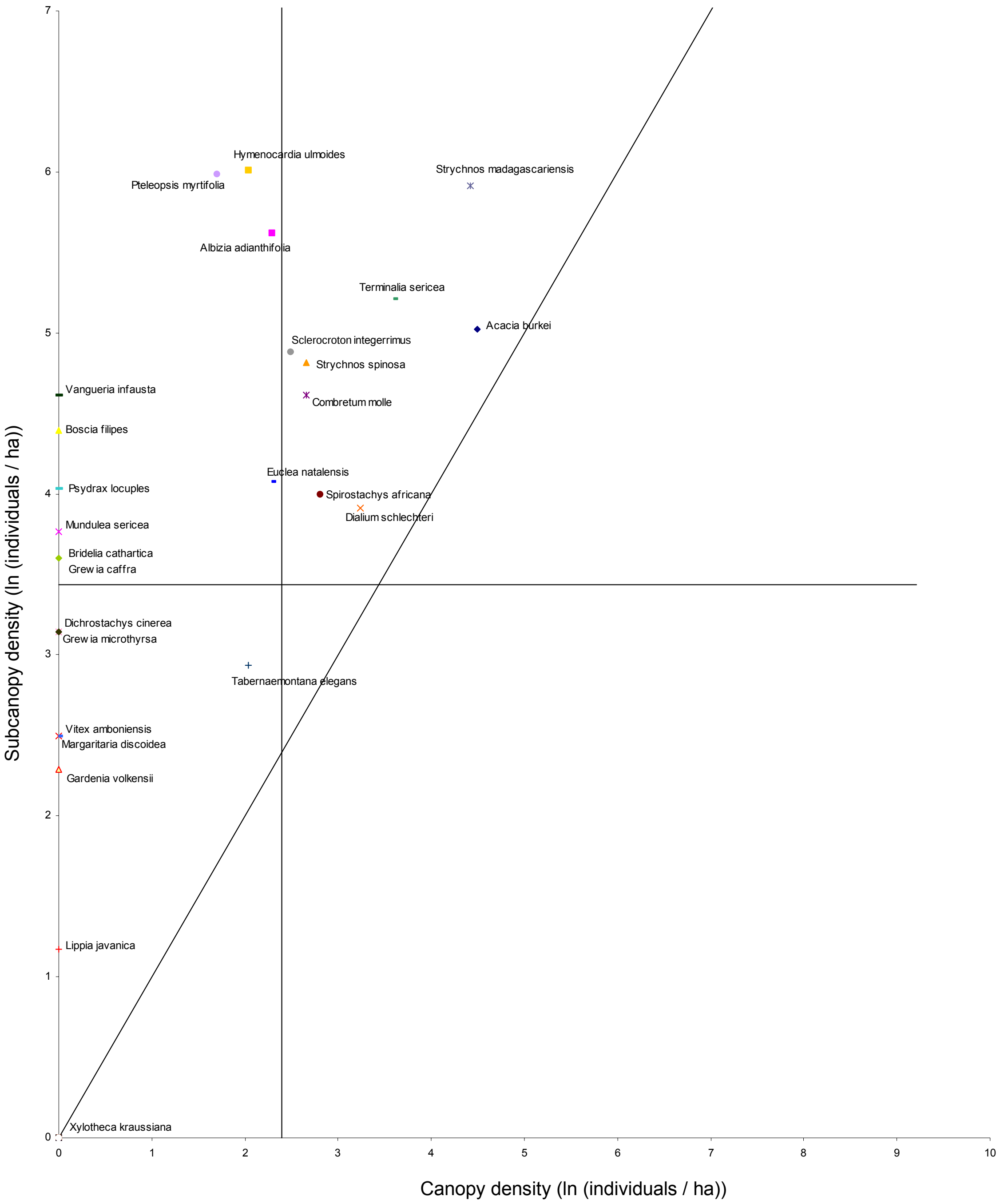

Figure 10: The grain of Closed Woodland on Sand woody species for which at least 30 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

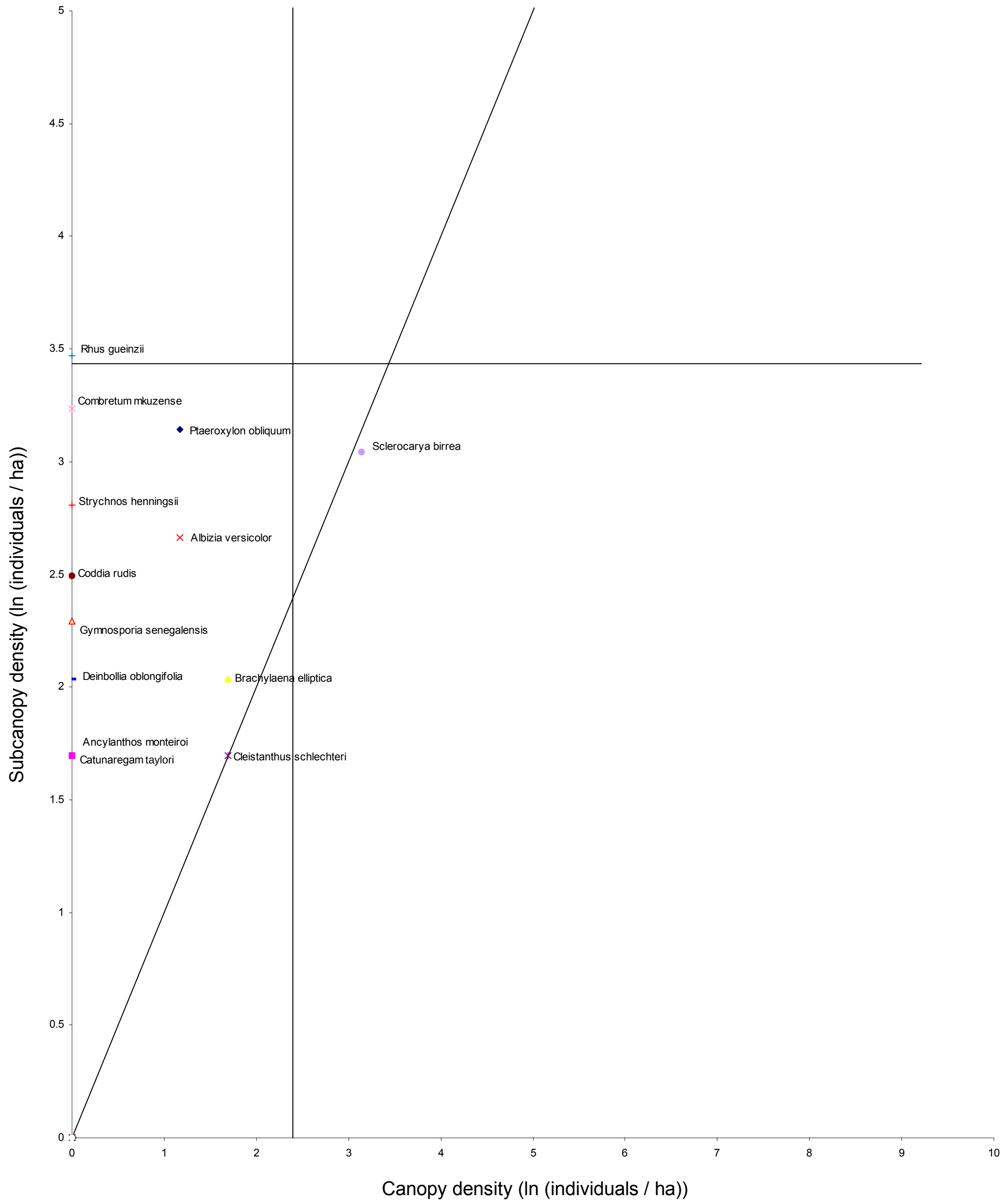

Figure 11: The grain of Closed Woodland on Sand woody species for which 10 to 29 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

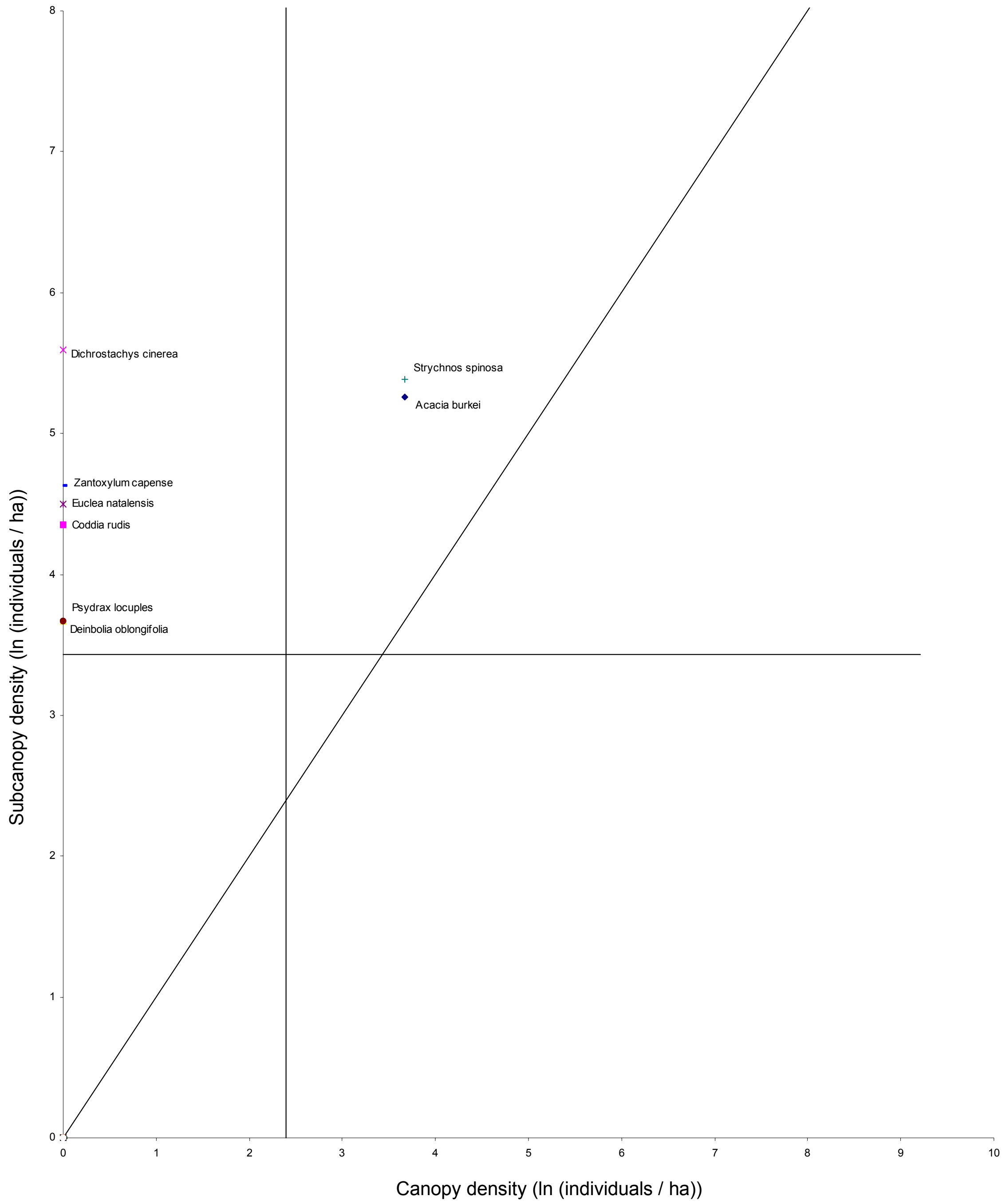

Figure 12: The grain of Closed Woodland on Sand woody species for which at least 30 individuals were sampled in the Manqakulane Rural Community village zone, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability.

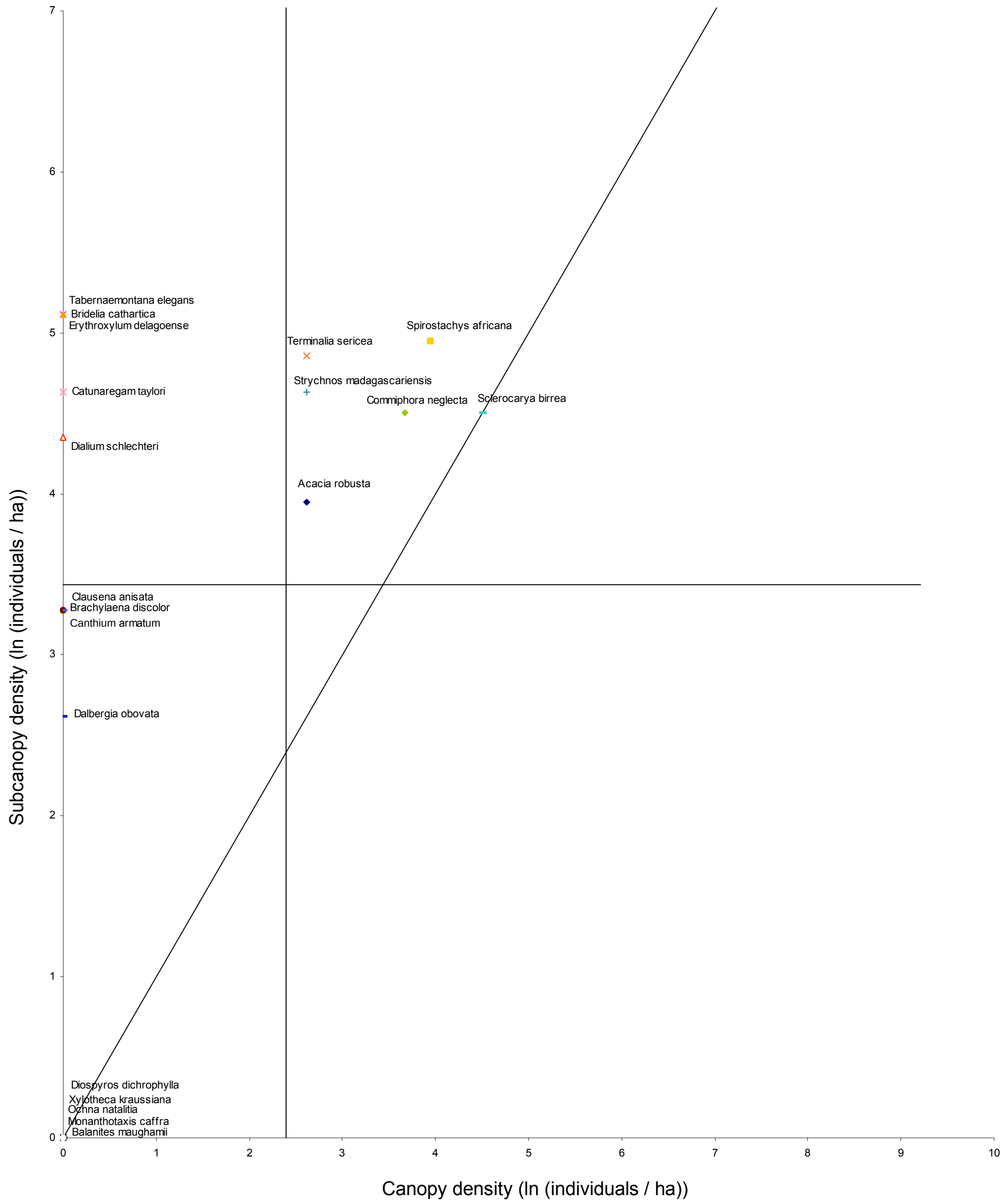

Figure 13: The grain of Closed Woodland on Sand tree species for which 10 to 29 individuals were sampled in the Manqakulane Rural Community village zone, KwaZulu-Natal, South Africa. Values have been In-transformed to improve readability.

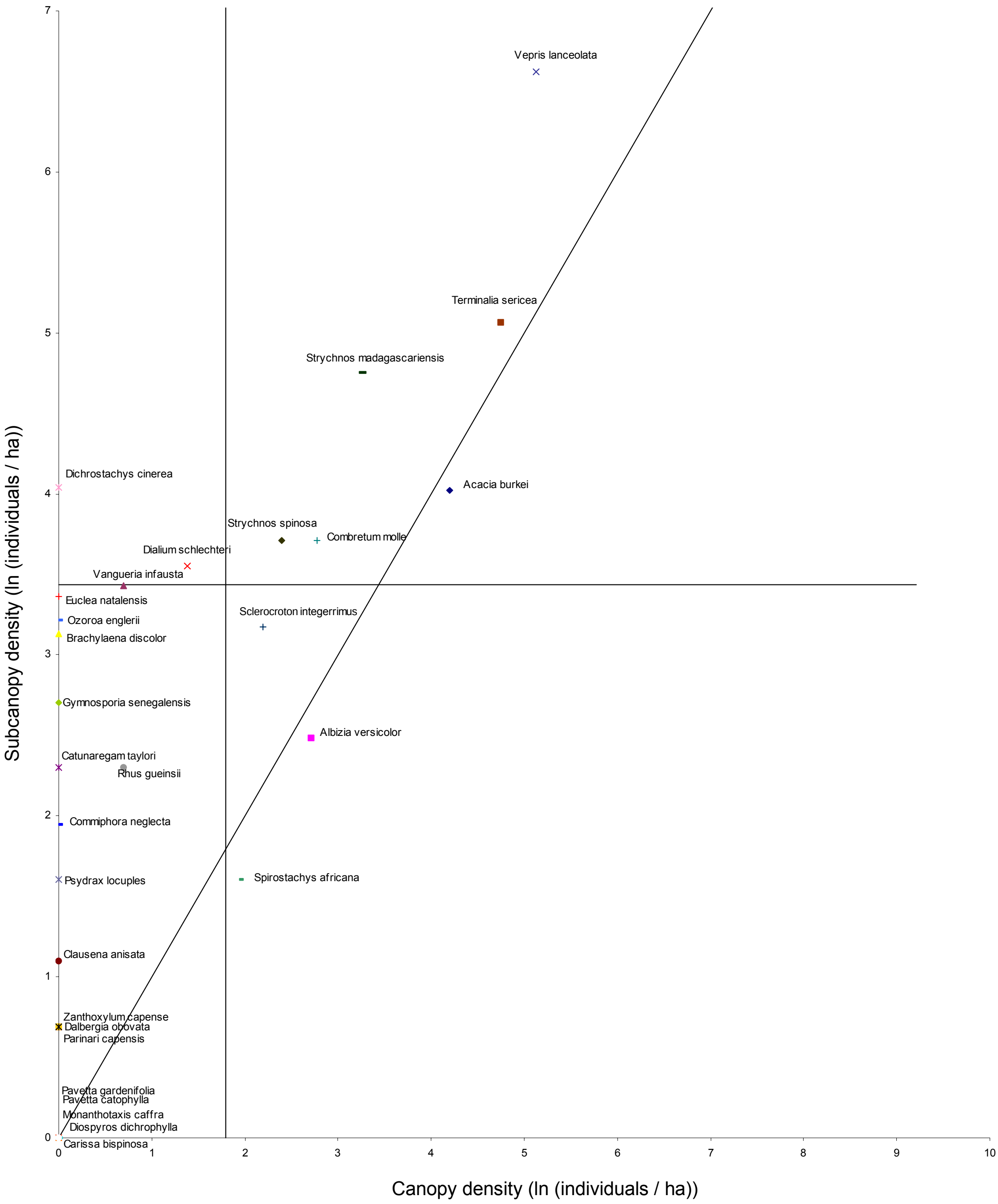

Figure 14: The grain of Open Woodland on Sand woody species for which at least 30 individuals were sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

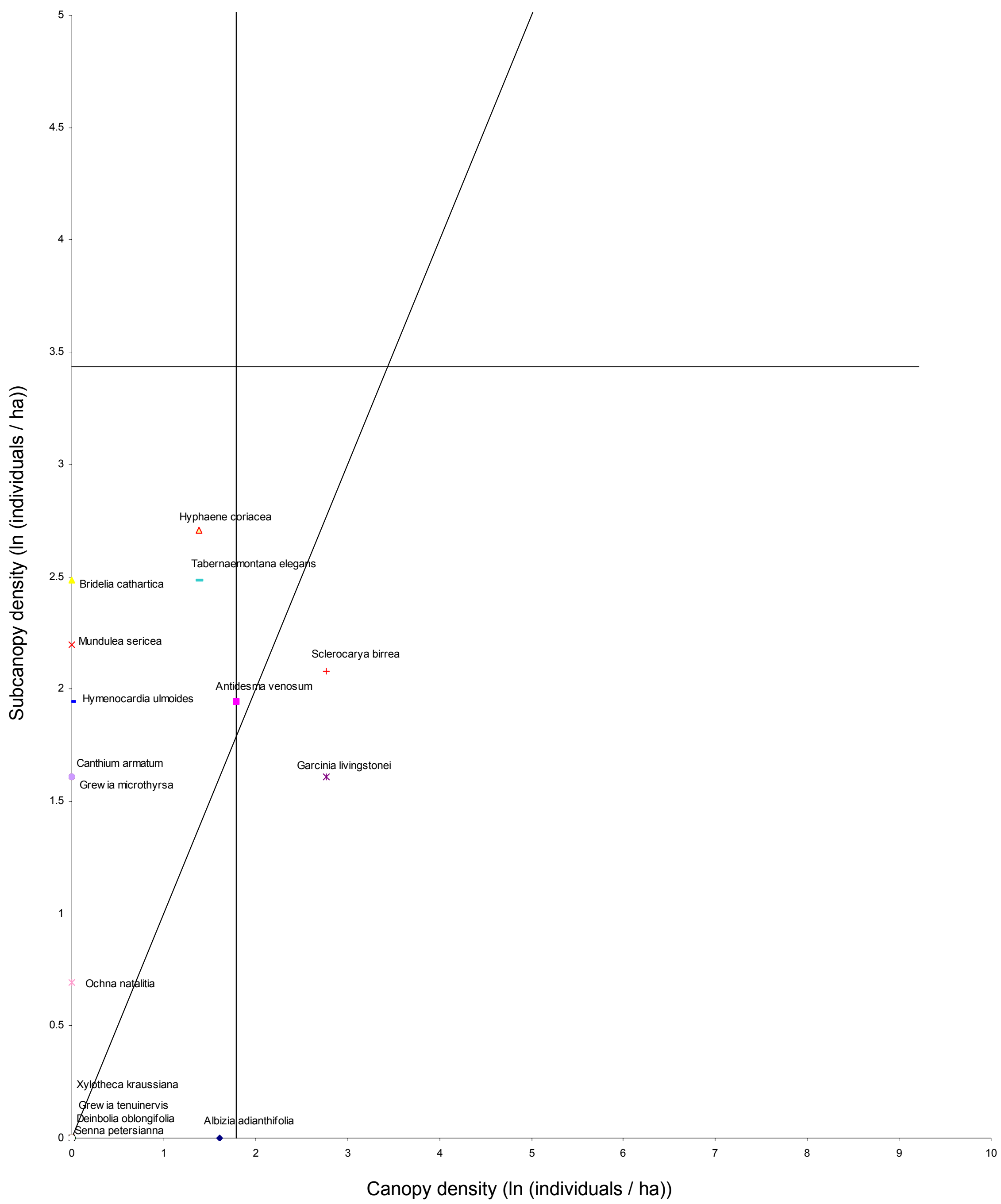

Figure 15: The grain of Open Woodland on Sand woody species for which 10 to 29 individuals were sampled in Tembe Elephant Park, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

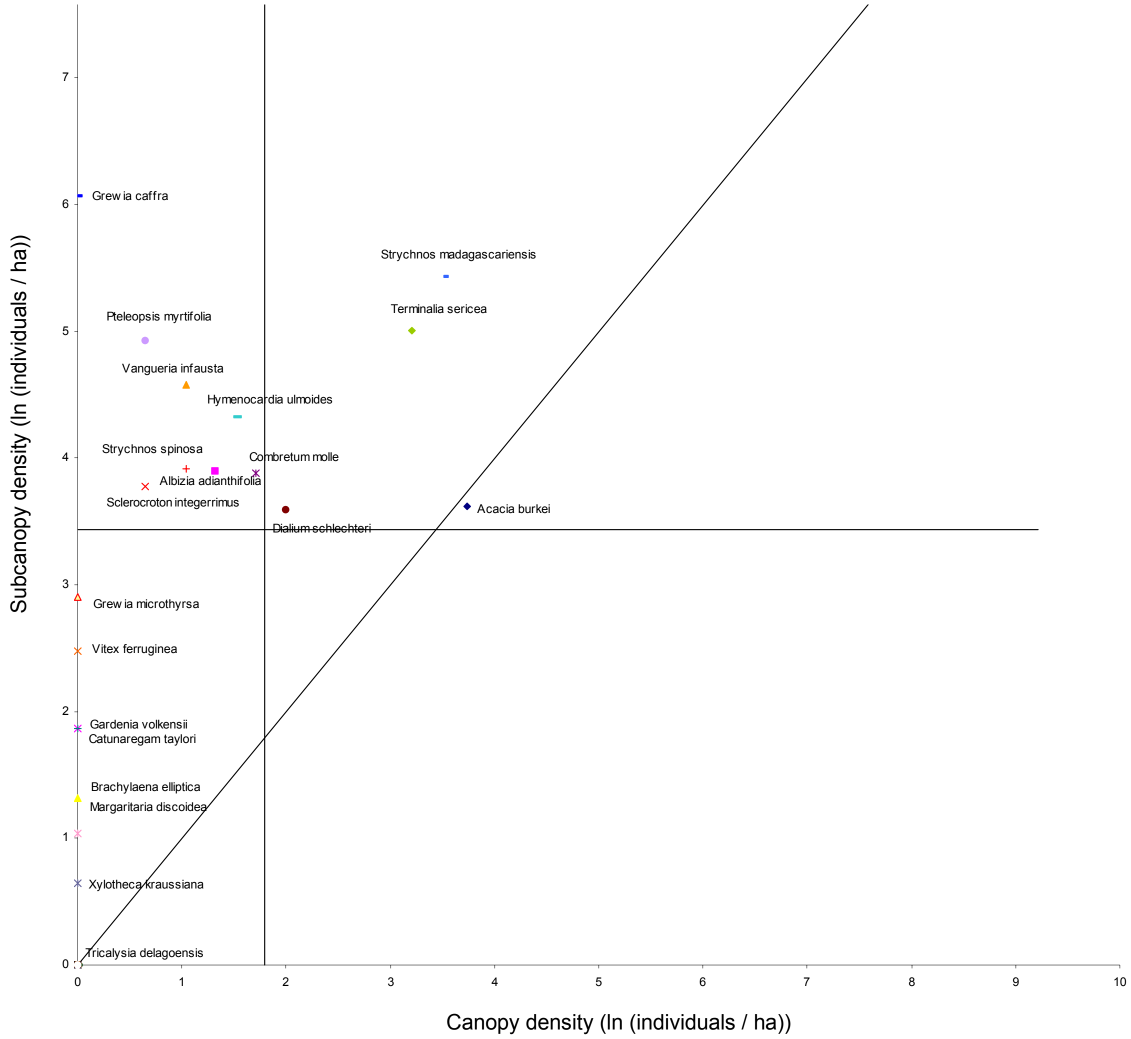

Figure 16: The grain of Open Woodland on Sand woody species for which at least 30 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

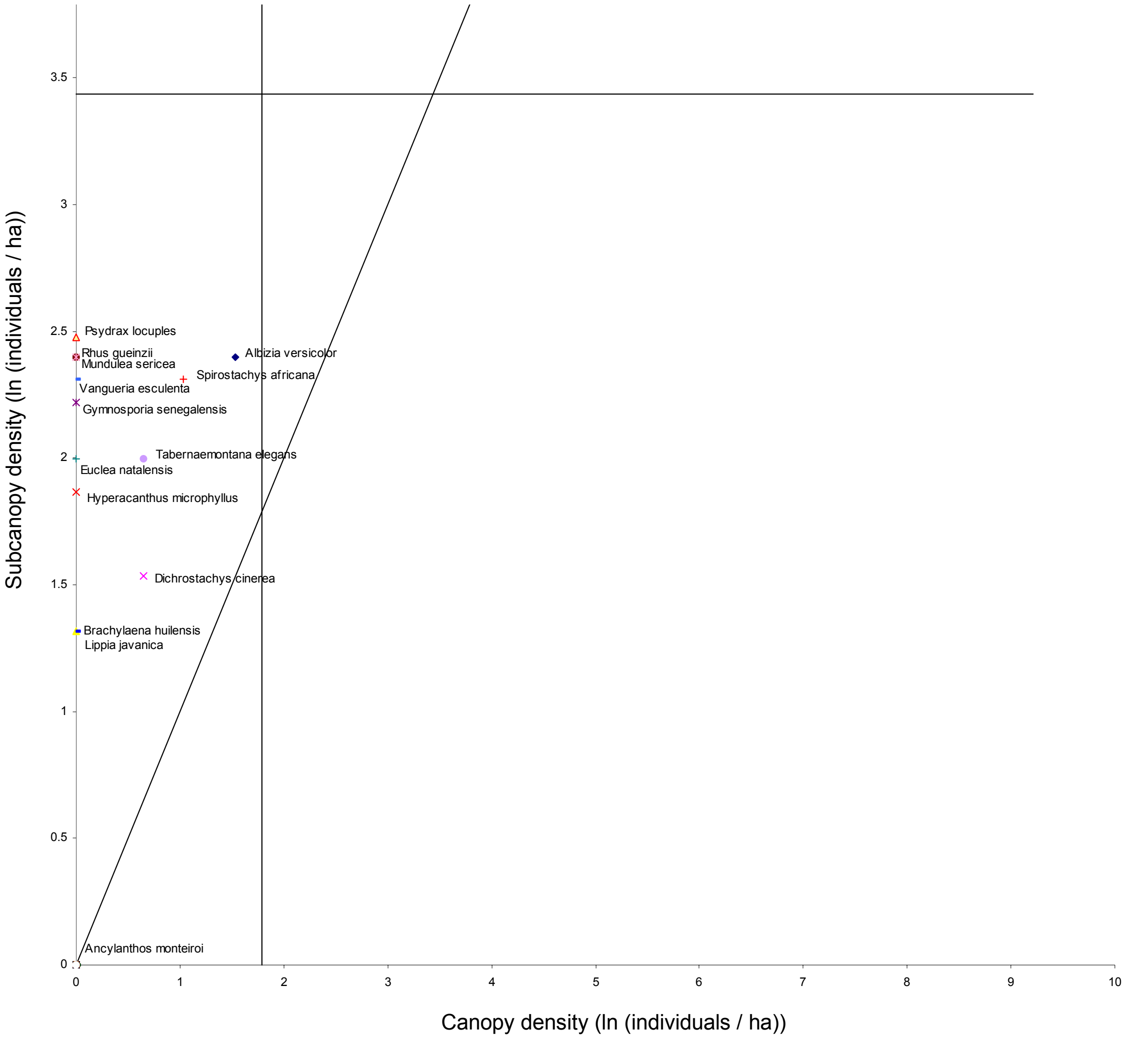

Figure 17: The grain of Open Woodland on Sand woody species for which 10 to 29 individuals were sampled in Tshanini Community Conservation Area, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

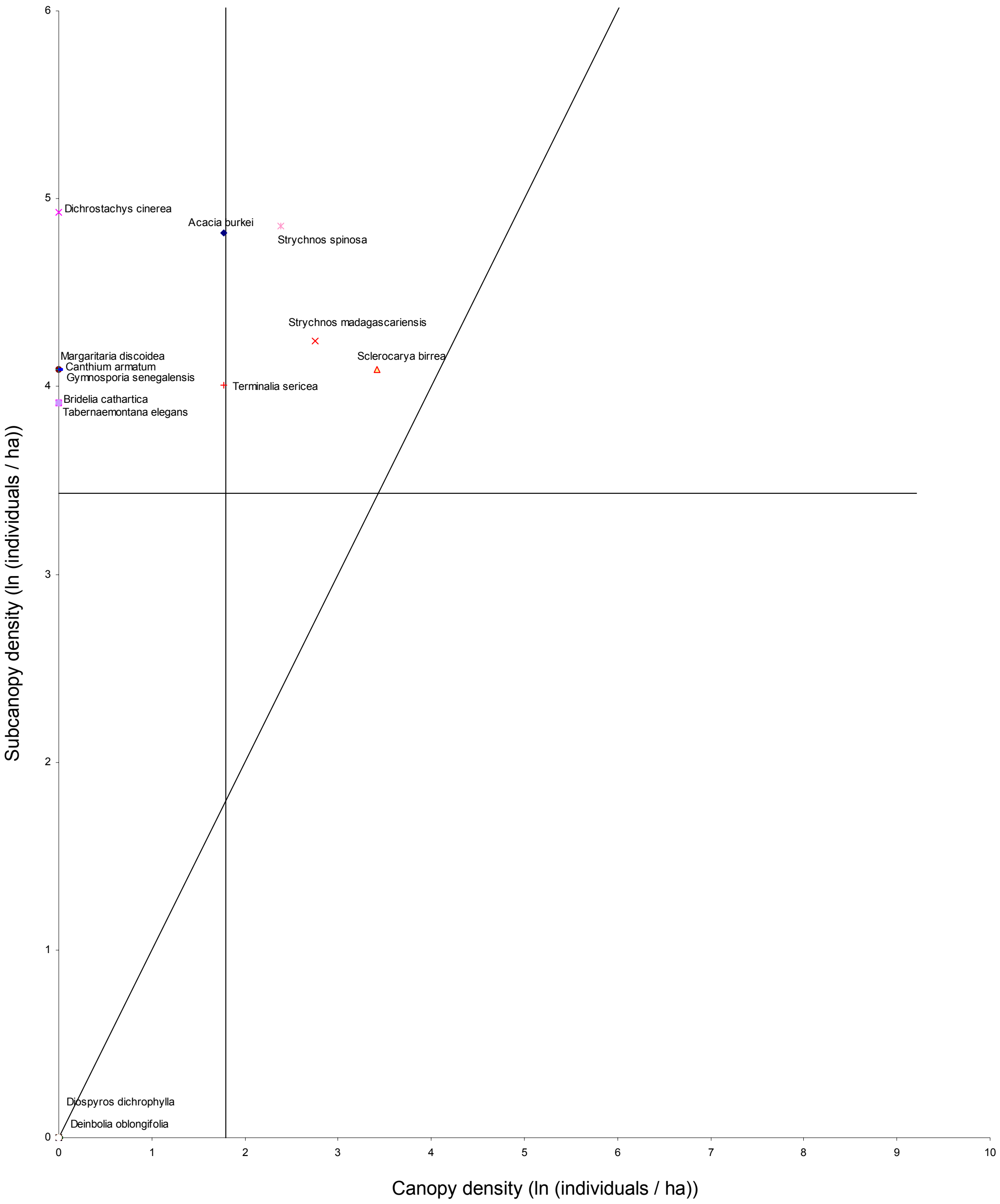

Figure 18: The grain of Open Woodland on Abandoned Household sites woody species for which at least 30 individuals were sampled in Manqakulane Rural Community village zone, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

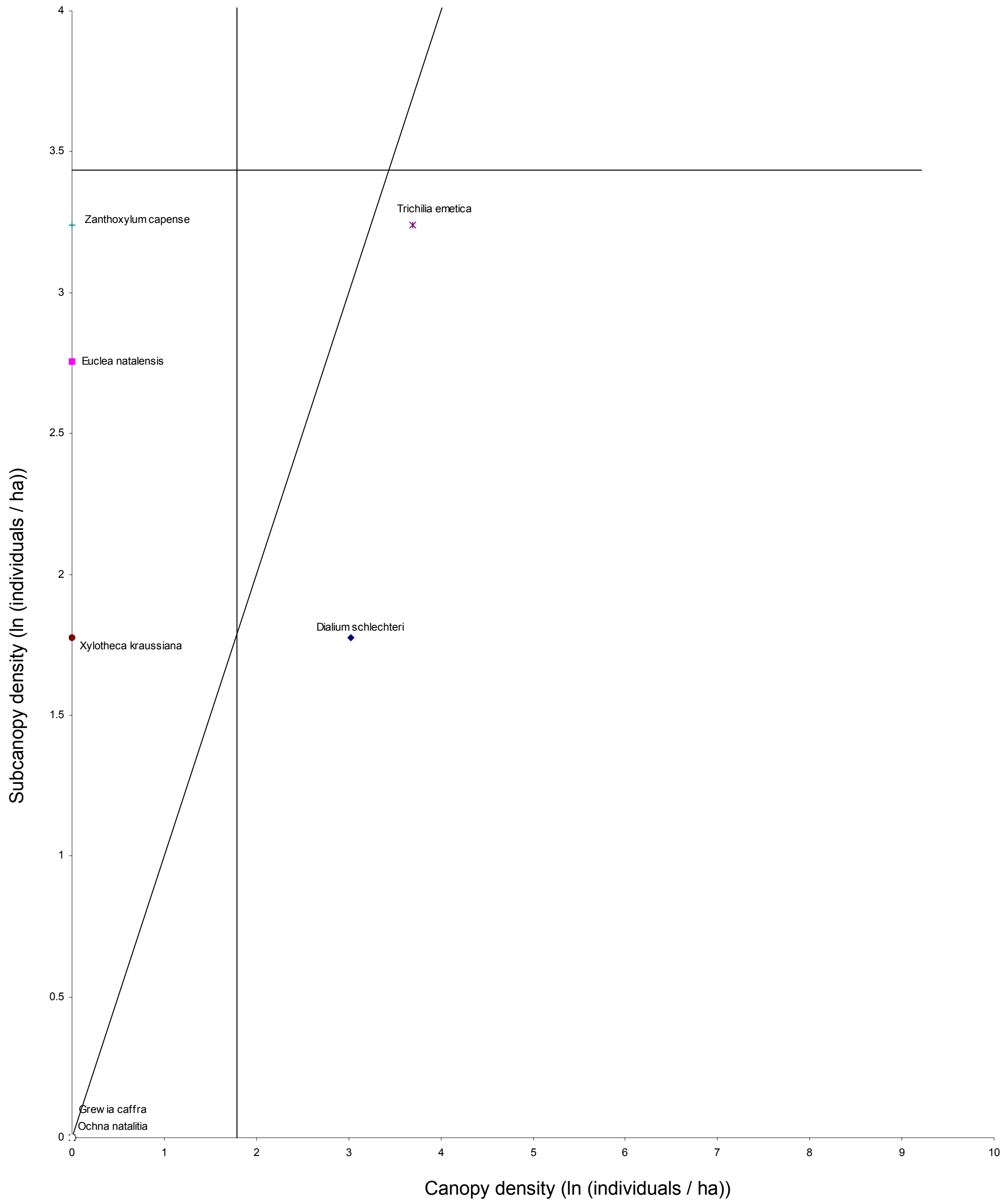

Figure 19: The grain of Open Woodland on Abandoned Household sites woody species for which 10 to 29 individuals were sampled in Manqakulane Rural Community village zone, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 5 individuals per ha.

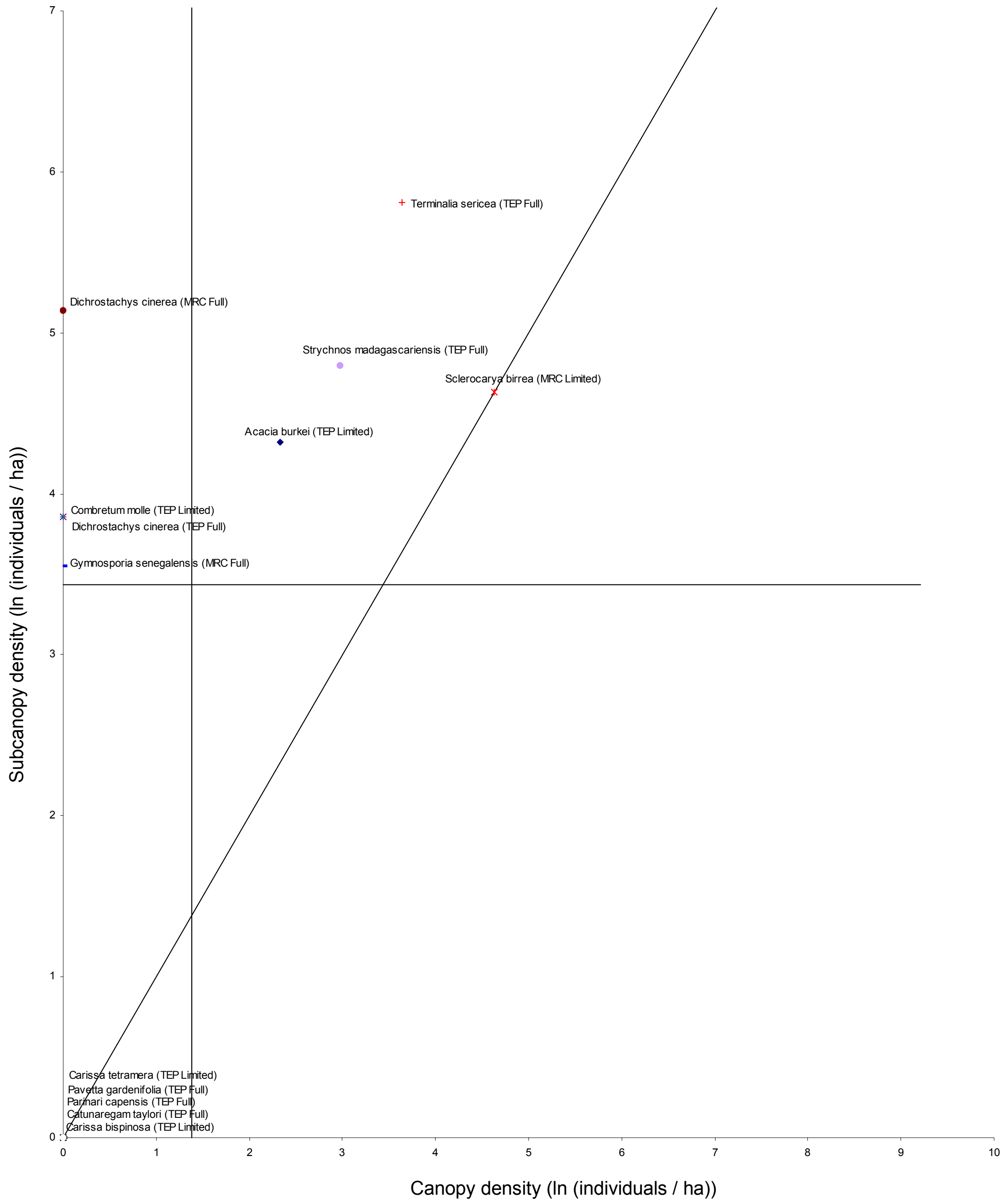

Figure 20: The grain of Sparse Woodland on Sand woody species sampled in the Tembe elephant Park (TEP) and Manqakulane Rural Community (MRC) village zone, KwaZulu-Natal, South Africa. Values have been ln-transformed to improve readability. The lower boundary for canopy density has been relaxed to 3 individuals per ha. The full analysis represents species for which at least 30 individuals were sampled, while the limited analysis represents species for which only 10 to 29 individuals were sampled.

Table 15: The number of species by grain category and the derived community grain for the various vegetation units of Tshanini Community Conservation Area (TCCA), the Manqakulane Rural Community village zone (MRC) and Tembe Elephant Park (TEP), Maputaland, northern KwaZulu-Natal, South Africa

Grain	Number of species per grain category by vegetation units and sites													
	Closed Woodland Thicket			Closed Woodland on Clay		Closed Woodland on Sand			Open Woodland on Sand			Open Woodland on abandoned household site	Sparse Woodland on Sand	
	TEP	TCCA	MRC	TEP	MRC	TEP	TCCA	MRC	TEP	TCCA	MRC	MRC	TEP	MRC
Fine	2	1	4	3	1	3 (5)	7 (1)	7 (1)	4 (1)	3	0	3	3	1
Intermediate	0	0 (2)	0	1 (3)	0	0	0	0	1 (2)	1	0	0	0	0
Coarse	0	0	0	0 (2)	0	1	0	0	0 (4)	0	0	2	0	0
	Derived status of the vegetation unit or sub-unit													
Fine	X	-	X	-	X	X	X	X	-	X	-	-	X	X
Intermediate	-	X	-	X	-	-	-	-	X	-	-	X	-	-
Coarse	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: The numbers between brackets correspond to the number of species for which grain was determined but where frequency of occurrence precluded their inclusion in the grain model which occur in low numbers as the climate appears unfavourable for the latter, and better cattle grazing fields occur in the hygrophilous grasslands further east (Gaugris 2004; Matthews 2006; Peteers 2005; Gaugris *et al.* 2007). The strong influence of seedlings and saplings on the shape of the curves as indicated by the shifts in centroid positions as well as the steepness of the slopes (Niklas *et al.* 2003) can be attributed to the absence or low abundance of limiting mammalian herbivores and the presence of man. Of note is that many large trees remain in Manqakulane, especially those species that provide fruit or shade. This could be explained by the reluctance to cut these trees, a fact documented in rural areas of west, central and east Africa (Lykke 1998; Luoga *et al.* 2002; Banda *et al.* 2006b) but also in South Africa (Shackleton *et al.* 2005). However, there appears to be a gap between the lower size classes and the larger ones, which corresponds to the size classes utilised for household building observed in this rural community (Gaugris *et al.* 2007). While untested in the present study, the link is obvious, and documented by other studies (Obiri *et al.* 2002; Boudreau *et al.* 2005).

In Tembe, the influence of mammals is more difficult to discern than that of man in Manqakulane, but differences appear in terms of centroid locations. In general, the Tembe woodland sites have populations of woody species with a centroid either slightly biased to the left or in a central position of the SCD range. This indicates mature populations (Niklas *et al.* 2003). However, a shift of at least two size classes frequently observed in mean centroids 1 and 2 positions shows some influence from seedlings and saplings on the curve shape, indicating that recruitment is potentially stimulated (Everard *et al.* 1995; Lykke 1998; Niklas *et al.* 2003) in a more active manner than in the Tshanini site where the shift was usually only one size class. Because the sites are geographically so close to each other, climatic conditions are considered similar (see Yeh *et al.* 2000), and because human influence in Tshanini and Tembe is controlled (Gaugris 2004; Matthews 2006), the remaining shaping agents for Tembe and Tshanini woodlands are either herbivores or fire.

The centroid location biased to the right means that many large individuals contribute to the population structure (Niklas *et al.* 2003). In Tembe this statement could be biased due to the fact that a range of the smaller size classes must be utilised by herbivores or removed by fire, thus reducing the influence of smaller size classes on the centroid location. This bias in Tembe appears possible because in the absence of animals in Tshanini, the centroids for that site are biased to the left with little influence from seedlings and saplings to the curve shapes as evidenced by the minimal changes in centroid positions between the two analyses. Fire as shaping agent occurs in both Tshanini and Tembe, although at a higher frequency in the former (Gaugris *et al.* 2004;

Matthews 2006; Guldemond and Van Aarde In Press). But as it appears to have little effect on the population curves in Tshanini (seedling germination and sapling growth can also be induced by fire events (Barnes 2001; Ickowitz 2006)), it appears possible to deduce that its effect in Tembe should be similar, and therefore that animals are most likely the shaping agent in Tembe. This impression is reinforced by the case of some species that seem to be on the verge of disappearing in Tembe (especially in the Open Woodland on sand vegetation unit), whereas populations of the same species in Tshanini are healthy. If this trend continues Tembe faces the risk that herbivores, and especially elephants, will bring some species to local extinction by repeated utilisation, as has been documented elsewhere (Guldemond and Van Aarde In Press; O'Connor *et al.* 2007).

In general, species in Tshanini are healthy and regenerating well, even those species classified within Type 3 have fairly high densities at both subcanopy and canopy levels. The species of Type 3 are usually found within the limited analysis and often grow into large trees. Large, long-lived (>200 years) woody species are known to establish a strong canopy level and a sufficient but somewhat episodic recruitment through the subcanopy (Everard *et al.* 1994; Everard *et al.* 1995; Peters 1996; Condit *et al.* 1998; Burslem and Whitmore 1999), which could therefore explain the flat or even positive slopes, indicating both long-term scales of regeneration and mature species (Lykke 1998; Niklas *et al.* 2003). These species are by nature less numerous than others as only a few large trees are necessary to form a closed canopy (Peters 1996; Burslem and Whitmore 1999), and the fact that they were classified within the limited analysis does not appear to warrant a particular concern.

The evaluation of grain of species undertaken in the present study contributes some interesting views. However, some limitations of the use of the model must be stated, as it was not used in the classical way. The model was tentatively applied to woodlands by Gaugris (2004) in Tshanini during a previous study and its application to woodlands therefore remains largely invalidated. In addition, the concept was here divided in two aspects, the grain of the unit was defined by all species where grain could be determined, and therefore did not take into consideration the frequency of occurrence as required in the forest application (Lawes and Obiri 2003). The frequency of occurrence is here only considered of interest for utilisation purposes, which are discussed below. Another restriction applies, in the sense that unit grain rests on a few species for which grain is determined, and it may therefore lead to wrong assumptions in some instances.

Species grain should preferably always be evaluated in conjunction with the size class distributions (Obiri *et al.* 2002; Lawes and Obiri 2003). A wealth of Type 1 species and an abundance of the same species at both subcanopy and canopy levels define fine-grained vegetation communities in forests (Everard *et al.* 1994; Everard *et al.* 1995). As such, the fine-grained character of some of the vegetation units evaluated here could be fairly conclusively shown (Tables 3 and 15). The implications of fine-grain forests are that natural processes of regeneration of shade-tolerant species are based on small-scale processes, and therefore that regular small-scale disturbance is required to maintain the vegetation structure (Midgley *et al.* 1990; Everard *et al.* 1994; Everard *et al.* 1995; Obiri *et al.* 2002; Lawes and Obiri 2003). Coarse-grained species are on the other side of the scale, and regenerate poorly under frequent small scale disturbance regimes, but rather require relatively frequent large scale disturbance, such as the opening of large gaps, to maintain their populations (Midgley *et al.* 1990; Everard *et al.* 1994; Everard *et al.* 1995; Obiri *et al.* 2002; Lawes and Obiri 2003). Given the absence of disturbance, coarse-grained forests are thought to evolve into fine-grained ones as shade-tolerant species progressively replace the shade-intolerant ones (Everard *et al.* 1994; Everard *et al.* 1995).

Closed Woodland units of Tshanini have been recognised as forest like (Gaugris 2004; Gaugris *et al.* 2004), and it is expected that the grain model should therefore work well when applied to the Closed Woodland units in general. However, a problem occurs for the grain theory in the case of Open and Sparse Woodland units, where the gap concept that drives grain theory would not be relevant anymore. The gap concept relies on the assumption that there are gap-demanders (light sensitive germination, fast growing, regular fruiting, dormant seed bank) (Burslem and Whitmore 1999) and non-gap-demanders (light insensitive germination, slow growing, irregular fruiting, sapling bank), but Open and Sparse Woodland species are not gap-limited. The grain concept in these woodlands could indicate the frequency at which disturbances that trigger favourable conditions for regeneration occur.

In terms of management and conservation, the implications of an intermediate to fine-grain status for the woodlands in the region are therefore a good sign, as it simplifies their management considerably. It appears possible that regular small disturbances by animals and man that do not destroy the canopy significantly are tolerable and even desirable, up to a level (Everard *et al.* 1994; Everard *et al.* 1995). In the case of Tembe, the Closed Woodland on clay and Open Woodland on sand are intermediate-grained communities, whereas the Tshanini or Manqakulane equivalents are fine-grained. It can be hypothesised that elephants may have broken the canopy to such an extent that the species composition of these woodlands is changing towards a coarse-grained composition.

The grain theory balances the Manqakulane situation rather well (Table 15), where under human utilisation, the canopy remains, thus keeping the fine-grain character, but the undergrowth becomes utilised. As a layer of the subcanopy is removed, the ground layer benefits from added space and light and the result is a noticeably increased regeneration pattern (Babaasa *et al.* 2004; Hitimana *et al.* 2004; Boudreau and Lawes2005). The latter should however be monitored carefully, as the abundance of young individuals for woody species such as *Dichrostachys cinerea* could also be the beginning of bush encroachment. The grain theory remains valid for the Manqakulane Open Woodland on Abandoned Household sites unit. In that case, the clearing of woodlands for cultivation and households is a canopy-breaking disturbance, which is maintained by recurrent human activity. Once human activity ceases, it appears logical that shade intolerant species would first re-colonise the sites, followed by the shade tolerant cohort (Poorter *et al.* 1996; Colón and Lugo 2006; Karlowski 2006). An interesting indication offered by this theory is that it has taken less than 20 years to regenerate intermediate-grained woodland, which appears relatively rapid.

In Tshanini, the Closed Woodland Thicket is an intermediate grain vegetation type (Table 15), while the same unit is fine-grained in both Tembe and Manqakulane. The grain status in Tembe is well corroborated by the spread of species in Types (Table 3), indicating that the community grain should be correct. Additionally, the spread of species in the various groups is reminiscent of mature tree populations in the absence of disturbance (Burslem and Whitmore 1999; Niklas *et al.* 2003). The situation is intriguing and somehow contradictory as in Tshanini, disturbances have been eliminated from the system since 1992 (Gaugris 2004), and fire is also thought to have had a limited influence. According to the grain theory, the logical resulting unit should have been a fine-grained one. A hypothesis is proposed that in the absence of disturbance, the closure of the canopy has allowed new shade-tolerant species to develop and a new situation is evolving altogether, whereby a fine-grained Closed Woodland Thicket has started a transition towards a forest state. The hypothesis is reinforced by the facts that some forest species (Table 3) appear to regenerate well in the subcanopy (*Cleistanthus schlechteri, Dialium schlechteri, Hymenocardia ulmoides, Pteleopsis myrtifolia*), but also occur in the canopy (*Balanites maughamii, Cleistanthus schlechteri, Dialium schlechteri, Hymenocardia ulmoides*). Moreover, this unit differed the most from its equivalent units in Tembe and Manqakulane (Table 6).

In general, the grain model appears to have worked successfully when applied to a woodland environment. The situations tested mostly agree with the theory, and it appears a useful tool to determine the type of dynamics that drive woodland communities. The success of the model for the Closed Woodland units in the present study is possibly inherent to the fact that they are closely related to forests. However, the concept seems to work in Open and Sparse Woodland units as well. But in those instances, it appears possible that the grain does not necessarily reflect the frequency and intensity of gap-formation but rather the frequency with which recruitment occurs. In occurrence, fine-grained species seem to find suitable conditions for recruitment continuously whereas coarse-grained species have limited opportunities and pulsed recruitment. The nature of these limited opportunities is difficult to determine at present but some options such as a temporary and simultaneous release from fire and grazing or favourable climatic conditions appear possible.

From the present study it appears that the influence of man and herbivores on the vegetation has taken quite a toll on areas where their presence is limited either by tribal rules or fences. The effects of man and herbivore utilisation can be described as "classical" and have been documented in several papers and reviews (Perrings and Lovett 1999; Ticktin 2004; Wiseman *et al.* 2004; Guldemond 2006; Ickowitz 2006; O'Connor *et al.* 2007). The method to deal with the wildlife utilisation aspect should be based on documented evidence that reduced populations of herbivores, especially elephants, have led to spectacular recoveries of woodlands in short time spans in affected areas elsewhere (Western and Maitumo 2004; Western In Press). However, to discuss these methods would be beyond the scope of the present paper.

With regards to human utilisation, the issue is far more complex, as development is an inalienable right of rural people (Perrings and Lovett 1999). The attitude of many communities is however, favourable to conserving sections of land that have no agricultural value (Gaugris 2004). In this region of Maputaland it is particularly fortunate that this very same land harbours the biodiversity rich woodlands and Sand Forest that make Maputaland special (Eeley *et al.* 2001; Smith *et al.* 2006). This represents the most easily accessible solution to preserving the natural landscapes of Maputaland. The implications of fine-grained communities further enhance the options as it allows the controlled but sustained utilisation of resources (Lawes and Obiri 2003).

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