

Quantifying the potential of restored natural capital to alleviate poverty and help conserve nature: A case study from South Africa

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Summary

Poverty and environmental degradation seem to be endemic in many of the former homeland territories of South Africa. The political legacy of Apartheid might have ceased, but the economic and environmental consequences thereof still have to be dealt with. In one interesting case such a poverty-stricken and environmentally degraded area (Bushbuckridge) lies adjacent to a world conservation icon, the Kruger National Park. Currently, however, the community of Bushbuckridge does not enjoy much benefit from this unique geographic location. On the contrary there seems to be increasing tension between the community in their quest for survival and the national park as a conservation enclave. This tension will not disappear automatically. The situation needs to be managed. It is proposed here that by broadening the conservation corridor through land restoration and by incorporating the Bushbuckridge communal land as an IUCN Category VI protected area (a protected area within which sustainable resource harvesting by communities is permitted) into the Kruger National Park and under the provision that the community remains the land owner, the conservation initiative could benefit the community as much as by a factor of four. For this to be successful a proper managerial and institutional system will have to be in place, including a system that will allow the trade in ecosystem goods and services.

KEYWORDS: Conservation; Degradation; Ecosystem goods and services; Poverty; Restoration; Valuation

Biological diversity is an intrinsic feature of natural ecosystems supplying people with an array of environmental goods and services upon which society depends (Diaz & Cabido 2001; Engelhardt & Ritchie 2001; Ghilarov 2000; Millennium Ecosystem Assessment 2003). These goods and services include the provision of food resources, water purification and cycling, nutrient cycling, the regulation of atmospheric composition and the development and protection of soils (Cervigni 2001; Nunes, Van den Berg, & Nijkamp 2003). Negative impacts on biodiversity are therefore likely to have negative consequences for ecosystem processes and functions.

In South Africa much of the current environmentally degraded land used to be *homelands*, i.e. the reserves for Black African people under the former Apartheid regime (DEAT 1997; Hoffman a Todd 1999). The degradation resulted since people were forced to live on marginal land with little or no infrastructure and/or means for economic survival. This caused overgrazing and high levels of biomass harvesting for energy and construction purposes (Hassan 2002). Notwithstanding the fact that a stable democracy has replaced the Apartheid regime, by far the majority of people who live on these degraded areas are still poor (earning less than \$1 a day) (SARPN 2003).

The question addressed in this chapter is whether a community conservation initiative (coupled with the restoration of degraded land) can be considered a feasible alternative land use option compared to subsistence agriculture. This question has been discussed elsewhere (Barnes, Boyd, & Cannon 2003; Luckert & Campbell 2003), but here we will tackle it by presenting alternative economic scenarios for an impoverished rural community living outside a national park in South Africa.

Background

One area where a community conservation initiative would make sense is in a portion of the Bushbuckridge district in the Limpopo Province, South Africa. The area under consideration comprises 234,761 hectares of which 184,301 hectares are communal land not subject to any form of cultivation or habitation, but to which some 500,000 community members have open access for resource harvesting. Of this area, 43% is heavily degraded (CSIR 1996). In 2000, the average income earned per person in the district was estimated at R3400 (= \$485) per annum with an unemployment rate of 65% with formal employment declining by 1.2% annually over the period 1995-2000 (Limpopo Government 2002). Thus poverty is entrenched in the area and alternatives to alleviate poverty need to be considered. One of the most noteworthy features of this area is that it borders the Kruger National Park (hereafter referred to as "Park"), a world-renowned conservation region. The adjacent communal area enjoys the same climate and in the past would have had the same vegetation and animal life as the Rooibos Bushveld zone of the Park. Currently, however, the Park area is still intact, and delivers a wide range of ecosystem goods and services, while the communal area is becoming increasingly degraded. This ecological dichotomy reflects different land use practices, and leads to an increase in economic and political tension. Neither the poverty nor the tensions will disappear unless a concerted effort is made to rehabilitate the land and restore the indigenous vegetation. The current land use practice is the result of lack of choice due to the current lack of alternative means of livelihood and of infrastructure and economic activity for local people. We assume that a land use change is possible, that game could replace current livestock and that the area could be managed as a private protected area. Answering the question of whether community conservation in the Bushbuckridge (BBR) area poses a viable alternative land use option to the current subsistence land use implies comparing the total economic value of ecosystem goods and services provided by the Rooibos Bushveld area in the Park with the value of products extracted from the adjacent communal area. We compare both the value of composition and the value of the biodiversity function activities of the Park area with that of the actual return from the current land use in BBR. Using this information a potential communal conservation-based capital stock value and flow of income stream will be calculated. This potential value is based on the premise that one could change the land use practice from subsistence agriculture to community (private) conservation, but allowing sustainable resource harvest from the area. Such a community resource-harvesting regime in a protected area is not uncommon and the area would constitute an IUCN Category VI protected area (see also Mulongoy & Chape 2004). In practice this implies the realignment of the fence between Park and communal area to incorporate part of the latter into a larger conservation area and the local community operating the conservation area as a private nature reserve, though sharing the animals with the National Park, but, based on land tenure, the proceeds (after cost) from the land would be flowing to the community.

Method

Since the Park and communal study areas are adjacent, separated only by a wire fence, they do belong to the same eco-region, namely the combined Lowveld Sour Bushveld and Lowveld Savanna (Acocks 1988). Comparison of composition and function are therefore straightforward, and appropriate. The study calculates the value of the standing stock of all tradable plant and mammal species to determine the value of the biodiversity composition for the two study areas. In this context stock values refer to the accrued value of the natural capital over time. Thereafter the value of the various biodiversity function components (direct use, non-consumptive and indirectly consumptive use) is calculated. These values are treated as flow variables, i.e. generating an annual stream of income or benefits to the owner(s) or beneficiary(ies) of the goods and services provided by the respective ecosystems.

Results and discussion

Composition or stock of natural capital

As very little game now exists on the communal land and no survey of livestock has been

undertaken, the value of animals could not be calculated.

For the adjacent area of the Park, densities of the main tradable mammal species were obtained from Zambatis and Zambatis (1997). The numbers were adjusted to reflect 2002/03 levels based on expert opinion (J Victor, D Grobler & D Cilliers, personnel communication, 2003) and a total stock of tradable mammals calculated (Appendix A). Based on the most recent auction prices (differentiating between trophy animals and breeding herds) the total value of the tradable mammal stock was estimated to be \$25.37 million or US\$155.74/ha (Table 1). This is the market value should all the animals be liquidated at 2003 auction prices.

A list of tradable plant species was assembled from various sources (Botha, Witkowski, & Shackleton 2001; Hassan 2002; Shackleton & Shackleton 1997, 2000; Van Zyl 2003). Based on Netshiluvhi and Scholes (2001), Scholes et al. (2001), Shackleton and Scholes (2000) the biomass per species and per hectare and for the whole Rooibos Bushveld area of the Park was calculated (Appendix B). Based on these sources, it was also possible to specify the percentage of the biomass of each species used for various products. Based on the 2003 market prices for the various uses of products, it was possible to determine that the standing stock value of the tradable plant species, should they all be harvested completely, the value would amount to US\$481.3 million or US\$2954.7/ha (see Table 1). Though this hypothetical amount is considerable, it still only accounts for the value of the standing biomass traded in the market. This does not incorporate the value of the non-traded species. The tradable plant stock value for the communal area was taken as 57% of the Park value applied to the communal land area size, since 43% per cent of the communal area was determined as being degraded.

Function or flow values

Direct use values

The direct or extractive and consumptive use of natural biota includes wood for construction and timber as well as for energy purposes, medicinal products, edible fruit, herbs, vegetables, thatch and the value of livestock and the hunting of game. Table 2 shows a summary of the direct use values for the areas under consideration, which will subsequently be discussed in more detail.

Rooibos Bushveld area of the Park

The Kruger National Park is according to the IUCN's classification, is a Category II national park, which, by definition, excludes the exploitation of natural resources. The direct use values for Rooibos Bushveld area of the Park are therefore zero. Despite this, one can ascertain the potential volumes of harvestable goods should the area be managed as a Category VI protected area, within which sustainable resource use is allowed.

Bushbuckridge communal area (actual direct use values)

Various studies have been carried out to calculate the actual value of resource harvest in the Bushbuckridge communal area (Botha et al. 2001; Hassan, 2002; Netshiluvhi & Scholes 2001; Scholes et al. 2001; Shackleton 1998; Shackleton a Scholes 2000; Shackleton a Shackleton 1997, 2000, 2002; Van Zyl 2003). These studies are based on primary household survey data. The values in Table 2 are based on a consolidation of data from these studies and have been adjusted to 2002/03 levels using the consumer price index.

Table 1. Value of all tradable mammals and plants in Rooibos Bushveld area of the Kruger National Park: 2002/03

Species name	Common name	Total value (US\$ 1000)		Unit value (US\$/ha)	Species name	Common name	Total value (US\$ million)	Unit value (US\$/ha)
		Trophy	Breeding units					
Hippotragus equines	Roan antelope	3	43	0.28	Sclerocarya birrea	Marula	194.12	1191.6
Connochaetes taurinus	Blue wildebeest	28	40	0.42	Ziziphus mucronata	Buffalo thorn	50.37	309.2
Tragelaphus scriptus	Bushbuck	4	7	0.07	Grewia bicolor	Bastard brandybush	13.77	84.54
Syncerus caffer	Buffalo	1404	7787	56.42	Lansea	False marula	15.17	93.14
Taurotragus oryx	Eland	2	3	0.03	schweinfurthii	Jakkalsbessie	70.51	432.86
Crocota crocuta	Spotted hyena	10	183	1.19	Diospyros mespiliformis	Natal plum	1.54	9.44
Acinonyx jubatus	Cheetah	2	42	0.27	Carissa edulis	Knob thorn	41.16	252.65
Giraffa camelopardalis	Giraffe	65	637	4.31	Acacia nigrescens	Scented thorn	91.82	563.64
Tragelaphus strepsiceros	Kudu	24	19	0.27	Acacia nilotica	Umbrella thorn	2.87	17.61
Panthera leo	Lion	34	649	4.19	Acacia tortillis			
Panthera pardus	Leopard	7	141	0.91	Total		481.3	2954.7
Tragelaphus angasi	Njata	2	2	0.02				
Loxodonta africana	Elephant	233	2952	19.55				
Ceratotherium simum	White rhinoceros	707	8236	54.9				
Diceros bicornis	Black rhinoceros	0	557	3.42				
Redunca arundinum	Reedbuck	0	1	0.01				
Aepyceros melampus	Impala	108	124	1.42				
Hippopotamus amphibious	Hippopotamus	0	523	3.21				
Hippotragus niger	Sable antelope	9	129	0.85				
Phacochoerus aethiopicus	Warthog	0	5	0.03				
Kobus ellipsiprymnus	Waterbuck	31	41	0.44				
Lycan pictus	Wild dog	0	18	0.11				
Equus burchelli	Zebra	85	472	3.42				
Total		2758	22611	155.74				

Source: Adapted from Appendices 1 and 2.

Table 2. Comparison of direct use values for the Rooibos Bushveld area of the National Park land, with actual values for communally owned land (BBR) under subsistence management and its potential values following restoration of natural capital: 2002/03

	Rooibos Bushveld			BBR (Actual)			BBR (Potential)		Difference (potential less actual)
	Ha	US\$ millions	US\$/ha	Ha	US\$ millions	US\$/ha	US\$ millions	US\$/ha	
Fuel wood	162 904	0	0	184 301	5.76	31.24	3.50	18.96	-12.28
Timber	162 904	0	0	184 301	2.70	14.65	4.41	24.01	9.36
Crafts	162 904	0	0	184 301	0.25	1.34	51.22	278.22	276.89
Medicinal	162 904	0	0	184 301	4.78	25.92	47.11	255.38	229.46
Edible fruit, herbs and vegetables	162 904	0	0	184 301	9.28	50.36	1.51	8.19	-42.17
Thatch	162 904	0	0	184 301	7.01	38.02	0.61	3.19	-34.82
Livestock	162 904	0	0	184 301	9.38	50.88	0.00	0.00	-50.88
Wild animals	162 904	0	0	184 301	0.00	0.00	4.3	23.4	23.4
Other: reeds, sticks, grass brushes, birds, etc.	162 904	0	0	184 301	1.49	8.08	0.00	0.00	-8.08
Total direct consumptive use	162 904	0	0	184 301	40.63	220.48	112.6	611.35	390.88

Sources: Adapted from Scholes et al. 2001; Van Zyl 2003; Netshiluvhi and Scholes 2001; Shackleton and Shackleton 1997; Hassan 2002.

The direct consumptive use value is estimated to be US\$220 per hectare, or, alternatively, US\$40.63 million for the whole study area (Table 2). This implies US\$81.26 per person based on a beneficiary population of 500,000 (Hassan 2002). The major contributors to value from resource harvesting are the sales of livestock, edible fruit, herbs and vegetables as well as thatch and fuel wood.

Some households harvest resources for their own consumption; others sell them. It is not possible to distinguish between the number of harvesters and the number of buyers, but it as appears that a portion of the US\$40.63 million discussed above are benefits in kind, i.e. resource extraction for own consumption. Irrespective of whether the resources are traded or harvested for own use, they are not recorded within the ambit of the formal economy and compilation of the GDP. This implies an underestimation of the GGP by US\$40.63 million.

Bushbuckridge communal area (potential direct use values)

Should the communal area be incorporated into the Park, but managed as an IUCN Category VI protected area that allows for the sustainable use of natural resources, mainly to support the livelihoods of local communities, then there would still be direct use, but under strict guidelines. Shackleton and Shackleton (1997, 2000) argue that the biomass production of the area under consideration is 3% per annum, but that not all biomass production is suitable for economic use, (see Appendix B for the distribution of tradable woody resources per species and the eligible component of each species by product). The sustainable harvest was conservatively assumed to be 1% of biomass for fuel wood, construction timber and branches and 0.5% for crafts and medicinal products (the assumption for crafts and medicinal plants is lower given the limited market options). The harvest of edible fruit comprises 50% of the full annual production. To calculate the volume of tradable biomass that can be harvested, the biomass per species and by product (from Appendix B) was multiplied by either 1 or 0.5% or the production volume and multiplied by the going market price.

Based on these assumptions (Table 2), the potential direct use values are US\$611.35 per hectare, much of which is allocated to crafts and medicinal products, the two products with a considerable value-added component. The total size of the market is unclear and though it would be possible to generate the returns per hectare as indicated in Table 2, the possibility of realising these values over the whole study area is questionable because of market saturation. No value for

livestock has been estimated since livestock would be excluded from the area, but trade in game would replace it and that is included. Trade in game (which includes hunting) has been restricted to 50% of the number of new births per species per year to allow for natural off-take through predation and death and also to allow for replacement (Appendix A).

Non-consumptive values

Non-consumptive values comprise those direct use values that are non-extractive in physical terms and here only tourism was considered for this activity. Tourism within the communal area is currently zero and to calculate the potential tourism value, the value of tourism to the adjacent area of the Park was calculated, expressed in terms of US\$/ha, and applied to the communal area since we assume that tourism in the restored communal area is likely to be equivalent to that of the protected area.

Although the Rooibos Bushveld area comprises only 8% of the Kruger National Park (KNP), 24% of the parks tourist accommodation facilities are in this area. Calculation of the total tourism value for the area is based on this proportion (SANParks 2003). The total number of visitors to the Rooibos Bushveld area of the Park was calculated as 254,189 per year. After distinguishing between day visitors and local and international overnight visitors, and assuming an average stay duration of 1.76 days per over night visitor, the total number of bed nights is estimated to be 213,207 per year. The total turnover value of visitors to this part of the Park, inclusive of gate fees, overnight accommodation and expenditure at Park stores, amounts to US\$8.54 million. This translates to an average expenditure per visit of US\$70.

It has been indicated that the travel cost method is an acceptable method to determine visitors' willingness-to-pay for the unaccounted amenities, or consumer surplus, for a recreation site (Dixon, Scura, Carpenter, & Sherman 1994). After differentiating between the various local modes of travel and accounting for the average numbers of passengers per vehicle (based on Turpie & Joubert 2001), the total number of kilometers traveled in South Africa to and from the area is calculated as 28 million (this excludes any foreign travel). Given a crude average cost per travel of US\$0.27/km (based on standard motor hire and Automobile Association estimates) the total cost of travel amounts to US\$7.46 million. This implies a total tourism value of US\$16 million, or US\$98 per hectare. Based on information provided in SANParks (2003), it was possible to disaggregate the tourism value into its components of passive tourism (appreciation of scenic beauty and uncluttered landscape), adventure tourism (direct use of landscapes such as hiking) and eco-tourism (the direct appreciation of biodiversity through bird and animal watching and botanical appreciation). Passive tourism is by far the largest.

Indirect consumption values

Indirect consumption values comprise, first, produced environmental goods and services useful to people and include honey production, carbon sequestration, livestock grazing and soil nutrient recycling, and, second, option and existence values which capture the possible future use of environmental goods and services from ecosystems. Regarding the first type it is considered inappropriate to include livestock grazing since the value of livestock sales is already included under direct consumptive use values and, also, livestock activities would not influence the potential value of the restored communal area. No data regarding soil nutrient recycling could be established. There are currently no formal honey production activities in either the Park or communal area, but based on an average of 20 kg per hive (Turpie, Heydenrych, & Lamberth 2003) and 1 hive per 5 km² (Crewe, personnel communication, 2003) and an average price of US\$4.56 per kilogramme, the potential retail value of honey production is estimated to be US\$0.85 million or US\$4.56.

No formal market for carbon currently exists in South Africa. Carbon trading in Park would also not be feasible given the principle of additionality, which implies that carbon trading based on existing biomass does not count, since it does not contribute to additional carbon storage. The communal area, however, has a good carbon trading potential. Based on a carbon absorption capacity of 4t/ha (Scholes & Bailey 1996; Scholes & Van der Merwe 1996) and an average price for carbon of \$15.7/t or \$4.2/t CO₂, the potential value of the carbon sequestration market therefore amounts to US\$12.31 million or US\$66.87/ha.

Option, existence and bequest values have been defined above and are estimated simultaneously since distinguishing between them is seldom possible. A comprehensive study estimating the willingness-to-pay for conservation, either by contingent valuation and conjoint analysis, has not yet been done in South Africa. Results of two regional studies (Turpie 2003; Turpie & Joubert 2001) indicate, however that these values are most likely to be between \$54.3 and \$67.5/ha. An average of \$60.8/ha was used in this study.

Summary

The information provided above is summarised in Table 3. Though it was not possible to establish an actual value for the mammal stock in the Bushbuckridge communal area, the composition value of tradable vegetation is considerably below its potential given the degradation. With regard to biodiversity function-related activities, the actual extraction value is US\$220.48 per hectare, but the potential is US\$841.8, implying a net benefit of restoring the degraded land and conservation, i.e. the re-introduction of indigenous biomass and the appropriate management of the area, similar to that of the adjacent private protected areas, of US\$621.34/ha.

Should one reduce the crafts and medicinal values, the value of tourism and the option and existence values by 50%, one can determine how vulnerable the community would be to the non-realisation of these values. This alternative, a much more conservative scenario, yields an economic return of US\$495.7/ha, that is US\$275.1/ha more than the actual current value.

Conclusions and applications

The potential total economic value of the communal area under discussion is considerably higher than that of the actual value currently derived from the land. This is based on the premise that the area could be incorporated with the Kruger National Park, but with unchanged land tenure and allowing selective access to resource use. Such a system is possible given that even the IUCN recognises the possibility of having a protected area with selective resource use, and that there are privately owned conservation units adjacent to the Park. Our result is fully consistent with that of Van Schalkwyk and Balyamujura (1996) who studied various land use scenarios within the same study area. This latter study did not quantify the benefits of alternative land use options, but reached their conclusion based on a multilevel criteria technique using a preference function to determine the most equitable, socially optimal and economically viable land use option among various scenarios.

There are however five possible problems, any one of which has the potential to spoil the viability of the proposed scheme. First, total economic value does not imply money in the pocket. It would be necessary to introduce a national system that would reward rural communities for providing ecosystem goods and services. High-level intervention is therefore required to create a market for the ecosystem goods and services, involving communities in a biodiversity conservation programme by developing the required incentive structures to promote biodiversity conservation and biodiversity beneficial land use practices.

The second potential pitfall is that market penetration for either the direct consumptive or indirect consumptive use products might be low. The only way to mitigate this problem is through a strong marketing campaign.

The third problem relates to management structure (see also Olukoye, Wamicha, Kinyamario, Mwanje, & Wakhungu 2003). Though it could be foreseen that the protected area will be managed

Table 3. Comparison of the total economic value of National Park land under conservation, with communally owned land (BBR) under subsistence management and following restoration of natural capital

	Park (Rooibos Bushveld)			BBR Subsistence (Actual)			BBR Restored (Potential)		BBR diff (US\$/ha)
	Size of area	Total value (US\$ million)	Value (US\$/ha)	Size of area	Total value (US\$ million)	Value (US\$/ha)	Total value (US\$ million)	Value (US\$/ha)	Potential less actual
Value of the standing stock at prevailing market prices									
Mammals	162 904	25.38	155.74	184 301	n/a	n/a	28.72	155.74	n/a
Vegetation	162 904	483.43	2967.98	184 301	311.70	1691.49	546.96	2967.98	1365.50
Total value	162 904	508.81	3123.72	184 301	311.70	1691.49	575.68	3123.72	n/a
Biodiversity function or flow values									
Direct consumptive	162 904	0	0	184 301	40.58	220.48	112.6	611.35	390.88
Direct non-consumptive:	162 904	15.96	98.25	184 301	0	0	18.09	98.25	98.25
Tourism									
Total indirect consumptive use	162 904	20.82	127.66	184 301	0	0	24.41	132.22	132.22
Indirect-consumptive (Type 1)									
Honey production	162 904	0	0	184 301	0	0	0.85	4.56	4.56
Carbon sequestration	162 904	10.94	66.87	184 301	0	0	12.31	66.87	66.87
Indirect-consumptive (Type 2)									
Option & existence values	162 904	9.91	60.83	184 301	0	0	11.25	60.83	60.83
Function: Grand total	162 904	36.78	225.95	184 301	40.58	220.48	155.15	841.8	621.34
Function: Total of alternative scenario	162 904	36.78	225.95	184 301	40.58	220.48	91.3	495.7	275.1

Source: Own analysis.

by a professional service provider and the proceeds (after cost) from the protected area be centralised into a community-conservation fund and then recycled to the various community members, this arrangement will have to be negotiated, well documented and allow community buy-in. It has been mentioned that bad management systems will lead to failure of community conservation initiatives.

A fourth hurdle that will have to be overcome is that of insurance risk and the resultant cost. The concept as discussed here has not yet been tested in South Africa. Neither does an environmental investment sector exist and given the uncertainty surrounding global carbon sequestration markets, high insurance premiums on the sale of ecosystem goods and services could be expected. These premiums could act as significant barriers to trade. It could be argued, however, that the current degree of environmental degradation and the economic marginalisation of the communities involved were the result of various government and market failures. Government should therefore play an active role in providing the required incentive to rectify these failures.

The fifth consideration is that of the cost of restoration. Calculating this was not possible since the actual management and restoration plan would directly determine the cost of restoration, but should the cost exceed the economic benefits discussed here, then restoration would not make sense.

Based on the potential total economic value of the ecosystem goods and services derived from community conservation, this seems to be a plausible alternative to subsistence agriculture in Bushbuckridge. This conclusion has been reached using a natural resource accounting approach towards biodiversity valuation. From these calculations the value of the actual return from the current land use practice is estimated as amounting to US\$220 per hectare, a portion of which is benefits in kind. The total economic value of community conservation has been estimated at US\$841.8/ha and US\$495.7/ha under conservative assumptions. The value of restoring degraded land is therefore considerable.

For the community to realise this potential increase in return from their land, solutions to various managerial and institutional challenges must be found. One such a solution might be the development of an environmental investment sector in the economy. Establishing such a sector could reduce insurance risk and link the suppliers of ecosystem goods and services and those in demand for such services much more readily, thereby reducing the transaction cost of such an activity.

Acknowledgements

The views expressed in this chapter are those of the authors and do not necessarily reflect those of any institution with which they are associated. The authors gratefully acknowledge the assistance of Nolan Loxton.

Appendix A

Tradable mammal species in the Rooibos Bush-veld Area of the Kruger National Park Table A1.

Appendix B

Key data inputs of tradable plant species in the Rooibos Bushveld Table B1.

Table A1

Species name	Common name	Ratios in saleable breeding units		Density of species Animals/ha	Numbers of individuals				Birth rate %	Price	
		Female	Male		Female	Male	Trophy	Total		Trophy (US\$ per unit)	Food & Trade (US\$ per breeding unit)
<i>Hippotragus equinus</i>	Roan Antelope	2	1	0.00006	7	4	1	11	10	5530	14029
<i>Connochaetes taurinus</i>	Blue wildebeest	7	3	0.010255	1 257	539	84	1 890	12	338	252
<i>Tragelaphus scriptus</i>	Bushbuck	8	2	0.0009	126	32	7	166	8	557	485
<i>Syncerus caffer</i>	Buffalo	6	2	0.018	2 364	788	147	3 317	8	9574	22363
<i>Taurotragus oryx</i>	Eland	8	2	0.0003	42	11	2	55	7	1017	661
<i>Crocuta crocuta</i>	Spotted hyena	1	1	0.0012	105	105	9	221	12	988	1311
<i>Acinonyx jubatus</i>	Cheetah	1	1	0.00012	11	11	1	22	17	2280	429
<i>Giraffa camelopardalis</i>	Giraffe	2	1	0.005697	665	332	46	1 050	7	1397	2167
<i>Tragelaphus strepsiceros</i>	Kudu	7	3	0.004558	559	239	42	840	8	654	268
<i>Panthera leo</i>	Lion	4	1	0.0012	168	42	11	221	21	3494	8114
<i>Panthera pardus</i>	Leopard	1	1	0.0006	53	53	6	111	6	1520	504
<i>Tragelaphus angasii</i>	Nyala	12	3	0.00018	25	6	2	33	8	1584	883
<i>Loxodonta africana</i>	Elephant	5	1	0.006275	916	183	58	1156	4.5	4559	7909
<i>Ceratotherium simum</i>	White rhinoceros	1	1	0.004558	399	399	42	840	4.5	19042	23351
<i>Diceros bicornis</i>	Black rhinoceros	4	2	0.0003	35	20	0	55	4	n/a	68389
<i>Redunca arundinum</i>	Reedbuck	3	1	0.00009	12	5	0	17	12	n/a	304
<i>Aepyceros melampus</i>	Impala	8	2	0.086598	12 130	3 032	798	15 960	17	153	93
<i>Hippopotamus amphibius</i>	Hippopotamus	3	1	0.002114	278	112	0	390	6	n/a	6079
<i>Hippotragus niger</i>	Sable antelope	3	1	0.00018	24	8	2	33	9	6435	18566
<i>Phacochoerus aethiopicus</i>	Warthog	7	3	0.002279	279	141	0	420	20	n/a	128
<i>Kobus ellipsiprymnus</i>	Waterbuck	8	2	0.003418	479	120	31	630	10	1116	773
<i>Lycaon pictus</i>	Wild dog	8	2	0.00012	17	4	1	22	0	0	0
<i>Equus burchelli</i>	Zebra	4	1	0.022789	3 192	1 008	0	4 200	9	456	669

Sources: Own calculations based on SANParks (2003), Zambatis and Zambatis (1997), Victor, J. (personnel communication, 2003), Grobler, D. (personnel communication, 2003), Cilliers, D. (personnel communication, 2003), Van Aarde, R. (personnel communication, 2003), Game and Hunt (2003).

Table B1

Species name	Common name	Density of species	Number of individuals	Diameter	Biomass	Biomass	Fuel wood	Construction timber	Crafts	Branches	Waste	Edible fruit	Medicinal products
		Specimens/ha)	Number	mm	kg/tree	t/ha	First row: Product as % of biomass or as volume per specimen (economic yield) and Second row: Price of product in US\$/kg (2002/03 values)						
<i>Sclerocarya birrea</i>	Marula	14	2280656	500	829.04	11.61	0.30	0.20	0.01	0.10	0.39	50 kg/female tree	0.01
							0.05	0.10	3.80	0.05	0.00	0.04	2.43
<i>Ziziphus mucronata</i>	Buffalo thorn	16	2606464	300	172.53	2.76	0.30	0.30	0.01	0.10	0.39	0.00	0.01
							0.05	0.10	3.80	0.05	0.00	0.04	2.43
<i>Grewia bicolor</i>	Bastard Brandybush	13	2117752	30	285.28	3.71	0.5	0	0	0	0.5	0	0
							0.05	0.10	3.80	0.05	0.00	0.04	0
<i>Lannea schweinfurthii</i>	False marula	2	325808	450	629.25	1.26	0.40	0.30	0.00	0.00	0.30	0.00	0.01
							0.05	0.10	3.80	0.05	0.00	0.04	2.43
<i>Diospyros mespiliformis</i>	Jakkalsbessie	2	325808	900	2689.52	5.38	0.20	0.40	0.00	0.10	0.30	14 kg/t biomass/ha	0.01
							0.05	0.10	3.80	0.05	0.00	0.04	2.43
<i>Carissa edulis</i>	Natal plum	4	651616	20	101.20	0.40	0.50	0	0	0	0	14 kg/t biomass/ha	0
							0.05	0.10	3.80	0.05	0.00	0.04	0
<i>Acacia nigrescens</i>	Knob-Thorn	7	1140328	450	434.17	3.04	0.20	0.30	0.01	0.10	0.39	0.00	0.00
							0.05	0.10	3.80	0.05	0.00	0.04	0.00
<i>Acacia nilotica</i>	Scented thorn	22	3583888	400	585.35	12.88	0.40	0.20	0.00	0.10	0.30	0.00	0.00
							0.05	0.10	3.80	0.05	0.00	0.04	0.00
<i>Acacia tortillis</i>	Umbrella thorn	2	325808	200	275.89	0.55	0.70	0.00	0.00	0.00	0.30	0.00	0.00
							0.05	0.10	3.80	0.05	0.00	0.04	0.00

Sources: Adapted from Scholes et al. 2001; Van Zyl 2003; Netshiluvhi & Scholes 2001; Shackleton and Shackleton 1997, 2000; Hassan 2002.

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