Population assessments of priority plant species used by local communities in and around three Wild Coast reserves, Eastern Cape, South Africa

By

JOCLYN J. FEARON

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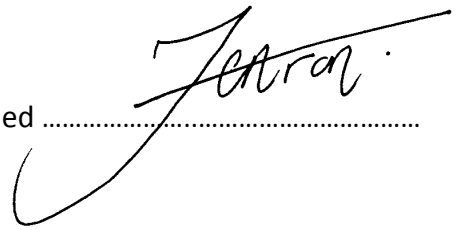
Abstract

The project was initiated by Eastern Cape Parks (ECP) as a request for the construction of inventories of priority species and their population levels inside three nature reserves on the Eastern Cape Wild Coast, South Africa, and to develop a strategic management plan to manage these natural resources in each reserve. Thirty key species were identified by local communities in and around Dwesa-Cwebe, Silaka and Mkambati Nature Reserves through community workshops. For forested areas belt transects of 100 m x 6 m where used. The basal circumference of key tree species within the belt transect was measured as well as the height of saplings (height < 150 m). Tree species were categorized based on densities, size class distribution (SCD) curves and values, and spatial grain. For grassland areas straight transects of 200 m long were used, along which ten 3 m x 3 m quadrates were placed at 20 m intervals. Within each grassland transect the height of herbs or tuft diameter of grasses was recorded and percentage cover estimated. Grassland species were categorized based on density, SCD curves and percentage cover. All species were placed into harvesting categories based on analysed ecological data that was collected in the field. Category 1 species were very rare or not found in the reserve and it was recommended that species be conserved and monitored. Category 2 species had low densities in the reserve indicating declining populations and was suggested that these be monitored and not harvested. Category 3 species had high densities and have potential for harvesting with strict limitations. Category 4 species were most abundant with very high densities and can be harvested within management guidelines. These categories were grouped further using social and ecological data such as harvesting risk, frequency of collection, use value and number of uses. This highlighted which species have conservation priority within each category and a decision can be made as to how intense or limited extraction should be. By incorporating GIS the distribution of each species was looked at and harvesting and non-harvesting zones established to determine where species can be extracted. Monitoring plans must consider the quantity of plant material collected, fire regimes, optimal harvesting rates and harvesting zones, and be able to pick up changes in populations. Also, it is important that the community be involved in conserving and monitoring these species. Adaptive monitoring and management must be used to steer harvesting practices in the Wild Coast reserves. This allows for the development of harvesting practices through ‘learning by doing’, and the evolution of good questions to guide monitoring decisions.

Declaration

I declare that this work is my own and has not been submitted in any form to another University. It has been accordingly acknowledged in the text where I have used the work of others.

Signed ……



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Contents

List of Tables

List of Figures

List of Appendices

CHAPTER ONE: Introduction and Objectives

1. Introduction

Despite the growing popularity of community-based natural resource management (CBNRM) programmes around the world, the relationship between natural resource use and formal conservation strategies is frequently uneasy. Conservation agencies and managers typically err on the side of caution and at times can be overtly antagonistic to the harvesting and use of biological resources for any purposes (e.g. Struhsaker 1998, Shackleton *et al*. 2009). Their concerns are, at times, well founded, with numerous studies showing declines in biodiversity generally or over-harvesting and consequent population declines of specific species, especially those for which external markets exist (e.g. Botha *et al*. 2003, Dold & Cocks 2002, Ticktin 2004). Consequently, the creation of nature reserves and national parks as zones where extraction of biological resources is prohibited is a mainstay strategy in modern conservation (McDonald & Boucher in press).

On the other hand natural resource use is a significant component of rural and urban livelihoods throughout the developing world (Koziell & Saunders 2001, Shackleton *et al*. 2007a, Davidar *et al*. 2008). Much of the firewood, construction timber, medicines and wild foods are harvested from the wild or fallow lands. People in the developed world also harvest wild resources, although the drivers of use are usually different (e.g. Clason *et al*. 2008, Kilchling *et al*. 2009). In developing countries, natural resource use is frequently one of multiple livelihood strategies, in which rural households mix and match arable agriculture, animal husbandry, migrant labour, petty trade, local casual labour and natural resource use. This is necessary because no single livelihood strategy alone is sufficient to support the household, and it also helps diversify risk. A number of studies have shown that the natural resource use component contributes between 10 % and 50 % of total livelihood incomes (e.g. Campbell *et al*. 2002, Vedeld *et al*. 2004, Ezebilo & Mattsson 2010). In southern and South Africa it is typically closer to one-fifth or one-quarter of livelihood incomes (Shackleton *et al*. 2007a). Thus, if such resources were unavailable to rural communities their livelihoods would be adversely affected and the already high poverty levels would increase.

Overharvesting of resources on which rural communities depend does happen, especially where human population densities or commercial extraction is high. The underlying causes are context and species specific. However, a key one is a reduction of resource supply when protected areas are created by state agencies. Rural communities are then prohibited from harvesting resources in lands they previously owned or to which they had rights (Fabricius 2004, Brockington & Igoe 2006). The reduction in area available results in increased harvesting pressures in the remaining lands. Restriction on resource harvesting may also apply in lands outside of formally protected areas. For example, during the colonial period bans on hunting of wildlife without a permit or felling of valuable timber species were introduced in many countries of the world and in all southern African countries (Willis 2004). Thus, even within their own lands, rural communities are not always free to harvest at will, or practice traditions that have been part of their culture for millennia. This frequently resulted in antagonistic relationships between conservation agencies and local communities (Adams & Hulme 2001).

In the last two or three decades, conservation lobbyists have sought to bridge this divide and forge a closer understanding and working relationship between rural communities and conservation objectives and strategies (Magome & Fabrcius 2004). Additionally, evicted communities are increasingly making claims on lands or resources from which they were dispossessed during the colonial era, and their rights are being recognized in international and national fora and courts of law (e.g. Reid & Turner 2004). Thus, rather than total prohibitions on harvesting, conservation agencies are seeking to promote wise and sustainable harvesting practices, within a broader conservation paradigm. This may even include allowing access to controlled harvesting of selected resources within formally protected areas, as a means of contributing to poverty allegation and to redress historical rights and equity (Adams & Hutton 2007, Roe 2008).

South Africa is no exception to these debates and processes. Many communities were forcibly removed from their lands during the colonial and apartheid periods to create protected areas (Fabricius 2004). With the transition to a democratic dispensation in the early 1990s the State has sought to address some of these inequities through amendments to the national conservation policies and practices to promote increased benefit sharing. Additionally, some communities have used the legal avenues open to them under the national Land Reform Programme to claim back their rights to the lands from which they were evicted (Reid & Turner 2004, Fay 2009). Many have been successful, but frequently conditions

have been made that the primary land use remains conservation. Thus, communities own the land and receive a portion of the revenues from the land, but they cannot convert the primary land use. Another benefit stream under such an arrangement is that communities be provided access to key resources for cultural, consumptive or income-generating purposes. But the harvesting needs to be within sustainable limits and not jeopardize the broader conservation objectives for the land. This is the situation for the Wild Coast reserves, which are the focus of this study.

The Wild Coast is one of the most underdeveloped regions of South Africa. This is a consequence of its relative remoteness from large urban centres, the rugged terrain making infrastructure supply difficult and its neglect during the apartheid era when it was one of the thirteen former racially-defined homeland or Bantustan areas of South Africa. By South African standards, local communities are extremely poor, with low levels of literacy, formal education and employment opportunities. Most rely on farming, collection of wild resources, migrant labour in far away urban centres and State grants. Reliance on grasslands and forests for fodder, wild foods, firewood, medicinal plants and fibre species for weaving is high (Shackleton *et al*. 2007b). However, the Wild Coast boasts magnificent landscapes and high levels of biological diversity. There are four provincial nature reserves along the Wild Coast, and there is a GEF funded programme to develop and promote wider conservation orientated activities and ecotourism along the entire coast. A community-based model is necessary because the land belongs to the communities (or land claims are still pending), to redress the inequities of the past imposed in the name of conservation, as well as to contribute avenues towards meaningful poverty alleviation (Adams *et al*. 2004). This, in turn, is anticipated to lead to better relations with local communities and improved support for conservation in general, as has been the rationale for similar initiatives elsewhere in the world (e.g. Arjunan *et al.* 2006, Vodouhé *et al*. 2010).

In early 2009 the Eastern Cape Parks (ECP) commissioned a project for the construction of inventories of priority species and their population levels in nature reserves on the Wild Coast of the Eastern Cape. This would then form the basis for developing a strategic management plan for managing natural resources in each reserve. Priority species were regarded as those identified and used as such by local communities in and around Dwesa-Cwebe, Hluleka, Silaka and Mkambati Nature Reserves. To identify what the priority species are in each area local communities were engaged via workshops, where information was directly attained from the participants on the plants and animals used and their

significance. ECP felt there was an urgent need to incorporate detailed ecological data into the development of management strategies, preliminary estimates of harvesting levels and areas of potential concern. Also it is important that information be meaningful and defendable where monitoring and management guidelines concern the local communities. A minimum of fifteen days where spent in each reserve in order to have adequate sampling sizes. The project involved a team of five which included a Master student (myself), M. Cocks (head of community workshops), A. Dold, J. Gambiza and C. Shackleton (Head of the project).

2. Objectives and key questions

It is clear that rural people rely greatly on the natural resources in their everyday lives and therefore it is necessary to manage and monitor resources not only for the benefit of wildlands and protected areas, but also for the benefit of rural people in the future. The objectives of the project are to (1) determine what the priority plant species are by engaging with local communities via workshops; (2) use field techniques to assess the abundance and population status of priority species; and (3) design management and monitoring plans where necessary using expert advice. The key questions asked are:

(1)What are the key species and their uses?

(2) What is the abundance and population status of key species across the reserve?

(3) What is the current distribution of key species within and around the reserves?

(4)What is the scope/potential for beneficial community harvesting?

3. Thesis layout

This chapter incorporates a literature review of natural resources used by rural peoples in South Africa. The review goes on to discuss natural resources used by local communities living around the relevant nature reserves on the Wild Coast. The literature review aims at revealing the extent of literature focused on the topic of 'natural resource use' in the Wild Coast reserves.

Chapter Two is the study area section detailing the location, climate, geology and soil, vegetation, fire regimes and local communities of each reserve.

Chapter Three involves the first stage of data collection. This chapter looks at the community workshops held in the Wild Coast with rural communities around the reserves. The aim of the workshops was to find out which natural resources are considered to be most important in the lives of rural people. Other objectives were to establish the frequency and quantities of material collection and to gather information on species usage.

Chapter Four looks at the second stage of data collection involving the key species identified from the community workshops. In this section methods of data collection and analysis are detailed. Data was analyzed following methods used by Obiri *et al.* (2002), Lykke (1998), Condit *et al.* (1998) and Everard (1995). This chapter aims at constructing inventories that explain the population status for each of the key species.

Chapter Five aims at categorizing key species according to their harvesting potential. Harvesting potential was based on data analysis from Chapter Four. Further grouping, focusing on conservation priority, was based on a paper by Dzerofos and Witkowski (2001). Included in this chapter is the mapping of harvesting and conservation zones in each reserve using geographical information systems (GIS) incorporated with species distributions.

Chapter Six is the concluding chapter and looks at management and monitoring practices in brief. It also discusses the use and importance of adaptive management and monitoring in the Wild Coast reserves. The chapter draws on issues discussed during an expert workshop with ECP member Jan Venter and other experts in the field from Rhodes University in June 2010.

4. Natural resource use by rural people in South Africa with emphases on the Eastern Cape

Just under half of the South African population resides in rural areas. But the distribution of these rural dwellers is not uniform. For most of the 20th century the South African government restricted landownership, use and residency on the basis of racial grounds, now known as the apartheid era. Under a series of racially discriminatory laws, black South Africans were forcibly removed to small

pockets of land (homelands or bantustans) according to ethnic groups. Due to these policies and neglect by the central government these areas became nodes of severe poverty, the legacy of which remains visible today. Relative to other areas of South Africa, they are densely populated, with high levels of poverty, unemployment and inadequate infrastructure. As a consequence, rural inhabitants typically adopt a wide range of livelihood activities to make ends meet (e.g. Hebinck & Lent 2007). A significant one is the collection of wild resources for household consumption, trade and use as a safety net during adverse times (Shackleton & Shackleton 2004). This manifests as extensive extraction and use of hundreds of species in dozens of use categories to provide basic needs such as energy, food, forage, shelter, medicines and weaving fibers.

Within south and Southern Africa there has been extensive research on the use of wild natural resources and their role and importance in local livelihoods (e.g. Campbell 1996, Campbell *et al*. 1996, 2002, Lawes *et al*. 2004, Chidumayo & Gumbo 2010, Shackleton *et al*. 2010). Much of it parallels the literature from other developing regions as India and Southeast Asia and Latin and South America (e.g. see chapters in Kusters & Belcher 2004, Hussain 2008). The importance of natural resources in absolute amounts and relative contribution to livelihoods are significant. This poses policy and regulatory challenges to ensure natural capital is not irreversibly eroded with obvious consequences for poverty and conservation scenarios.

The Eastern Cape province includes two of the former homeland areas, namely Transkei and Ciskei, and so a high level of poverty exists in the Eastern Cape mostly due to unemployment (49 % of 6.3 million people) and economic stagnation (Dold & Cocks 2002, Gyan & Shackleton 2005). It is therefore no wonder that the use of natural resources or non-timber forest products (NTFP) plays a large role in rural livelihoods as a source of sustenance and as a safety net during difficult times (Cocks *et al*. 2004, Shackleton *et al*. 2004, Gyan & Shackleton 2005, Shackleton *et al*. 2007). This is particularly true for the poorest of households where natural resources may be the only source of income, while wealthier households may acquire substitutions to natural resources (Botha *et al*. 2004a, Cocks *et al*. 2008). The relationship between poverty alleviation and biodiversity conservation is uncertain; the two are seen to conflict as resource rights limit income, and at times it is argued that rural development may pose a threat to biodiversity (Kepe 2004, Gyan & Shackleton 2005, Kobokana 2007). Indigenous medicines from plant material are estimated to be used by 27 million consumers in South Africa, with 700 plant species

traded and harvested from the wild for medicinal purposes (Dold & Cocks 2002, Keirungi & Fabricius 2005). The growing urban population throughout Africa has led to scarcity of numerous medicinal plants due to an increase in trade demands which greatly threatens biodiversity (Dold & Cocks 2002, Botha *et al*. 2004b). This harvesting pressure affects the productivity and viability of popular medicinal plants causing the income of traders to wane (Botha *et al*. 2004b). Uncontrolled harvesting of wild plant populations has already resulted in species scarcity, such as *Juncus kraussii* used for weaving in KwaZulu-Natal, or even extinctions from the wild such as *Siphonochilus natalensis* (wild ginger) and *Warburgia saltutaris* (pepper bark tree) (Cawe & Ntloko 1997). NTFPs can be described as wild edible herbs and fruit, craft materials, medicinal plants, wood for fuel and construction, mushrooms and various other natural resources (Dovie *et al*. 2007). The most common NTFPs (wood for fuel and handicrafts, grasses or wild spinach and edible fruit) in South Africa are used by over 85 % of rural households and 30 000 households in Kwazulu-Natal province alone trade in wild plants for income resulting in 4 000 tones of plant material traded annually summing to approximately R60 million (Botha *et al*. 2004a, Cocks *et al*. 2004, Shackleton & Shackleton 2004). Cocks *et al*. (2008) found that 243 plant species were being used in the Peddie and King William's Town district, Eastern Cape, with only 14 of these species being exotic. Natural resources not only provide income through trade and other commercial uses, but also for subsistence and cultural uses (Shackleton & Shackleton 2004). A study from the former Ciskei area in South Africa showed that a third of wild plant species used were for cultural and spiritual purposes (Cocks *et al*. 2008).

Wood is the most extensively used resource in rural communities in South Africa and has numerous uses such as for fuelwood, handicrafts and construction materials, including for houses, kraals, fencing and cultural woodpiles (Shackleton *et al*. 2002, Timmermans 2002, Shackleton & Shackleton 2004, Cocks *et al*. 2008).Generally, most rural people preferred using indigenous trees to introduced trees as they are more durable and are more suitable for traditional construction and fire-making (Motinyane 2002). In the state forest and community forest of Umzimvubu district of the Eastern Cape only two species (*Englerophytum natalensis* and *Millettia grandis*) could sustain the current levels of harvesting due to their high densities and recruitment capabilities (Obiri *et al*. 2002). The study by Shackleton *et al*. (2002) in the Kat River Valley showed that the preferred fuelwood species by two of the studied villages in the area were *Acacia karroo*, *Tarchonanthus camphoratus*, *Coddia rudis* and *Maytenus heterophylla*. The trees species *Ptaeroxylon obliquum, Pappea capensis, Schotia afra, Maytenus undata* and *A. karroo* are

preferred species for fuelwood in Pikoli in the Peddie district of the Eastern Cape (Motinyane 2002). Motinyane (2002) gives a list of 23 indigenous tree species and their use in Pikoli district.

Important species for fencing and construction in the Umzimvubu district of the Eastern Cape include *Drypetes gerrardii, Duvernoia adhatodoides, Englerophytum natalensis, Ptaeroxylon obliquum* and *Millettia grandis* which had the highest harvesting levels in comparison to tree species seldom used for construction (Obiri *et al*. 2002). In the Woodlands village of the former Ciskei, kraals are constructed by 84 % (n = 123) of the households and amount to 52 kg of poles and 913 kg of branches per annum per household as shown in the study by Cocks and Wiersum (2003). Obiri *et al.* (2002) found that trees most harvested fall into the 10 to 20 cm diameter category as they are used as poles. Kraals and woodpiles (used for cultural and ritual purposes) in the rural villages of Peddie and King William's Town are maintained using wood from *Olea europaea* subsp. *africana* and *Ptaeroxylon obliquum* selected for their durability, lasting over a century untreated (Che & lent 2004, Cocks *et al*. 2008). These two species also hold a cultural significance as they are used as platters on which sacrificed animal carcasses are placed. 'Igoqo' in the Woodlands households are woodpiles with cultural significance particularly to women of the household and use approximately 1 399 kg of wood per annum per household (Cocks & Wiersum 2003). Scheepers (2004) also mentioned *Schotia latifolia* and *Acacia caffra* as being used as kraal posts. Wood is used for crafting furniture and utilitarian items (spoons, bowls, walking-sticks, handles and tools, etc.) that can be used in the household or traded (Shackleton *et al*. 2002, Shackleton & Shackleton 2004).

Fibrous plants such as reeds, grasses and palms provide material for making crafts such as mats, baskets and brushes (Pereira *et al*. 2006). The most commonly used species in the Eastern Cape are *Cyperus textilis*, *Juncus kraussii*, *Phoenix reclinata, Cannamois virgata* and *Flagelleria guineensis* (Gyan & Shackleton 2005, Pereira *et al*. 2006). The palm leaves of *P. reclinata* are shredded and bound together to make short handled brushes (Gyan & Shackleton 2005). *Cannamois* species (Restionanceae family) are also used for making brushes (Shackleton & Shackleton 2004). In the Nelson Mandela Metropole grass brooms are made from *Cymbopogon validus*, a common grass throughout the eastern region of South Africa (Cocks & Dold 2004). Large and small grass brooms are used for cleaning and cultural purposes are replaced up to three times a year (Cocks & Dold 2004). The tall sedge *C. textilis* was

considered as the most important material for making baskets and mats in Khanyayo Village in the Pondoland region of the Wild Coast (Makhado & Kepe 2006).

In the study by Cocks and Wiersum (2003) in the Woodlands village of the former Ciskei, 33 % (n = 49) of the households used wild plants for traditional medicine amounting to 12 kg per annum per user household. Fifty five species were used in traditional medicines with *Bulbine latifolia* (used to cleanse the blood), *Dioscorea sylvatica* (body wash to ward off evil) and *Ballota africana* (treats coughs and fevers) being the predominantly used species (Cocks & Wiersum 2003). Indigenous plant medicines purchased in the Eastern Cape were predominantly used as protection against evil spirits (61 %), for good luck (23 %) and for cleansing the blood (10 %) (Cocks & Dold 2004). Cocks *et al*. (2004) listed the top 10 medicinal species sold by traditional healers in the Eastern Cape; these included *Helichrysum odoratissimum, Hypoxis hemerocallidea* and *Rhoicissus digitata*. Keirungi and Fabricius (2005) listed the 17 most important medicinal plants used in the Nqabara Administrative Area in the Wild Coast of the Eastern Cape. Of these the tree *Strychnos henningsii* was most important followed by two climber species *Araujia sericifera* and *Behnia reticulata*. Half of the species listed were trees of which *Protorhus longifolia* and *Schotia latifolia* were ranked highly. Traditional healers in the Nqabara Administrative Area divulged that medicinal plants had become scarce; especially large trees used for their bark (Keirungi & Fabricius 2005). Certain species are used for cosmetics such as *Cassipourea flanaganii* bark and *Hypoxis argentea* both used to smooth and lighten facial complexion, and sap from *Ganoderma* spp. used in cosmetics (Che & Lent 2004). Bhat and Jacobs (1995) list 26 medicinal plant species and their uses, and Rose (1972) list over 50 *Senecio* species used as medicine and food in the Transkei.

Shackleton *et al*. (2002) found that wild edible herbs were used extensively by the rural villagers in the Kat River valley. They found that between 86 % and 95 % of households per village were consuming wild edible herbs. Wild herbs provide nutrients that are often lacking in rural peoples diets and adds spice and taste to a meal (Dovie *et al*. 2007). Species commonly collected in the Kat River valley were *Taraxacum officinale*, *Chenopodium album*, *Urtica urens*, *Raphanus raphanistrum* and *Amaranthus hybridus* var. *hybridus* (Shackleton *et al*. 2002). In the Transkei about 21 types of leaf are used as condiments and about 23 roots and bulbs used when available (Wehmeyer & Rose 1983). Wild spinach is also important in rural diets because many wild spinach species are rich in vitamin A (McGarry 2008, McGarry & Shackleton 2009). In the study by McGarry and Shackleton (2009) wild spinach species most

frequently consumed are *Cucumis metaliferus, Bidens pilosa, Solanum nigrum, Amaranthus* spp*., Urtica urens* and *Sonchus oleraceus*. Other common wild plant species or 'imifino' used as spinach in the Transkei are *Sonchus asper, Chenopodium album* and *Centella coriacea* (Wehmeyer & Rose 1983).In the Transkei as many as 83 wild fruit species are collected when available (Wehmeyer & Rose 1983). About 26 wild fruit species were used in the Kat River Valley including *Scutia myrtina*, *Dovyalis rotundifolia* and *Pappea capensis* with *Opuntia ficus-indica* (prickly-pear) being the most consumed wild fruit species (Shackleton *et al*. 2002).

The use of bushmeat in the Kat River valley consisted mainly of trapping and opportunistic kills of small birds and animals (Shackleton *et al*. 2002). Some households hunt occasionally, however only a small few households consume bushmeat (Shackleton *et al*. 2002). Rock hyraxes, doves, scrub hares and two species of fish were recorded by Shackleton *et al*. (2002) as being used. Animal parts are also used in traditional medicine primarily to "instil a sense of power and magic to a potion" as quoted by White *et al*. (2004). The trade in mammal parts is greater than for birds, reptiles or invertebrates and are commonly derived from forest mammals such as the vervet monkey (*Cercopithecus aethiops*), bushbuck (*Tragelaphus scriptus*) and the large-spotted genet (*Genetta tigrina*) (White *et al*. 2004).

5. The use of natural resources in and around three nature reserves on the Wild Coast

The Wild Coast is situated in the Transkei in the Eastern Cape and stretches for 300 km along the coast from the Great Kei River in the south to the Umtamvuna River in the north (Figure 1). The Wild Coast has poorly developed infrastructure and severe poverty, but is admired for its undisturbed coasts and its rare and endemic vegetation. The vegetation is characterized by open grassland and six different forest types which include Pondoland Coastal Forest, Dune Forest and Swamp Forest (Kepe 2002). Literature on natural resource use was reviewed for the following three coastal reserves in the Wild Coast namely Dwesa-Cwebe, Mkambati and Silaka Nature Reserves. Appendix 9 lists the species recorded in the literature and their uses.

5.1. Dwesa-Cwebe Nature Reserve

The Dwesa-Cwebe Nature Reserve incorporates two state forests that protect some important natural resources. Natural resources are collected from the surrounding pockets of forests outside of the reserve. The forests provide wood for fuel, crafts and building as well as medicinal plants (Timmermans 2002).

Shackleton *et al*. (2007) reported that all households in the Dwesa-Cwebe area use fuelwood, with Ntubeni and Cwebe villages using a mean annual weight of 4725 kg and 4074 kg, respectively. The annual direct-use value of this resource per household amounted to R3 662 at Ntubeni and R3 257 at Cwebe. The most commonly used species for firewood are *Buxus macowanii* (boxwood), *Acacia karroo* (sweet thorn) and occasionally *Eucalyptus* species (Timmermans 2002).

Local forests provide wood for the construction of houses, kraals and fences, and also for utilitarian items such as storage bins, plough handles and sledge baskets (Timmermans 2002, Shackleton *et al.* 2007). The style and size of the house determines the type and amount of wood used. Houses range from rondavels that are made from wattle and daub and hewn poles (this requires up to 75 poles for construction), to flats and modern houses that use bricks, mortar and tin (Timmermans 2002). The study by Palmer *et al*. (2002) found that commonly used trees for poles were *Ptaeroxylon obliquum* (sneezewood), *Xymalos monospora* (lemonwood) and *Eucalyptus* species. To fence a garden requires between 200 and 500 poles and between 40 and 80 poles to construct a kraal. Species such as boxwood and spiny gardenia are used as weaving material in between poles (Timmermans 2002). Thorn branches are occasionally stacked in between poles (Shackleton *et al*. 2007). The annual direct-use value across all households in Ntubeni and Cwebe is R33 for fences and R32 for kraals (Shackleton *et al*. 2007).

Handicrafts such as walking sticks and traditional weapons are made from woody species such as *Combretum krausii*, *Strychnos decussate*, *Vepris lanceolata* and *Millettia grandis* while items such as sledges, ploughs and hoes are made from species such as *Zanthoxylum capensis*, *Heywoodia lucens*, *Clerodendrum glabrum*, *Mimusops caffra*, *Ochna natalitia*, *Buxus macowanii*, *Millettia grandis*, *Vepris lanceolata* and *Apodytes dimidiata* (Timmermans 2002). Shackleton *et al*. (2007) found in their study that fighting sticks, axe and hoe handles, and spoons were the most used item in households. Over the

past 5 to 10 years households have felt that availability of wood has decreased due to the restriction of harvesting in Dwesa and Cwebe forests (Shackleton *et al*. 2007).

The study by Shackleton *et al*. (2007) found that thatch grass was used by 96 % of households in Ntubeni and Cwebe as roofing material for rondavels and other structures, and that 77 % of households in Ntubeni collected their thatch from the reserve. Thatch grass is more abundant in the reserve due to harvesting regulations while distribution is patchy outside of the reserve (Timmermans 2002). Many residents from the Ntubeni village feel that the abundance of thatch grass has decreased, thought to be due to wild fires, while residents from Cwebe feel that there is sufficient thatch grass (Shackleton *et al*. 2007). Two *Cymbopogon* species (*C. excavatus* and *C .validus*) are favored as thatching material for their smooth finish and durability of over 20 years. Other thatch grass used are *Miscanthus capensis* and *Sporobolus fimbriatus* (Fay 1999, Timmermans 2002).

Certain grasses and reeds are used for weaving items such as sleeping mats, place mats, beer strainers and baskets (Fay 1999, Timmermans 2002, Shackleton *et al*. 2007). Important reeds used are *Cyperus textilis* (the common rush) and *Juncus kraussii* (Fay 1999, Timmermans 2002). Shackleton *et al*. (2007) found that the annual direct-use value of weaving reeds to households in Ntubeni and Cwebe is R106. Of the weaving items mentioned sleeping mats had the highest direct-use value per annum at Ntubeni and Cwebe. Between four and five sleeping mats were used per household (Shackleton *et al*. 2007).

Grasses in the Dwesa-Cwebe area have other uses such as for making rope, bracelets and brooms (Fay 1999, Timmermans 2002, Shackleton *et al*. 2007). Rope is made from grasses such as *Cymbopogon* species, *Typhae latifolia*, *Sporobulus africanus* and *S. fimbriatus* (Fay 1999). Short and long handled brooms are used by households and according to Fay (1999) are often made from the wiry grass known as ‘Isilevu’.

The sedge *Cyperus pulcher* was mentioned by Fay (1999) as being used in rituals, such as ‘intonjane’, a femal life-cycle/fertility ritual where it is laid on the floor of the women’s isolated hut. Also mentioned are two grasses only known as ‘intsasela’ and ‘ukwane’ used in ‘intonjane’ and in the construction of circumcision huts for men, respectively.

In Ntubeni and Cwebe about 22 wild fruits were mentioned as being used and amounted to a direct-use value of R51.10 per user household per annum. Most common fruits used include *Harpephyllum caffra* (wild plum), *Rubus rigidus* (bramble) and *Scutia myrtina* (cat-thorn) (Shackleton *et al*. 2007).

Fay's (1999) study on natural resource use in Dwesa-Cwebe showed that 90 % of the people in the area make use of edible wild plants. Wild spinach species are commonly consumed totaling to 1 561 wild spinach plants consumed a year per household (Shackleton *et al*. 2007). Other less conspicuous natural resource used on occasion are wild honey, wild mushrooms and bushmeat. Animal species most commonly eaten include *Tragelaphus scriptus* (bushbuck), *Potamochoerus pocus* (bushpig), *Cercopithecus aethiops* (monkey) and *Sylvicapra grimmia* (common duiker) (Shackleton *et al*. 2007).

5.2. Silaka Nature Reserve

Cloete (2004) presents a checklist of floras in the Port St. Johns area (Appendix 3 of Cloete 2004) listing 1,053 species, 582 genera and 164 families. A key species used in income-generation activities is the common climber *Flagellaria guineensis*, used in the Port St. Johns district for weaving baskets which are sold in cities throughout South Africa. Cawe and Ntloko (1997) estimated that 56 tonnes were harvested between 1979 and 1989 from 97 forests in the area. Cawe (1999), working further north, concluded that there was scope for greater harvests and intensification of the industry. Fielding *et al.* (2006) provide a list of plant species in the Silaka Nature Reserve. Obiri *et al*. (2002) reported on detailed work with respect to use of forest tree species from the forests around Port St. Johns. Twenty six species are listed, for a variety of purposes. *Drypetes gerrardii* and *Ptaeroxylon obliquum* were used for the greatest number of purposes, followed by *Englerophytum natalensis*. Purposes using the widest number of species were construction and poles, both of which were represented by 11 species.

It was in the region of Port St. Johns that Obiri & Lawes (2002) surveyed the attitudes of local communities to different management models for State forests, and whether or not harvesting should be permitted. There was strong support amongst communities that harvesting from State forests should be (i) permitted, and also (ii) controlled. Many favoured that the management and control should be via State agencies, or a partnership between State and communities groups. Relatively few were in favour of the primary responsibility for management and control being transferred to communities.

5.3. Mkambati Nature Reserve

Natural resources in the area surrounding the Mkambati Reserve and within the reserve contributes to rural peoples livelihoods by providing grass for grazing and thatching, wood for fuel and construction, and medicinal plants that enrich rural people's livelihoods (Kepe & Scoones 1999, Cousins & Kepe 2002). The vegetation is mainly grassland with forests near river gorges and small patches of swamp forest in low-lying areas (Shackleton 1992, Shackleton & Shackleton 1994, Cloete 2004). With more than 80 % (62.5 km^2) of the Mkambati Nature Reserve consisting of grassland, rural people (especially poor women) make extensive use of thatch grass for building and crafts (Shackleton 1989, Kepe *et al*. 2000, Prinsloo 2000).

Grass is collected inside the reserve via payment to reserve officials or is collected outside of the reserve (Cousins & Kepe 2002), however the distribution and availability of favored thatch grass species such as *Cymbopogon validus* is greater inside the reserve (Shackleton 1989). Kepe (2002) identified 11 species used for thatching in his study in the Ngwenyeni village, located 15 km inland from Mkambati Nature Reserve. Although *C.validus* is preferred because of its smooth finish and durability, other species such as *Aristida junciformis*, *Digitaria eriantha*, *Miscanthus capensis* and *Hyperrinia hirta* are also used as thatching material (Kepe *et al*. 2000, Cousins & Kepe 2002, Kepe 2002). The demand for *C. validus* from the reserve as a thatching material was shown to be 13 688 bundles per annum by Shackleton (1989) which is approximately 18 % of the total grass available at the time of the study. Thatch material is used not only for dwelling huts but also to construct storage huts for maize and livestock huts to keep livestock in at night or out of bad weather (Kepe 2002). In the Ngwenyeni village within a two year period 51 % of households had used thatch material to build roofing for new huts, and 60 % had used thatch material to repair their roofing (Kepe 2002).

The sedge *Cyperus textilis* is the most used and important species in craftwork in the Mkambati region. It is used to make sitting mats, food mats and collecting baskets (Kepe 2002, Kepe 2003). Harvested from local streams this sedge is in high demand with bundles of 2 kg to 4 kg of culms harvested to make a sleeping mat which lasts between 3 and 5 years (Kepe 2002). Other species used in crafts include *Typha capensis* (pillows), *Digitaria eriantha* (rope, bangles and floor mats) and *Aristida junciformis* (brooms) (Kepe 2002, Kepe 2003).

Wild edible leaves, known as 'imifino', form an important part of rural people's diet as a supplement to a maize-based diet, and are recorded by Kepe (2002) as being regularly used by every household in the Ngwenyeni village. From Kepe's (2002) study 20 species were identified as being used as 'Imifino'. Of these species *Amaranthus* sp., *Bidens pilosa*, *Scuria* sp. and *Urtica urens* are amongst the most preferred wild edible leaves, but are also regarded as being the most difficult to collect, besides *Bidens pilosa* (Kepe 2002).

Most medicinal plants in the Ngwenyeni village are collected for trade in city markets and are most often harvested from the reserve while medicinal plants used domestically are found in the surrounding area of the village (Kepe 2002). Important plants identified by Kepe (2002) included *Artemisia afra* (used to treat common colds), *Knowltonia vesicatora* (used to treat common colds and toothache) and *Gunnera perpensa* (used in childbirth and treatment of wounds). Of the 12 most commonly traded medicinal plants recorded only three were scarce while most were relatively easy to access. Kepe (2002) provides a list of medicinal plants used in the region of Mkambati (Appendix 7.1 of Kepe 2002).

Hunting of wildlife in and around the Mkambati Nature Reserve is mentioned by Kepe *et al*. (2000) and again by Cousins and Kepe (2002). Unemployed men from surrounding villages hunt as a supplement for their diet and to trade certain animal species and parts for traditional medicine as an additional source of income.

CHAPTER TWO: Study Area

1. The Wild Coast

The Wild Coast is situated in the section of the Eastern Cape formally known as the Transkei (Figure 1). It covers an area of 42 240 km^2 and stretches for 300 km along the coast from the Great Kei River in the south to the Umtamvuna River in the north. The Eastern Cape is the third largest province in South Africa representing 14.4 % of the total population (Statistics South Africa 2000). The Wild Coast is estimated to house a population of 1.4 million people at a density of 96 people per km^2 (PondoCROP closure report 2005). People living in the Wild Coast face problems such as high unemployment rates, low levels of education and widespread illiteracy. This is largely due to poorly developed infrastructure and severe poverty. However, the Wild Coast is admired for it large tracts of relatively undisturbed coasts and its rare and endemic vegetation.

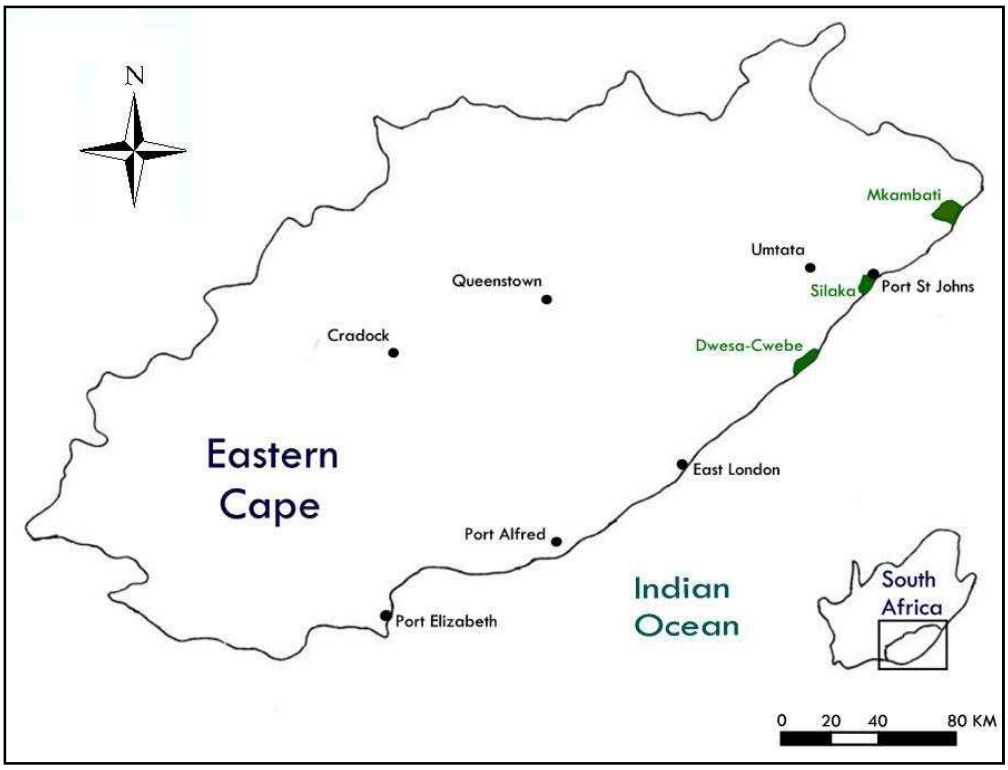

Figure 1: The Eastern Cape Province in South Africa and location of the Wild Coast Nature Reserves.

There have been very few biological inventory studies in the Wild Coast area, yet it is zoned as having a high proportion of endemic species. The Wild Coast is unique in that it is a transitional zone between the north-east and southern faunas, and represents an area with high probability of endemic species occurring as it has some geographically unique features (Burger 1996). Its off-shore areas display a unique mix of tropical and temperate ecosystems and its coastlines have pockets of sandy beaches and estuary mouths (Kobokana 2007). The vegetation is characterized by open grassland and six different forest types which include Pondoland Coastal Forest, Dune Forest and Swamp Forest (Kepe 2002). With its spectacular coastlines and unique geography the area has become one of the main tourist attractions in the province. There are a number of nature reserves which all have indigenous forests and form the main attraction for eco-tourism. These include Dwesa-Cwebe, Mkambati and Silaka Nature Reserves (Figure 1).

2. Dwesa-Cwebe

2.1. Location

The Dwesa-Cwebe Nature Reserve (32^{o}12'S and 28^{o}58'E) is situated on the Wild Coast between the Nqabara River and Ntlonyana River and covers an area of approximately 57 km^{2}. The reserve touches about 24 km of coastline and extends inland for 8 km where it is bounded by a fence (Palmer & Fay 2002, Timmermans 2004). The Dwesa and Cwebe sides are divided by the broad, fast-flowing Mbashe River (Figure 2). The closest towns inland to Dwesa are Willowvale (50 km) and Dutywa (75 km), while the closest towns to Cwebe are Elliotdale (50 km) and Umthata (100 km).

2.2. Climate

The reserve is located in a climatic transition zone between the temperate south coast and the subtropical north coast with wet summers and dry winters (Palmer & Fay 2002, Shackleton *et al*. 2007). The area generally has high temperature and humidity with a maximum temperature of 26 ^{o}C in the summer and a minimum of 12 ^{o}C in the winter. The average rainfall is 1 069 mm per annum and the area is frost free (Palmer & Fay 2002).

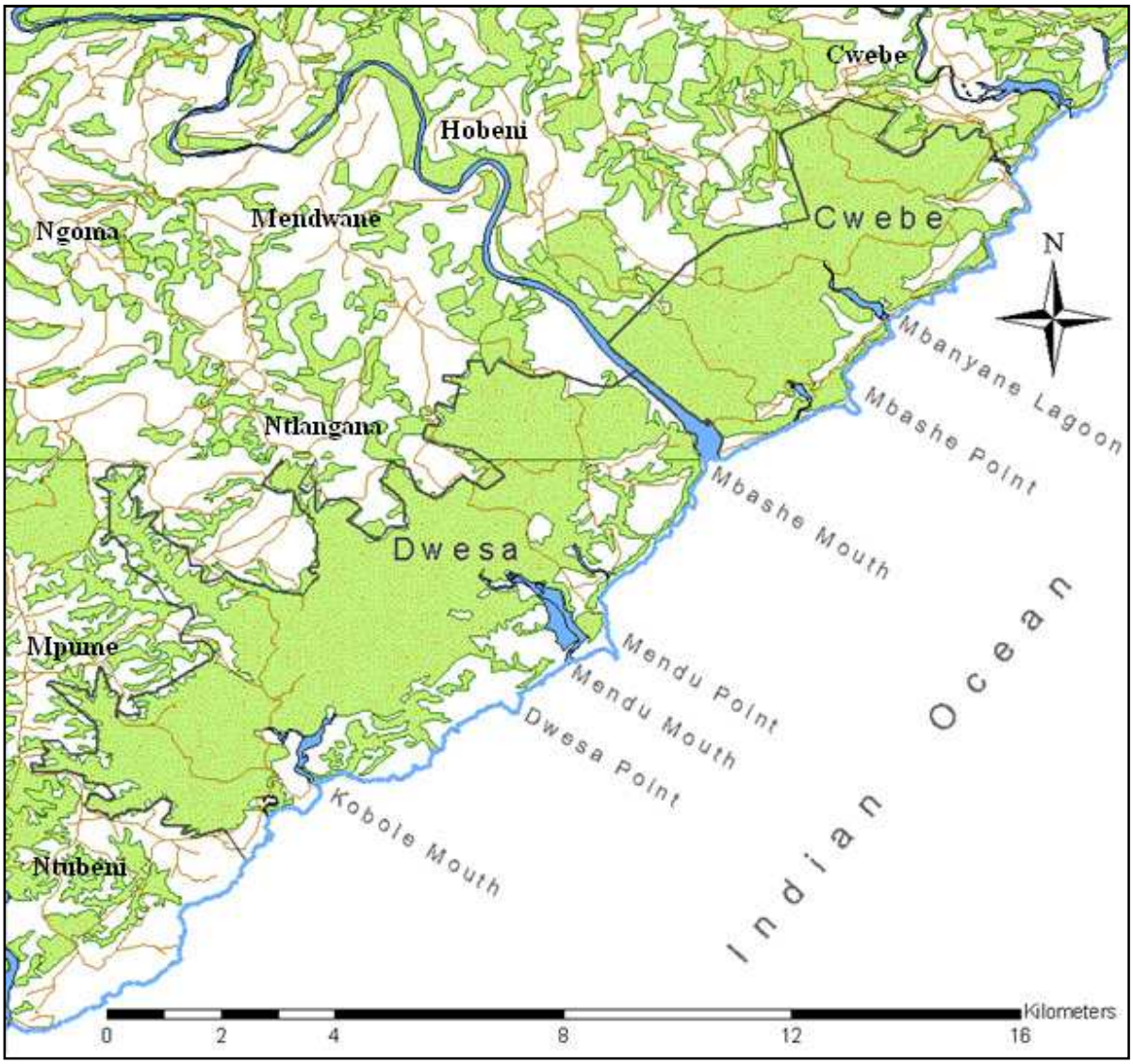

Figure 2: The Dwesa-Cwebe Nature Reserve and surrounding villages in the Wild Coast.

2.3. Geology and soils

The most common rock material in the area is Beaufort and Ecca shales derived from the Karoo subgroup (Timmermans 2004). These shales are described as mineral poor, giving rise to fine-textured soils which tend to become water logged in wet seasons and are prone to desiccation in dry seasons.

The soils often become leached and acidic with high rainfall and are deficient in phosphate and potassium. Overall the soils are considered to be poor, weakly developed and not suitable to agriculture.

2.4. Vegetation

The area falls within the Tongoland-Pondoland Regional Mosaic and the vegetation type was initially described by Acocks (1988) as Coastal Forest and Thornveld (Timmermans & Naicker 2002). The more recent mapping by Mucina & Rutherford (2006), classify it as Transkei Coastal Belt vegetation interspersed with South Mistbelt and Scarp forests. The reserve comprises of two State forest reserves and a national marine reserve. The indigenous State forests stretch for 18 km along the coast and covers 68.5 % of the reserve (Palmer 2003). On the Dwese side the indigenous forest is vast covering an area of about 27.9 km^2 which makes up 72.2 % of the reserve (Timmermans 2004). On the Cwebe side the indigenous forested area is approximately 15.9 km^2 making up 83.1 % of the reserve. The subcanopy of the main forest in both reserves is dominated by *Buxus natalensis*, while *Millettia grandis* is in abundance at the forest margins. Grasslands and the coastline make up the majority of the remaining area (Palmer 2003, Timmermans 2004, Shackleton *et al*. 2007). The coastal grassland in the reserve is described as moist grassland, characteristically sour to mixed sour grasses being dominated by the salt-tolerant buffalo grass (*Stenotaphrum secundatum*) (Timmermans & Naicker 2002, Timmermans 2004). Other grass species found include *Themeda trianda* and *Apochaete hispida*. Outside of the reserve grassland is the most common vegetation type and is mostly associated with common grazing areas or old cultivated land. Common grass species outside include *Stenotaphrum secondatum*, *Dactylon austral*, *Tristachya leucothrix*, *Cymbopogon marginatus*, *Miscanthus capensis* and various *Eragrostis* species. Forest plantations and woodlots are established in the area to provide wood (predominately of *Eucalyptus grandis*) to the communities as an alternative to indigenous woods. Some of these woodlots include Gala-gala woodlot (0.5 km^2), Cwebe woodlot (0.3 km^2) and Tembu woodlot (0.06 km^2) (Timmermans 2004).

2.5. Wildlife

Ten large mammal species were introduced to the reserve during the late 1970s and early 1980s, most of which were not known to naturally occur in the area. However, they were introduced to create the

first national wildlife reserve of the Transkei. Poaching ensued with the introduction of animals such as small antelope, and became rife between the 1980s and 1990s due to unrest between communities and the reserve. Today poaching occurs on a smaller scale, generally with the use of dogs. Small buck, bush pigs and cane rats are commonly hunted. Also rock hyrax, monkeys and hares are hunted by groups of local boys. Larger animals in the reserve include buffalo, rhinoceros and zebra. Species classified as threatened that are found or expected to be found in the reserve include aardwolf, aardvark, African wild cat, blue duiker, giant golden mole, greater musk shrew, Samango monkey, serval, striped weasel, Schreibers long-fingered bat, and tree hyrax (Timmermans 2002). The area is considered to be highly productive with diverse terrestrial and marine environments (Shackleton *et al*. 2007).

2.6. Fire regimes

The use of fire for grassland management in the Dwesa-Cwebe area has declined in recent years, but was used historically in combination with grazing to maintain grassland areas (Timmermans & Naicker 2002). High rainfall in the area means that grass productivity is high, resulting in high biomass or burnable material. Grass becomes burnable in autumn (February to May) and the burning season is between February and November. As noted by Fay (1999), burning regimes are unlikely to conflict with harvesting of grasses for thatch as most building activities are done in winter, which preced the burning season.

2.7. People and the land

Between the 1890s and 1930s black residents living in the Dwesa-Cweb forested areas were removed by the state to make way for holiday cottages (Palmer 2003). Harvesting in the reserve was allowed between 1903 and 1976 under the local forestry regulations and with payment of forestry tariffs (Vermaak & Peckham 1996). Dwesa and Cwebe were managed as a combined National Wildlife Reserve from 1976, and consequently access by local communities was terminated until 1994. Following the protest action in 1994 over continued closure of the reserve the government agreed to partially reopen the reserve to harvesting of forest resources and thatch grasses. The marine area remained closed to harvesting (Shackleton *et al*. 2007). The land reform settlement agreement at Dwesa-Cwebe states that the reserve land is owned by the local communities, but must remain a protected area. This area is to be

managed by an agency outside of the community, currently Eastern Cape Parks (ECP). The local communities opted for a lease agreement where the ECP leases the reserve from the community and keeps any profits made by the reserve. However, the community must see benefits coming out of the reserve such as the use of natural resources.

There are four administrative sections that make up the greater Dwesa-Cwebe area. Some of the villages immediately inland from the reserve include Cwebe, Hobeni, Mendwane, Ngoma, Mpume, Ntlangano and Ntubeni. The communal areas are densely populated with an average of 155 people per km^2 (Palmer & Fay 2002). Villages such as Ntlangano have 81 households while larger villages such as Hobeni have 612 households (Shackleton *et al*. 2007). Ntubeni has the largest households and the highest employment rate (10.9 %) compared to other villages (Palmer & Fay 2002). Approximately half the Cwebe and Hobeni residents are above the age of 18, while the majority of Ntubeni residents are below the age of 18 (61.1 %). This may explain the lower percentage of pensioners at Ntubeni (4.5 %) compared to Cwebe (8.5 %) and Hobeni (9.7 %). The landscape is a mosaic of settlements, gardens, fields and grazing land. Many residential areas have abandoned fields which have now become invaded by *Acacia* woodlands. The Cwebe administrative area is mostly forested (25.4 %), however agricultural activities are heavily pursued, consequently limiting the establishment of woody vegetation (Timmermans 2004). The land is mostly used for agricultural and pastoral purposes. Maize is the main crop, and most households own pigs and chickens (Palmer & Fay 2002).The residents of the Dwesa side have a markedly different cultural and social aspect to the residents of the Cwebe side. Dwesa residents have taken on a more Western influenced style and are generally better-educated while Cwebe residents have taken on a more conservative and agrarian lifestyle. This difference can be seen in the construction of their houses such that Cwebe residents have cylindrical structures with thatched roofs, and the Dwesa residents have flats of the more European style. Field cultivation on the Dwesa side has been mostly abandoned in favour of enlarged home gardens, while residents on the Cwebe side practice both home gardens and field cultivation.

3. Silaka Nature Reserve

3.1. Location

Silaka Nature Reserve (29°29'00"-31'00"E and 31°39'10"-40'00"S) is situated in the Port St Johns area, which is located at the mouth of the Mzimvubu River in the Wild Coast (Fielding *et al*. 2006). Port St Johns is approximately 100 km from Umthata and falls within the Umzimvubu Magisterial District (Kepe 2001, Fielding *et al*. 2006). The reserve lies in a forested valley south of Port St Johns town from Second Beach to Sugarloaf Rock, and covers an area of approximately 3.7 km^2 (Figure 3) (Cloete 2004, Fielding *et al*. 2006).

3.2. Climate

The climate is subtropical and humid with a high average rainfall between 1 100 and 1 400 mm per annum. There is rainfall throughout the year but mostly in summer with most rain (70 %) falling between the months of October to March. The temperature is between 25 °C and 13 °C and relative humidity is high between 80 % and 50 % (Cawe 1990, Cloete 2004, Fielding *et al*. 2006). Winds blow north-east and south-west parallel to the coast (Fielding *et al*. 2006). Frost is absent in the area (Cloete 2004).

3.3. Geology and Soils

The area is composed of Karoo sediments of the Beaufort series with sandstones, mudstones, flagstones and shales dominating, and occasionally dolerite protruding. The reserve itself is located on an upstanding fault block of Table Mountain sandstone with younger aged sediments of Ecca, mostly shale, thrown down. The rocky coastal area comprises of Ecca sediments with many intrusions of karoo dolerite extending as far as the mouth of the Mngazi River (Fielding *et al*. 2006).

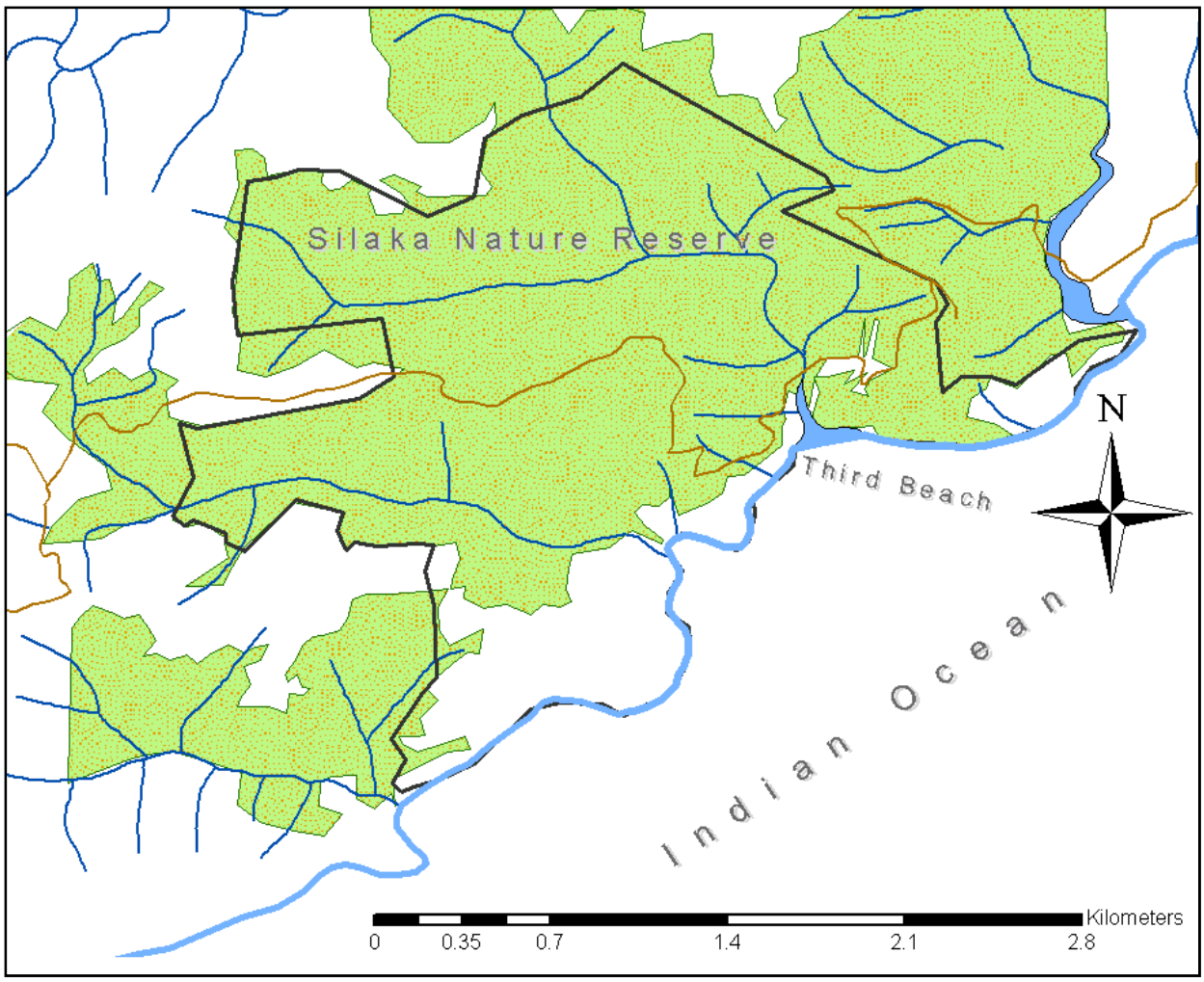

Figure 3: The Silaka Nature Reserve in the Wild Coast.

3.4. Vegetation

The area is described by Acocks (1988) as Coastal Forest and Thornveld, and the grassland as Pondoland Coastal Plateau Sourveld. But Mucina & Rutherford (2006) allocate it to the same vegetation types as Dwesa-Cwebe, i.e. Transkei Coastal Belt vegetation interspersed with South Mistbelt and Scarp forests. It falls within the Forest Biome with intrusions of Savannah Biome patches (Fielding *et al*. 2006). Moist subtropical forest, with tree species such as *Cola natalensis, Sapium ellipticum* and *Hibiscus tiliaceus*, occurs along the coast of Port St Johns northwards (Cloete 2004). The vegetation in the reserve is a mosaic of forest, thicket and wooded grassland with sea facing hills of grasses, *Aloe ferox* and *Strelitzia*

nicolai (Fielding *et al*. 2006). Cloete (2004) presents a checklist of flora in Port St. Johns (Appendix 3 of Cloete 2004) listing 1053 species, 582 genera and 164 families. There are about 80 patches of state forest in the Port St Johns region some as large as 934 ha and numerous patches of headman's forests (Cawe & Ntloko 1997, Kepe 2001). There are two types of forests namely Coastal and Dune forest. The reserve is dominated by Coastal forest which covers about 172 ha of the reserve. Dune forest is not well represented in the reserve. The reserve consists of only 40 ha of grassland which is dominated by *Cymbopogon*.

3.5. Wildlife

Introduced game animals include Blue Duiker, Bushbuck, Blesbuck, Blue Wilderbeest and Plains Zebra. High portions of some of these animals have been lost to poaching (Fielding *et al*. 2006).

3.6. Fire regimes

Fire management is practiced for maintaining the grasslands in Silaka. However, runaway fires and arson have made fire management redundant as efforts have gone into controlling fires rather than using it as a tool (Fieldings 2006). If fire management could be put into practice, regimes would be based on the accumulated mass of grass material resulting in burning every two to four years, with exception to excessively dry periods.

3.7. People and the land

Silaka was managed as a nature reserve from 1983 and comprises of a State-owned farm, an erf owned by the municipality of Port St Johns, portions of two demarcated Government forests on State land and a portion of State land in the Caguba Administrative Area. No arrangements have been made over the Silaka Settlement Agreement as it is still being settled.

Some of the villages in the area of the Silaka Nature Reserve are Caguba, Cwebeni, Isilaka, Mthumbane, Sicambeni and Vukandlule. It is estimated that approximately 7 000 people live in the Port St Johns town, and as many as 60 % of adults are not employed (Kepe 2001, Fielding *et al*. 2006). People are

dependent on subsistence farming, the collection of forest products and most importantly seafood. Livestock farming is poor in the area, however poultry, goats, pigs and cattle are common (Fielding *et al*. 2006).

4. Mkambati

4.1. Location

The Mkambati Nature Reserve (31°13'-31°20S and 29°55'-30°4'E) is situated in the north-eastern Pondoland region of the Lusikisiki district between Mtentu and Msikaba rivers (Figure 4). The reserve has a gentle topography and covers an area of about 7 000 hectares with 12 km of coastline (Shackleton 1989, Shackleton *et al*. 1991, Kepe *et al*. 2002, Kepe 2004, Kobokana 2007). The width of the reserve ranges from 5.5 to 8.2 km and is bounded by a fence to the west (Shackleton 1989, Prinsloo 2000).

4.2. Climate

Mkambati is classified as having a humid and temperate climate with a mean annual rainfall of 1 200 mm peaking in spring and summer (September to February) (Shackleton 1989, Shackleton & Shackleton 1994, Cousins & Kepe 2002). The average temperature for the area is 20 °C, with the warmest months being January and February and coldest being July and August reaching a low of 8.4 °C (Shackleton 1989, Prinsloo 2000). The relative humidity is high all year round with an annual mean of 74 %. Frost is absent in the area (Prinsloo 2000). Wind speeds vary on the coast line and predominantly blow in from the south-west and north-east directions parallel to the coast (Shackleton 1989, Prinsloo 2000). Winds reach a maximum during the summer season (Prinsloo 2000).

4.3. Geology and Soils

The reserve is underlain by a narrow belt of Paleozoic pre-Karroo sediments of the Natal Group sandstone which stretches for about 16 km parallel the coast (Shackleton 1989). The composition of the deposit has minor amounts of feldspar but is dominated by quartz with cementation primarily by silica. The soils are typical of those of the Natal Coastal Belt and are mostly loamy sands. Soils are described as

acidic, dystrophic and sandy, and often become waterlogged during the wet season, but are prone to excessive drying in the winter.

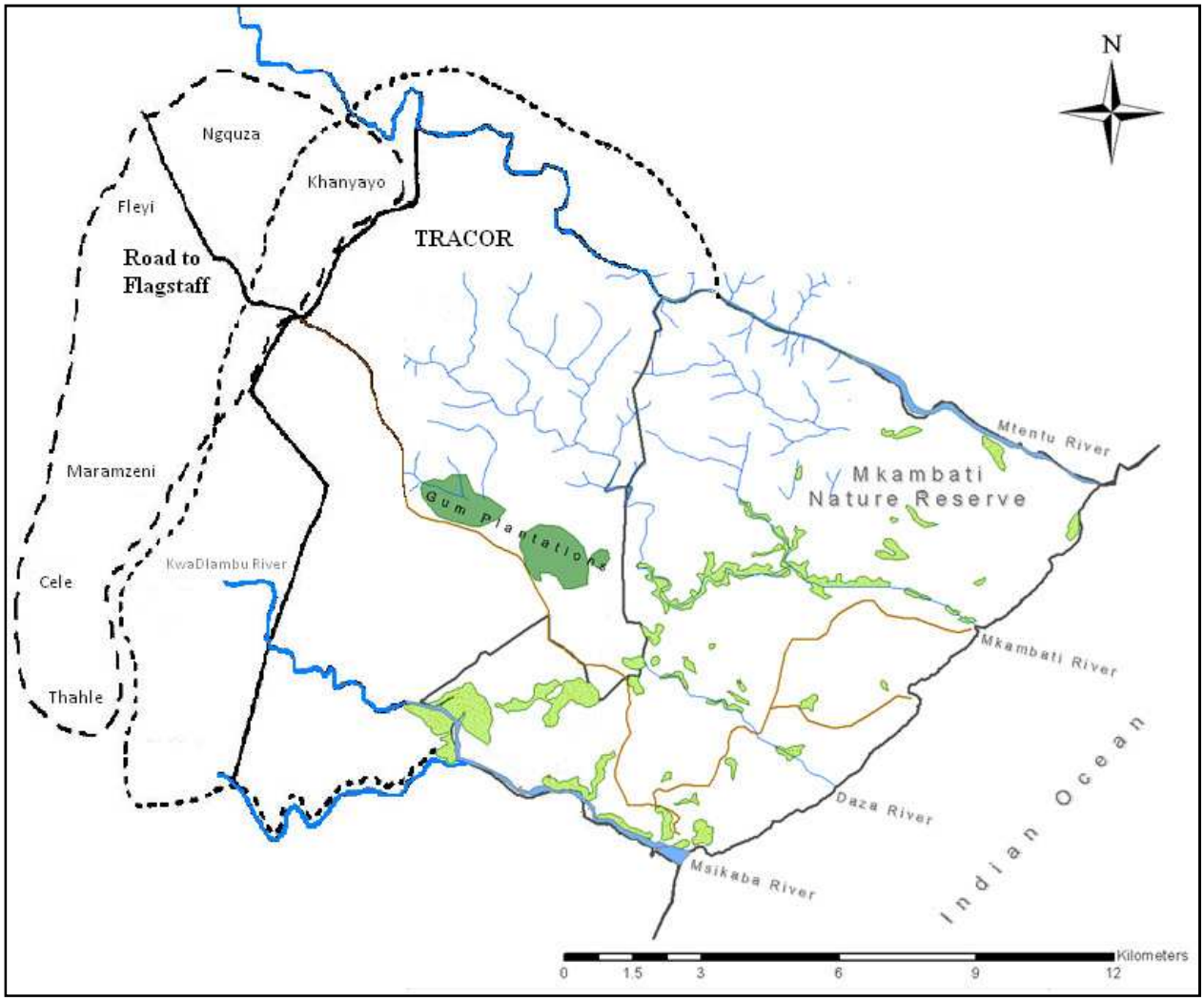

Figure 4: The Mkambati Nature Reserve and surrounding villages in the Wild Coast.

4.4. Vegetation

Mkambati is situated in the Indian Ocean Coastal Belt, which is divided into a mosaic of various vegetation types. One of these types is edaphic grassland which constitutes part of the Tongoland-Pondoland Mosaic which is part of the coastal regional flora and found in the southern portion of the

reserve (Shackleton 1989, Prinsloo 2000). Acocks (1988) describes the vegetation type as Coastal Forest and Thornveld, however the grassland state appears to be one of a highly variegated nature and classification fails to recognize such variation (Kepe 2004). At a finer scale, Mucina and Rutherford (2006) classify it as Pondoland-Ugu Sandstone Coastal Sourveld. Mkambati has a rich biodiversity and the area is considered as being of global importance to biodiversity conservation (Shackleton *et al*. 1991, Davis & Heywood 1994). It falls within the Pondoland centre of plant endemism, and is home to over 118 rare and endemic plant species such as the Pondo coconut palm (*Jubaeopsis caffra*) (Shackleton 1989, Prinsloo 2000, Cousins & Kepe 2002, Kepe *et al*. 2002, Kepe 2004). The reserve is about 80 % sour grassland, which is mostly *Tristachya leucothrix-Loudetia simplex* short grassland, *Cymbopogon validus-Digitaria natalensis* medium grassland and *Themeda triandra-Centella asiatic* dwarf grassland (Shackleton *et al*. 1991, Shackleton and Shackleton 1994). Forests mostly occur as small patches or in ravines. Swamp forests are also found in the area. Cloete (2004) makes an account of floras in the Mkambati region listing 972 species, 597 genera and 136 families (Appendix 3 of Cloete 2004). The area is relatively undisturbed resulting in few alien species (Cloete 2004).

4.5. Wildlife

Large mammals were introduced to the reserve in 1979 most of which were not indigenous to the area, and were largely introduced to support hunting which was established as an enterprise in the reserve (Shackleton 1989). In 1994 when Shackleton and Shackleton conducted their study in the Mkambati Nature Reserve there were about 1 600 wild herbivores. The most prolific herbivore in the reserve is the Blesbok, other species include Gemsbok, Springbok, Eland, Kudu, Impala, Red hartebeest, Blue wildebeest, Burchell's zebra and Mountain zebra (Shackleton 1989). Other species that are found in the area and that are all indigenous include Baboon, Black-backed jackal, Blue duiker, Buffalo, Bushbuck, Bush pig, Common reedbuck, Dassie, Leopard, Porcupine, Serval and Vervet monkey (Shackleton 1989). Mkambati also has one of the richest diversity of reptiles and amphibians in the Eastern Cape (Burger 1996).

4.6. Fire regimes

Burning frequency is high due to high plant productivity and can be burnt up to two or three times a year if desired. High burning frequencies have resulted in the dominance of fire tolerant and resistant species such as *Tristachya leucothrix*, *Trachypogon spicatus* and *Themeda triandra* (Shackleton 1989). Grasslands in the reserve have been burnt biennially since 1984 with three management blocks being burnt each year in July or August (Shackleton & Shackleton 1994).

4.7. People and the land

The area where the Mkambati Nature Reserve now exists was fenced off and established as a leper colony in 1920. This resulted in many residents being forcibly removed. The area was declared a nature reserve in 1977 when the leprosy institution closed down (Kepe *et al*. 2003). The 11 000 hectares of land inland from the reserve was allocated to the Transkei Agricultural Corporation (TRACOR), and the Department of Agriculture and Forestry (Transkei) was given control of the nature reserve in 1991 (Kobokana 2007). In 1992 Khanyayo residents living adjacent to the reserve staged a protest to gain access to resources in the reserve. Following this in 1997, the Khanyayo community formally lodged a land claim. However, this was complicated by community conflicts over land rights. This conflict resulted in intensified illegal harvesting which greatly compromised conservation (Kepe *et al*. 2003). After years of protest, residents gained ownership of the land in 2004 and agreed that it would remain a nature reserve in accordance with the settlement agreement (Kobokana 2007). The Mkambati Settlement Agreement is the same as that of Dwesa-Cwebe, where the reserve land is owned by the local communities, but must remain a protected area. However, unlike the lease agreement at DCNR where ECP leases the reserve from the community and keeps any profits made by the reserve, the communities at MNR claim a percentage of the profits.

The communal area comprises of six administrative sections each of which consists of several villages (Kepe *et al*. 2002). Some of the villages surrounding the Mkambati Nature Reserve include Cele, Khanyayo, Maramzeni, Mtshayelo, Ngquza, Ramzi, Thahle, Umtshayelo and Fleyi (Figure 4). The region also incorporates an area of state farm land belonging to the former Transkei Agricultural Corporation. The people living in the Mkambati area speak Xhosa and mostly live off the land by farming livestock and

crops, and collecting various natural resources (Kepe *et al.* 2002). According to the study by Kepe *et al.* (2002), most people live off remittance (31.2 %) and pensions (17.9 %), and only 15.4 % (n = 234) have full-time jobs (Kepe 2004). Livestock farming of cattle, goats, sheep and equines occurs on mixture of communal pastures that are intermingled among arable areas and settlements.

CHAPTER THREE: Natural resource use amongst communities living adjacent to protected areas along the Wild Coast

1. Introduction

Plants play an important role in all human societies, but perhaps even more so for rural underdeveloped communities, such as those of the Wild Coast. Such use embraces both subsistence, sale, safety-net in adverse periods as well as religious, spiritual and psychological (Bhat & Jacobs 1995, Alexiades 1996, Cocks *et al*. 2004, Shackleton & Shackleton 2004, Gyan & Shackleton 2005, Shackleton *et al*. 2007). The relationship between natural resources and the livelihoods of indigenous people has been well documented in the Eastern Cape (Chapter 1). Such documentation ranges from the importance of non-timber forest products to rural people's livelihood and security by Shackleton and Shackleton (2004), the trade of reed-based crafts products in rural villages by Pereira *et al*. (2006), to the use of wild resources by HIV/AIDS and poverty stricken children by McGarry and Shackleton (2009). Natural resources or non-timber forest products (NTFPs) can be described as wild edible herbs and fruit, craft materials, medicinal plants, wood for fuel and construction, mushrooms and variety of others (Dovie *et al*. 2007).

Local people hold a bank of indispensable traditional and ecological knowledge of their area and species, and so are vital stakeholders in ethnobotanical field surveys (Alexiades 1996, Balslev *et al*. 2010, Steele & Shackleton 2010). Inclusive approaches that also promote sharing and joint learning include a variety of workshop and participatory rural appraisal techniques with the communities that use these natural resources (Berkes *et al*. 2000, Lynam *et al*. 2007). Workshops actively involve the local communities allowing them to contribute meaningful information, with sufficient direction from the planners, that will contribute to a better understanding of the relationship between their needs and local biological resources, and hence towards management planning and conservation (Heberlein 1976). It is important to note that the level of local ecological knowledge is affected by the demographic characteristics such as gender, age, position in the community and household, level of education and ethnicity (Berkes *et al*. 2000, Balslev *et al*. 2010), and consequently workshops should include a wide range of participants and community members, unless specific sectoral perspectives and knowledge is required. The output of

local knowledge encompasses personal experience, traditional or cultural knowledge, former schooling and many other factors (Kaschula *et al*. 2009).

2. Methods

Community workshops were held to determine the key natural resources used by local rural people surrounding the Wild Coast reserves. Community workshops allowed the rural people and reserve staff to engage in discussions about important natural resources in the area and help identify key issues regarding resource use (Kepe 2004). The workshops where held in Mkambati Nature Reserve on the 6th April, Silaka Nature Reserve on the 8th April, Hluleka Nature Reserve on the 19th May and Dwesa-Cwebe Nature Reserve on the 21st May 2009. Workshop participants were given several activities to complete that illustrate the importance of natural resources to local livelihoods, what they are used for and the frequency and quantity collected. A primary output was a list of ten plant species regarded as priority species for subsequent resource inventories in and around each reserve (Chapter 4). A team from Rhodes University planned and conducted the workshops in order to attain guidance from local communities regarding priority species. Members of the group included Charlie Shackleton (Dept of Environmental Science) the project coordinator, Michelle Cocks from the Institution for Economic and Social Research (IESR) and coordinator of the workshops, James Gambiza from the Department of Environmental Science, botanist Tony Dold from the Schonland Herbarium and Joclyn Fearon a Masters student in the Department of Environmental Science. Workshops were pre-arranged by community liaison staff from ECP. Participants were drawn from all neighbouring villages. The number of participants varied from 28 at Dwesa-Cwebe and Mkambati to 37 at Hluleka.

Workshop participants were divided into three groups each led by a Rhodes team member (Michelle Cocks, Tony Dold and James Gambiza). Participants were evenly distributed between the groups, particularly those that were identified as traditional healers, crafters, traders or reserve rangers. Each participant was confidentially asked to give their age, gender, education level, occupation, position in the household, number of household members and the name of the village in which they reside for demographic purposes. The groups were then given a set of activities to complete.

For the first activity participants were asked to list all the resource groups that they used at household level. This included fuelwood, wood for construction or poles, thatching, medicinal plants and animals, fruits, wild spinaches, bushmeat resources, marine organisms. They were then asked to name all the species they use in their households by going through each resource group until the names were exhausted. Each species was written on a card with a permanent marker in its isiXhosa name.

The listed species then had to be ranked according to the frequency that they were used. This was done using three categories as follows:

- 'occasionally collected' (collected once every six months or so)
- 'often collected' (collected monthly)
- 'commonly collected' (collected weekly or more)

These categories were graphically displayed using cut-out circles that represented each frequency so that the small circle represented 'occasionally collected', the medium circle represented 'often collected' and the large circle represented 'commonly collected'. Participants were then asked to choose a category that they thought a species belonged in and to place the species card in the according circle. This information was then recorded by a group leader. Terrestrial animals and marine species were excluded form this exercise as well as the following exercises as plants were the main focus.

Participants were then asked to rank the plant species into three categories according to their importance. The categories were:

- 'important'
- 'very important'
- 'most important' (species that the participants felt they could not live without)

Again cut-out circles were used with the small circle for 'important' and the large circle for 'most important'. The species cards were ranked into their according circles by the participants and then recorded. The participants were then asked to choose ten species from the 'most important' category which they considered the priority species and of exceptional importance to them.

The quantity collected annually of each resource category was then recorded at a household level for two of the groups. This was done by using graphical representations of the containers used to collect resources (bucket, wheelbarrow, pocket full, head load, plastic packet, etc.) and the mode of transport (tractor with trailer, horse cart, bakkie, etc.). Individual participants were then asked what they used to collect each resource category, how often they used it per year, if the season affected the amount collected, whether they traded it and if so what the selling price for the resources were for each quantity traded. Containers used for each resource category were then converted into masses (kg) based upon the work done by Michelle Cocks on quantities of resource material collected at household amongst peri-urban communities in the former Ciskei.

The third group led by Tony Dold was asked to draw a map as a group effort of where resource categories are commonly harvested. One to two participants from the group drew the map while the others helped to construct it. The map was drawn on a large piece of poster paper with different coloured permanent markers. Firstly the reserve, coastline, rivers and main roads were drawn in blue to gain perspective and orientation. Secondly the locations of the villages and their names were indicated on the map. Thirdly members from each village were asked to indicate where they harvested different resource categories. These areas were drawn in green (e.g. forest patches that they are harvested from). Lastly, participants drew in any landmarks or important features such as footpaths in red in order to gain bearing of scale and orientation when locating harvesting areas.

In the last activity participants were asked to describe how they felt resource availability and abundance had changed over the last ten years, whether it has decreased, increased or stayed the same.

Voucher specimens where collected for the top ten species the following day with the assistance of two to four workshop participants. The plant specimens where pressed and taken back to the Schonland Herbarium at Rhodes University for identification by Tony Dold.

3. Results

3.1. Dwesa-Cwebe Nature Reserve

3.1.1. Respondents

Of the 28 participants at the workshop 11 of were male and 17 were female. Respondents were drawn from the villages of Ehoboni, Hobeni, Lurhwayizo, Medwane, Mpume, Ngoma, Nkonjane, Nsimbikazi, Ntlangana and Ntubeni. The demographic survey showed that 17 (61 %) were unemployed, of which some owned livestock. Eight (28 %) were traditional healers and three had other occupations. As many as 20 (71 %) were above the age of 40, of which all males but one were above the age of 40. More than half of the participants (53 %) had an education level between grade 8 and grade 12 while two had no schooling at all (Appendix 1).

3.1.2. Natural resource use

A total of 171 plant species were recorded as being commonly used by participants (Appendix 5). The uses of 112 species were recorded of which the majority had medicinal uses (60.7 %). A number of edibles such as fruits and wild spinaches were identified (20.5 %) as well as building materials (13.4 %) and fuelwood (10.7 %). Other uses included furniture, crafts, brooms, thatching, rope and musical instruments. Others had multiple uses.

3.1.3. Collection of natural resources

On the workshop map of the Dwesa-Cwebe region (Figure 5) collection points of all natural resources are located inside the reserve. Fuelwood was indicated as being collected everyday of which none was purchased. It was estimated that approximately 3 656 kg of fuelwood was collected per household (n=9) per year. Building poles are purchased in the area at a cost of R50 for 40 softwood poles and R70 for 40 hardwood poles. However, participants stressed that they would like to have access to the hardwoods in the reserve. Participants indicated that wild fruits are only collected when collecting

fuelwood, and wild spinaches is only collected in summer at a mean weight of 134 kg per participant (n=9) per year.

Figure 5: Map of the Dwesa-Cwebe region drawn by workshop participants to indicate where natural resources are found (blue= reserve, coastline, rivers and main roads, green= harvesting areas (forest patches etc.), red=landmarks).

3.1.4. Species selected as top ten

Half of the species selected as the top ten most important are for medicinal purposes (Table 1). These include *Dioscorea dregeana* a climber, *Capparis sepiaria* var. *citrifolia* a shrub and *Protorhus longifolia* a tree (all found in the forest). The other medicinal species were the herbs *Helichrysum pedunculare* and *Silene undulata* found in grassland and forest margins, respectively. Two of the species are used in crafts (*Cyperus textilis* and *Juncus kraussii*) and are both herbs found in aquatic environments. One tree species was for building purposes (*Hyperacanthus amoenus*) and the other was used for cultural purposes (*Ptaeroxylon obliquum*), both are found in the forest. The last species, *Millettia grandis*, was used for building and crafts and is also a forest tree.

Table 1: The top ten plant species used by local communities at Dwesa-Cwebe.

Xhosa name	**Botanical name**	**Growth form/habitat**	**Use category**
Imizi	*Cyperus textilis*	Herb, aquatic	Craft
Ingcolo	*Dioscorea dregeana*	Climber, forest	Medicinal
Intsihlo	*Capparis sepiaria* var. *citrifolia*	Shrub, forest	Medicinal
Izicwe	*Helichrysum pedunculare*	Herb, grassland	Medicinal
Nozitholana	*Silene undulata*	Herb, forest margins	Medicinal
Uduli	*Juncus kraussii*	Herb, aquatic	Craft
Umsimbithi	*Millettia grandis*	Tree, forest	Building and craft
Umthathi	*Ptaeroxylon obliquum*	Tree, forest	Customs
Uthongothi	*Hyperacanthus amoenus*	Tree, forest	Building
Uzintlwa	*Protorhus longifolia*	Tree, forest	Medicinal

3.2. Hluleka Nature Reserve

Hluleka was part of the initial programme of investigating the Wild Coast reserves, and consequently community workshops were held there. However, after the workshops logictic challenges evolved in conducting the follow up field inventories of key species because the reserve was being renovated. Consequently, further work was abandoned at Hluleka, but the results from the workshops are reported here.

3.2.1. Respondents

There were 37 participants at the workshop of which 28 were male and 9 were female. All come from the villages of Bucula, Gangeni, Hluleka, Lucingweni, Ntsundwane and Xhthudwele. Half of these were unemployed, five (13 %) were pensioners and 16 had various occupations. Sixteen (43 %) were above the age of 40. Twenty three (62 %) of the participants had an education level between grade 8 and grade 12, with the majority having a grade 12. Only three of the participants had no schooling (Appendix 2).

3.2.2. Natural resource use

A total of 131 plant species were recorded as having a use value (Appendix 6). The uses of 81 species were identified of which most were edibles such as wild spinaches and fruits (37 %). A number of species were identified as being medicinal (24.7 %) or used as building materials (21 %). Other species were used as thatching materials, fuelwood, crafts, brooms and rope while some had multiple uses.

3.2.3. Collection of natural resources

The workshop map of the Hluleka region (Figure 6) shows that most of the natural resources are located in the forested areas within the reserve and only a few in the surrounding areas. Fuelwood is predominantly collected by women, this being virtually every day, and does not vary from summer to winter. The mean weight of fuelwood collected was 3 915 kg per participant (n=6) per annum. Fuelwood was not purchased by respondents interviewed (n=13). Construction poles are brought in and usually purchased at a cost of between R10 and R30 (primarily gum poles, which is the dominant species used in the area). Gum tree poles are considered appropriate as they are straight and can last for up to 30 years.

Both men and women collect thatching grass. Approximately 1800 small bundles are needed to thatch one roof which costs R150 to R200 and is estimated to last about four years before needing to be replaced. Wild spinaches are collected by women the whole year round and approximately 40.8 kg of imifino is collected per participant (n=6) per annum. Wild spinache is only collected by women and is eaten about three times a week. Consumption of these plants is becoming less common as local

preferences are changing. Wild fruits are collected primarily in March and April and are eaten mainly on site by children, as collection for household use is less common.

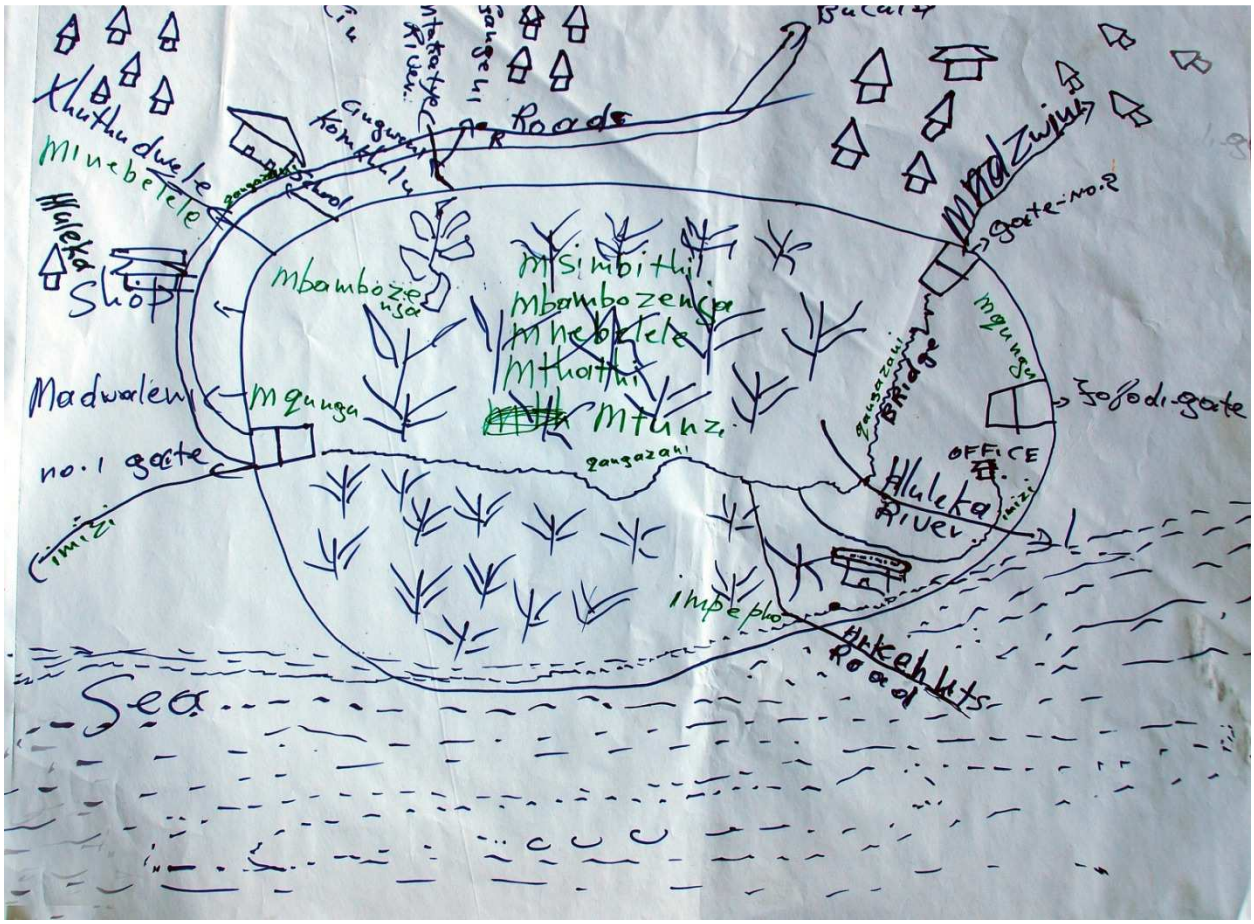

Figure 6: Map of the Hluleka region drawn by workshop participants to indicate where natural resources are found (blue= reserve, coastline, rivers and main roads, green= harvesting areas (forest patches etc.), red=landmarks).

3.2.4. Species selected as top ten

The top ten species selected are shown in Table 2. Three are exclusively used for medicinal purposes (*Helichrysum odoratissimum*, *Helichrysum pedunculare* and *Zanthoxylum capensis*), three are for craft work (*Cyperus textilis*, *Cymbopogon validus* and *Pristimera bojeri*), two are used for building (*Heywoodia lucens* and *Premna mooiensis*), one is used for building and crafts (*Millettia grandis*) and one is used for

cultural purposes (*Ptaeroxylon obliquum*). Half of the species are forest trees which includes *M.grandis, H.lucens, P. obliquum, P. mooiensis* and *Z. capensis*. Two of the medicinal herbs (*H.odoratissimum* and *H. pedunculare*) are found in grasslands and one, *C. textilis,* is found in aquatic environments. *Cymbopogon validus* is found in grasslands and *P. bojeri* is a woody scrambler found in the forest.

Table 2: The top ten plant species used by local communities at Hluleka.

Xhosa name	**Botanical name**	**Growth form/habitat**	**Use category**
Imizi	*Cyperus textilis*	Herb, aquatic	Craft
Imphepho	*Helichrysum odoratissimum*	Herb, grassland	Medicinal
Umsimbithi	*Millettia grandis*	Tree, forest	Building and craft
Umqungu	*Cymbopogon validus*	Grass, open grassveld	Craft
Umnebelele	*Heywoodia lucens*	Tree, forest	Building
Mbambozenja	*Pristimera bojeri*	Woody scrambler, forest	Craft
Isichwe	*Helichrysum pedunculare*	Herb, grassland	Medicinal
Umthathi	*Ptaeroxylon obliquum*	Tree, forest	Customs
Utyatyambani	*Premna mooiensis*	Tree, forest	Building
Umlungamabele	*Zanthoxylum capensis*	Tree, forest	Medicinal

3.3. Mkambati Nature Reserve

3.3.1. Respondents

The workshop was attended by 28 participants from the surrounding villages which included Cele, Khanyayo, Mahumuzeni, Mtshayelo, Nqusa, Ramzi, Tahle, Umtshayelo and Vlei. The demographic survey showed that of the 11 males and 17 females that participated, 13 (43 %) were unemployed. However, some farmed vegetables and livestock. Four (14 %) were herbalists or diviners, four (14 %) traded in medicinal plants, two (7 %) were students and five (18 %) had other occupations. Only eight participants were below the age of 40. In terms of education half of the participants had an education level of grade 8 to grade 12, five had no schooling or a grade 0 and the rest had a schooling level between grade 2 and grade 7 (Appendix 3).

3.3.2. Natural resource use

A total of 113 plant species (used as natural resources) were recorded as being used by local participants (Appendix 7). Unfortunately the uses of listed species were not recorded at this workshop.

3.3.3. Collection of natural resources

An important observation from the workshop map produced for the Mkambati region (Figure 7) was that each village had a forest patch from where the local villagers collected resources outside the reserve. Participants noted that all plant species used were found in the reserve. TRACOR (Transkei Agricultural Corporation) land as indicated in Figure 7 has a gum tree (*Eucalyptus*) plantation and was identified as the area from where most of the fuelwood is harvested. It was recorded by six participants that approximately two headloads are collected each week by each household. This equates to approximately 3 438 kg of fuelwood per household (n=6) per annum. Selected species included gum tree and stinkwood (*Ptaeroxylon obliquum*). Those families who can afford to purchase fuelwood do so, a 274 kg bakkie load costs R550. This lasts an average family for three months. In the summer months this amount lasts longer as fuelwood is substituted with the use of dung. Some families purchased truck loads (1 664 kg) of fuelwood, which was recorded as lasting for approximately nine months. It was noted that local timber tended only to be used for the construction of roofes and not the walls of homesteads. This timber tended to be primarily purchased (n=13). Timber poles were generally replaced every 10 years. Fencing poles were replaced every two years, equating to approximately 162 kg per annum for an average household, using 32 poles.

Grass for making rope was indicated as being collected outside of the reserve. The rope is made from grasses identified as uqhoko or umsuka, and is a skill that only the older women still possess. Women would be paid between R70-R100 for a 3 m rope. A number of households collect medicinal plants from the area for trade. Medicinal plants are collected locally and transported to Durban for resale on a bimonthly basis. Gatherers receive between R30 to R50 for a 50 kg bag depending on the type of medicinal plant collected. The most common species collected in the area was imphepho. A mean of 209.1 kg of wild spinaches was collected per participant (n=6) per annum.

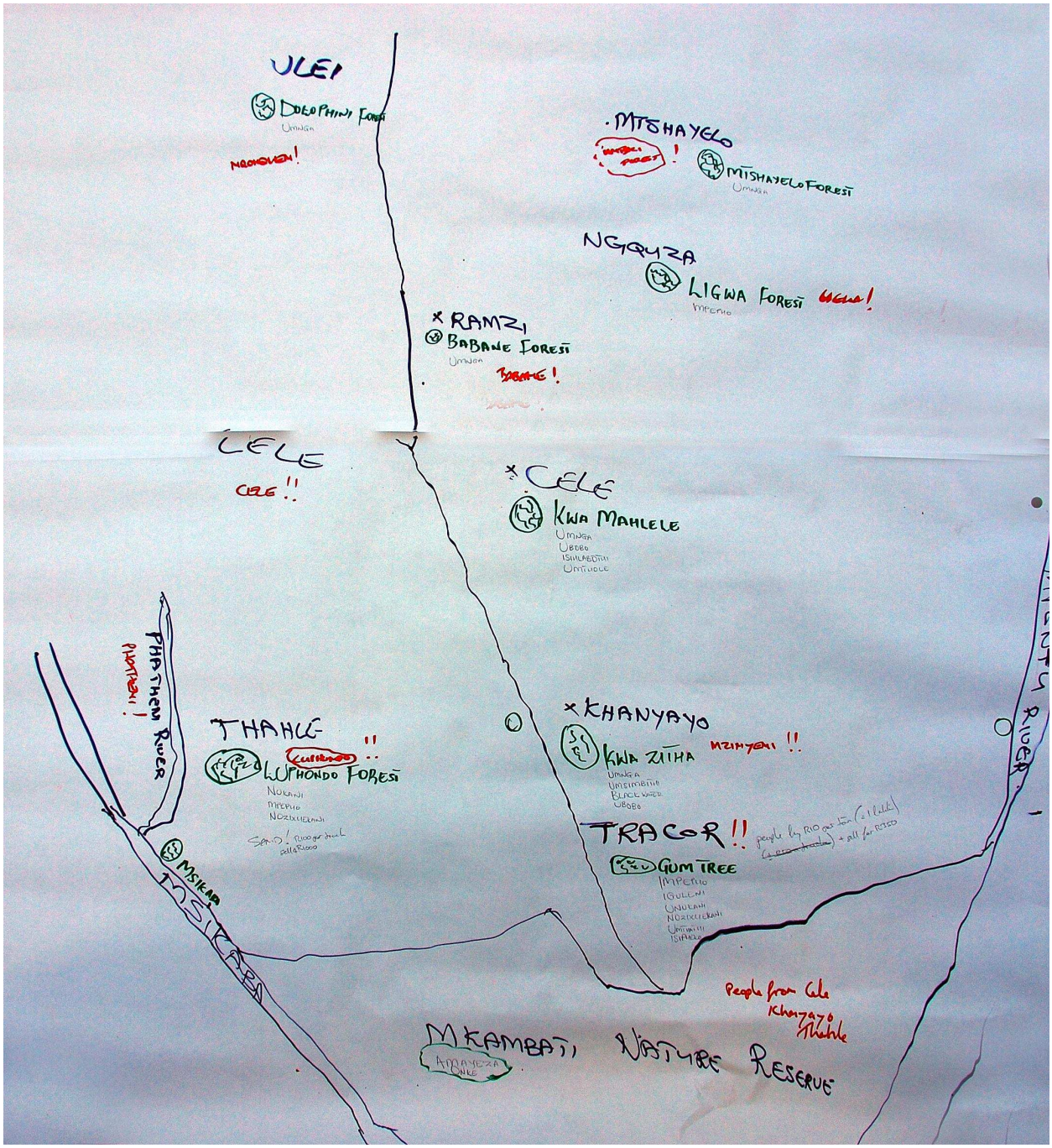

Figure 7: Map of the Mkambati region drawn by workshop participants to indicate where natural resources are found (blue= reserve, coastline, rivers and main roads, green= harvesting areas (forest patches etc.), red=landmarks).

3.3.4. Species selected as top ten

Of the top ten species selected as priority species all were for medicinal uses (Tables 3). Four species were herbs found in grasslands (*Helichrysum odoratissimum*, *Lotononis corymbosa, Osteospermum imbricatum* and *Ranunculus multifidus*), four were trees, two of which are found in the forest (*Vepris undulata* and *Protorhus longifolia*) and the other two (*Macaranga capensis* and *Polygala myrtifolia*) on forest margins. Two geophytes (*Hypoxis rigidula* and *Agapanthus campanulatus*) were selected as priority species both found in grasslands with *A. campanulatus* found on rocky outcrops in the grasslands.

Table 3: The top ten most important plant species used by local communities at Mkambati.

Xhosa name	**Botanical name**	**Growth form/habitat**	**Use category**
Umvuthuza	*Ranunculus multifidus*	Herb, forest	Medicinal
Umpumeleli	*Macaranga capensis*	Tree, forest margins	Medicinal
Ilabatheka	*Hypoxis rigidula*	Geophyte, grassland	Medicinal
Ubani	*Agapanthus campanulatus*	Geophyte, rocky outcrops in grassland	Medicinal
Isthethemfazi	*Polygala myrtifolia*	Tree, forest margins	Medicinal
Imphepho	*Helichrysum odoratissimum*	Herb, open grassland	Medicinal
Umzaneno	*Vepris undulata*	Tree, forest	Medicinal
Uvelebahleke	*Lotononis corymbosa*	Herb, grassland	Medicinal
Inthuthe	*Protorhus longifolia*	Tree forest	Medicinal
Umatshiqolo	*Osteospermum imbricatum*	Herb, open grassland	Medicinal

3.4. Silaka Nature Reserve

3.4.1. Respondents

There were 32 participants at the workshop 19 of which were male and 13 female. All came from the villages Caguba, Cwebeni, Isilaka, Mthumbane and Sicambene. The demographic survey showed that 13 (40 %) of the participants were unemployed, of which some cultivated or owned livestock. Eight (25 %) participants were traditional healers or diviners, four (12 %) were crafters, basket-makers or woodcrafters, two were students and five had other occupations. Fourteen (44 %) of the participants

were above the age of 40 of which the majority of older people were female. Over half the participants (59 %) had an education level of between grade 8 and grade 12 while four participants had no schooling or grade 0 and the rest had an education level between grade 4 and 7 (Appendix 4).

3.4.2. Natural resource use

Species used as natural resources totalled 179 (Appendix 8). The uses of 109 species were identified of which most of the species had medicinal uses (46 %). Some of the species were identified as being used for building (21 %) and as edibles such as wild spinaches and fruits (30 %). Few species were recorded as being used for thatching, fuelwood, crafts and baskets while others had multiple uses.

3.4.3. Collection of natural resources

The workshop map of Port St. Johns shows that the area is heavily forested (Figure 8). The reserve is small and surrounded by large forest patches. Participants indicated that they did not harvest any resources from within the reserve. However, during subsequent field work periods in the reserve several people were encountered at different times, collecting fuelwood, thatch grass and hunting for bushmeat.

Information on quantities used at a household level per annum were only recorded for fuelwood and consumption purposes in the form of wild spinaches. For example, for fuelwood approximately 3 362 kg is utilized at a household level per annum and approximately 141 kg of imifino per household (n=10) per annum.

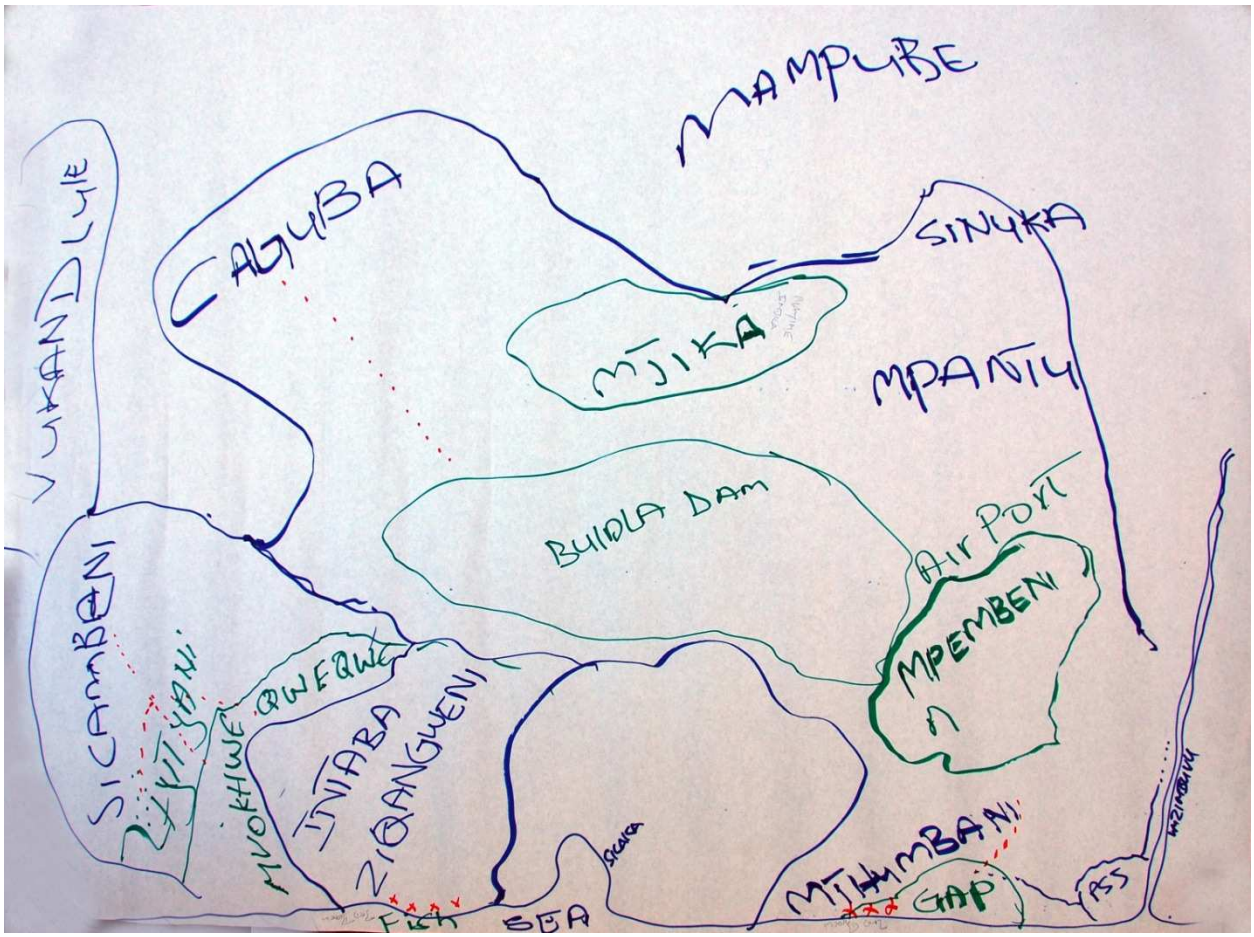

Figure 8: Map of the Port St. Johns region drawn by workshop participants to indicate where natural resources are found (blue= reserve, coastline, rivers and main roads, green= harvesting areas (forest patches, etc.), red=landmarks).

3.4.4. Species selected as top ten

All the species selected as top ten species were used for medicinal purposes (Table 4). Three of the selected species were herbs (*Ranunculus multifidus*, *Helichrysum odoratissimum* and *Nymphaea nouchali*). The herb *R.multifidus* is found in the forest, *H.odoratissimum* is found in grasslands and *N.nouchali* is found in fresh water habitats. *Talinum caffrum* and *Xysmalobium involucratum* are two tuberous herbs selected as priority species and found in open grassland. Three tree species were selected (*Rauvolfia caffra*, *Curtisia dentata* and *Macaranga capensis*) which are found in the forest

except for *M.capensis* which is found on forest margins. *Capparis sepiaria var. citrifolia* a woody shrub and the geophyte *Clivia miniata* which are both found in the forest were also selected.

Table 4: The top ten most important plant species used by local communities at Silaka.

Xhosa name	**Botanical name**	**Growth form/habitat**	**Use category**
Umvuthuza	*Ranunculus multifidus*	Herb, forest	Medicinal
Imfihlo (Intsihlo)	*Capparis sepiaria var. citrifolia*	Woody shrub, forest	Medicinal
Uphuncka	*Talinum caffrum*	Tuberous herb, open grassland	Medicinal
Udelanina	*Xysmalobium involucratum*	Tuberous herb, open grassland	Medicinal
Umayime	*Clivia sp.* probably *C. miniata*	Geophyte, forest	Medicinal
Umnxamu	*Rauvolfia caffra*	Tree, forest	Medicinal
Impepho	*Helichrysum odoratissimum*	Herb, grassland	Medicinal
Umlahleni	*Curtisia dentata*	Tree, forest	Medicinal
Intekwane	*Nymphaea nouchali*	Herb, aquatic	Medicinal
Umpumeleli	*Macaranga capensis*	Tree, forest margins	Medicinal

4. Discussion and Conclusion

The diversity and high species count (up to 179 at Silaka) recorded at all workshops exemplifies the vast amount of knowledge that participants owned. This also demonstrates the importance and reliance of local species to rural people. Given more time participants could have listed numerous more species. It is important to note that local knowledge is handed down from generation to generation and therefore may hold more value than specialist knowledge from outside sources. Most participants had a broad range of knowledge regarding natural resources. Individuals such as medicinal healers shared a greater amount of knowledge regarding plants and animal used for medicinal purposes, while young men shared a greater knowledge of building materials. This may have swayed the priority species chosen towards specific resource groups, so where a group of specialists was over represented, species in thier field of knowledge may be predominant. This may have been true at the Mkambati and Silaka workshops where all species had medicinal uses, however, the same proportion of medicinal orientated

participants at Mkambati were represented at Dwesa-Cwebe workshops, where only half the priority species had medicinal uses. Species with medicinal uses typically dominat free lists of species throughout Africa (e.g. Luoga *et al.* 2000, Kristensen & Balslev 2003). The Hluleka workshop resulted in only three out of ten priority species having medicinal uses which may have been influenced by no medicinal healers represented, which in turn may be affected by the uneven representation of gender. Only nine women (24.3 %) participated in the Hluleka workshop while gender was fairly well represented at the other three workshops. As mentioned in the introduction, demographics play a significant role in the quality of knowledge gained. From this study we cannot be certain of the level of influence demographics may have.

The majority of plants selected as the top ten species had medicinal uses such as the trees *C. dentata, P. longifolia, V.undulata* and *C. sepiaria* harvested for their bark, and herbs such as *R. multifidus* and *X. undulata* harvested for their roots, *T.caffrum* for its rhizomes and *H.odoratissimum* for its leaves and stems (Berry *et al*. 1994, Dold & Cocks 2002). A reason for more medicinal species selected as most important may be because harvesting of medicinal plants is more species specific than harvesting plants for firewood etc (Berry *et al*. 1994). Medicinal plants such as *Helichrysum* species, important as an antiseptic and to induce fast healing, may not be substitutable in certain areas and so are considered to be irreplaceable (Bhat & Jacobs 1995). *Zanthoxylum capensis* was described as having a medicinal purpose, but is also used in constructing sledges, ploughs and hoe handles along with *H.lucens* and *M.grandis* which is also used in crafting walking sticks and traditional weapons as well as for fencing and construction (Palmer *et al*. 2002, Obiri *et al*. 2002). *Hyperacanthus amoenus* (spiny gardenia) is used as a weaving material between poles (Palmer *et al*. 2002). The tree *P. obliquum* has many uses such as for fencing, poles and the construction of kraals and woodpiles (Palmer *et al*. 2002, Obiri *et al*. 2002). *Ptaeroxylon obliquum* also has a cultural significance, used as platters on which sacrificed animal carcasses are placed (Che & Lent 2004, Scheepers 2004, Cocks *et al*. 2008). *Cyperus textilis* and *J. kraussii* are two of the most commonly uses fibrous plants in weaving (Gyan & Shackleton 2005, Pereira *et al*. 2006). *Cyperus textilis* is used to make sitting mats, food mats and collecting baskets (Kepe 2002, 2003). The grass *C.validus* is considered to be most important for thatching throughout the Transkei region and is also used to make rope (Shackleton 1989, Fay 1999, Kepe 2002).

Participation at the community workshops was lively and productive. Most participants expressed an interest to learn from it. Many participants communicated that they had learned much about their culture which they had forgotten. At the Dwesa-Cwebe workshop participants indicated that they were unhappy about the restricted access to the reserve and communicated that they need access to the tidal areas in particular. This has been a long bone of contention with these communities (Palmer *et al*. 2002, Shackleton *et al*. 2007). In general, women and young men showed good participation while some of the older men showed some antagonism, especially at the Dwesa-Cwebe workshop. It has been suggested that females show greater involvement in sharing knowledge about plant resources than men (Dovie *et al*. 2008). At the Dwesa-Cwebe workshop the exercise of mapping where resources are harvested was dominated by one male participant despite efforts by the facilitators to include others. The resulting map indicated that all the resources were located in the reserve and none outside of it. This may suggest that the restricted access to the reserve has caused local people to feel 'hard done by' and they want it to be known that they need access to the natural resources in the reserve. Participants from Hluleka also indicated that most natural resources are located in the reserve, also probably due to conflict as large indigenous forest patches were seen outside of the reserve. In comparison to this, maps of the Mkambati and Silaka region indicated that many resources are found outside of the reserve. Participants at the Silaka workshop did not indicate any natural resources as being located in the reserve. This may be due to the fact that there are many forests surrounding the small reserve and its small size may also make it easier to police. Discussions of timeline trend showed that all participants felt that natural resources where more common outside of the reserve in the past, but now are rarely found outside the reserve and are difficult to access. In contrast to this the study, Obiri *et al.* (2002) showed that 78 % (n=47) of households felt that indigenous trees such as *M. grandis* and *P. obliquum* (which they often harvested) had increased in abundance in the same region over the past 20 years. Workshop participants appeared to hold the perception that all natural resource are common inside of the reserve but are not accessible because of the strict control over harvesting. This is corroborated by the findings of Shackleton *et al*. (2007), working near the Dwesa-Cwebe reserve, who reported that households felt that availability of wood has decreased over the past 5 to 10 years due to the restriction of harvesting in Dwesa and Cwebe state forests protected inside of the reserve.

In general, the group approach used in the workshops seemed to provide reasonable estimates of the quanitities used by the different communities, because (i) they were similar between sites, and (ii) they

were within the range derived from household surveys elsewhere in South Africa. For example, the amount of fuelwood reported for the four reserves ranged between 3 362 kg per household per year to 3 915 kg. The review by Shackleton & Shackleton (2004) of several household level studies across South Africa indicate a range of 2 993 to 8 468 kg per household per year. Similarly, with respect to wild spinaches, the four workshops gave a range of 41 to 209 kg per household per year which is comparable to the range from the Shackleton & Shackleton (2004) review of 13 to 198 kg per household per year.

Overall, the workshops were a viable approach with which to engage the local communities regarding their use of natural resources. Priority species were established for each reserve, which were then tagetted for field inventory (Chapter 4). The top ten for each reserve were combined into a single list for ECP, comprising 30 different species (because of some duplication between reserves) for subsequent inventory. The process of the workshops was also useful as it demonstrated to the communities that ECP is serious about hearing their voice and working with them regarding the supply and management of natural resources for their immediate needs.

CHAPTER FOUR: Population assessments of priority plant species in and outside of protected areas along the Wild Coast

1. Introduction

Information about vegetation is important in the management of protected areas, especially in the case of detecting and evaluating changes in natural communities with modifications to the landscape (Shute & West 1982, Moreno & Halffter 2000). Vegetation inventories are necessary tools in predicting plant community structure, composition and production as they determine the occurrence and abundance of one or more species within a given management area (Shute & West 1982, Dewey & Andersen 2004). Dewey and Andersen (2004) describe a species inventory as a single point-in-time evaluation of a targeted species accounting for its entire population within a delineated area. It is however impossible to account for all individual plants of the targeted species within a large area and therefore sample patches may be used which cover a wide enough area and that are thoroughly evaluated (Dewey & Andersen 2004). The downfall of this is that there is no way of knowing how complete it may be and in most cases impossible to compare or combine inventories due to incompatible sampling methods, terminology or data handling systems (Dennis & Ruggiero 1996, Moreno & Halffter 2000). Also, data is static which makes it difficult to estimate rates of population change where long-term data capture is lacking (Obiri *et al*. 2002). Ideally, vegetation and population inventories should be repeated at regular intervals so that management agencies can appraise the direction of any changes and take appropriate actions if necessary. In other words, vegetation inventory at appropriate spatial and temporal scales needs to be incorporated into efficient monitoring programmes. However, lack of financial and perhaps human resources mean many protected areas, certainly in developing countries, lack monitoring programmes, and relatively few have population inventories of key plant species. In Africa, inventory and monitoring is invariably focused on large mammals.

Size class distributions (SCD) of populations, with further analyses into population regeneration and life-history, are a useful proxy indicator of population sustainability, especially where population stability may be influenced by harvesting pressures (Obiri *et al*. 2002). Ultimately this information may reveal which species are vulnerable to human activities, such as harvesting (which could lead to local

extinction) as well as to predict compositional changes of vegetation (Lykke 1998). Size class distributions are also useful for determining a species population status. For example, a distribution profile in which the curve declines exponentially with increasing plant size is characteristic of a species with good rejuvenation. This type of SCD is referred to as reverse J-shape (Lykke 1998). A flat SCD is representative of a species with a high chance of juveniles becoming adults, however indicative of low recruitment (Midgley *et al*. 1990, Lykke 1998). This interpretation is complicated by fast growing species with high survival rates, which may have fewer juveniles than slow-growing species with a low survival rate as described by Lykke (1998). Unimodal or bell-shaped SCD curves characteristically describe a species with little recruitment (Everard *et al.* 1995). SCDs are useful in determining whether a species is declining or not by examining the abundance of individuals in the smaller size classes, and by comparing species to one another (Lykke 1998).

Spatial grain of tree and shrub species incorporated with SCDs may describe species stability and regeneration further. Species described as fine grained are those that typically show a reverse J-shape distribution, and are well represented over a small area with high densities of both understory and canopy individuals (Obiri *et al.* 2002). Coarse-grained species typically show a flat or unimodal distribution as there are few understory individuals relative to larger canopy individuals. They are poorly represented over a small area as they occur in relatively low densities and regenerate over a large area (Everard *et al.* 1995, Obiri *et al.* 2002). Everard *et al*. (1995) also explains how fine-grained species are typical of shade tolerant species that are able to regenerate in the understory environment, while coarse-grain species are those that are intolerant of shade and regenerate poorly in the understory environment. Shade intolerant species would typically take advantage of gaps in the canopy which may be created by tree fall, and are rarely found outside these gaps (Midgley *et al.* 1990).

There is little literature on size class distribution of perennial herbs in open grassland. African grasslands are dynamic and changes between different states are not linear, but rather affected by many trajectories dependant on the combination of events occurring (Kepe & Scoones 1999). Such events are factors such as fire, grazing, trampling, competition and human activities. An example of such a state transformation is the transition of high quality *Themeda triandra* grassland to poor quality grazing dominated by *Aristida junciformis,* probably due to heavy grazing and regular fires (Kepe & Scoones 1999). Depending on severity, a disturbance may have a positive or negative effect on community

dynamics. Positive effects may result in increased nutrient cycling, species diversity and seedling establishment, or alternatively, a negative effect would result in reduced cover and soil erosion (Shackleton *et al*. 1994). Belsky (1992) found that grazing and disturbances had a greater effect on species cover and diversity than fire and competition. Between 50 % and 100 % of the species analyzed were affected both negatively and positively by these two factors. Also, vegetatively reproducing species benefitted more from protection from grazing than sexually reproducing species. Successful reproduction relies to some extent on fire and grazing to remove excess above-ground biomass. As described by Belsky (1992), tall rhizomatous species in ungrazed areas become so dense that seeds of other species cannot germinate in the shade of the dense foliage, or stoloniferous species cannot expand vegetatively. Plant morphology and life-history explains largely the effect of competition between species within a community. Fire is important in African grassland communities such that it stimulates germination of certain hard coated seed species, and also induces flowering in some species (Bond & van Wilgen 1998, Dzerefos & Witkowski 2001). The abundance and recruitment of a species is also determined by the number of seeds it is capable of producing and seed size (Dzerefos & Witkowski 2001). Grasses and geophytes are well adapted to coping with fire. These species allocate nutrients and carbohydrates to below ground tissues allowing for effective regrowth in post-fire conditions (Dzerefos & Witkowski 2001).

This chapter aims at constructing population inventories that describe the current species status and to predict future changes in population stability. The results will be used as a foundation to determine harvesting potentials in the following chapter (Chapter 5).

2. Methods

2.1. Data collection

The size and structure of plant populations were quantified for 30 different species of varying types and habitats as identified at the community workshops in Chapter Three. Different methods were used for quantification of species in grassland, forest and aquatic habitats. Sample sites were plotted for each reserve using high quality aerial photographs (scale of 1:1000). Sites were evenly distributed throughout grassland and forest areas to ensure adequate representation within each of the reserves. Additional

sample plots were situated outside of each reserve within two kilometers of its boundaries. Sample sites for aquatic species were located using reserve ranger's knowledge of the area.

2.1.1. Forest Plots

Belt transects of 100 meters long and six meters wide were used for forest plots which were evenly spaced across the forested areas inside and outside of each reserve. Individuals of each of the key forest species listed by the community (Chapter 3) were identified within each belt transect and counted. The basal circumference of each identified tree and shrub was then measured. Where trees showed multiple branching from a single base the largest circumference was measured. The height of herbaceous forest species, such as *Clivia miniata,* and tree saplings (height < 150 cm) were measured. The creeper *Dioscorea dregeana* was recorded as being present or absent. The branch circumference of the scrambler *Pristimera bojeri* was measured where found. For the Dwesa-Cwebe Nature Reserve 34 forest plots were surveyed inside and 16 plots outside. In the Mkambati Nature Reserve 16 plots were surveyed inside and none outside as there was no forest within 2 km outside the reserve boundary. A total of 24 plots were done inside the Silaka Nature Reserve and 10 outside.

2.1.2. Grassland Plots

In grasslands the herbaceous layer was surveyed using line transects that were evenly distributed across the grassland areas using high quality aerial photographs. Ten quadrats of three by three meters were placed along each transect at 20 m intervals (200 m transect). For each target plant species the number of individuals were counted, percentage cover estimated and heights measured. For the grass *Cymbopogon validus* the tuft diameter was measured. Twenty-five grassland transects were done inside the Dwesa-Cwebe Nature Reserve with 16 outside. In Mkambati Nature Reserve 40 were surveyed inside and 20 outside, and in Silaka Nature Reserve 10 transects were done inside and 10 outside.

2.1.3. Aquatic Habitat Plots

Tall sedge populations occurring near water sources and river banks were quantified by measuring the dimensions of each patch. A patch was defined as an isolated area of a single reed species. The longest

distance through a patch ($length_1$) and the longest distance perpendicularly crossing it ($length_2$) were measured. Using these measurements the area of each patch was calculated by assuming elliptical shape, as follows:

$$AREA = PI \times ((0.5)length_1 \times (0.5)length_2)$$

For the aquatic herb *Nymphaea nouchali* individual pads were identified and counted within the water body.

2.2. Data analysis

Analysis was carried out using Microsoft excel and STATISTICA 9. All trees that were measured by basal circumferences are referred to as adult trees and all those measured by height are referred to as saplings. For each tree species the means per hectare were calculated for basal circumference of adult trees, height of saplings (height < 150 cm) and densities for both adults and saplings. The mean height or tuft diameter, percentage cover and density of individuals for each herbaceous species was calculated per meter squared. Statistical analysis of populations outside and inside of the reserves was done using a standard T-test for independent variables by group. Where data were not normally distributed the non-parametric Mann-Whitney U test was used. For analysis of tree species, the mean basal circumference and densities of adults and saplings were compared. In the case of herbaceous species the mean cover, mean height or tuft diameter and density were compared.

2.2.1. Population analysis of tree species

The stem circumference values of the tree species were categorized into size classes with the smallest class being ≤ 5 cm in circumference. All measurements were rounded to the nearest centimetre, for example a plant with a 15.7 cm circumference fell into the 15 cm class. Consecutive classes therefore have increments of 10 cm so that size classe values are as follows: ≤ 5, 6-15, 16-25, 26-35, 36-45,… ≥ 205. Saplings were represented in the smallest size class of ≤ 5 cm circumference. Bar-graphs were plotted using the size classes indicated above for both inside and outside of each reserve and the shape interpreted as either reverse J-shape, flat, bimodal or unimodel as described by Everard *et al. (*1995). A

species with a reverse J-shaped distribution would indicate that there are many small trees and relatively few large trees, a unimodal distribution would indicate few small trees relative to larger trees, and a bimodal distribution may indicate many large and small trees with few intermediate (Everard *et al.* 1995).

A linear regression (based on methods used by Obiri *et al*. (2002)) of size class distribution was calculated using the size class midpoint as the independent variable, and the number of individuals in that size class as the dependant variable. By using linear regressions the size class distribution (SCD) slopes can be used as good indicators of population structure. Four types of SCD slopes were used as described by Everard *et al.* (1995). Negative slopes indicate recruitment as larger size classes have fewer individuals in comparison to smaller size classes. Slopes of zero or approaching zero indicate a flat distribution with equal numbers of regenerating and mature trees. Positive SCD slopes often indicate unimodal distribution with many mature trees but little regeneration (Obiri *et al*. 2002). In order to derive straight line plots the midpoint was transformed by taking its natural log (ln), while the number of individuals (Ni) in that size class was transformed by ln(Ni + 1) because some classes had zero values.

Population stability of each tree species was determined using the permutation index (P) and Simpson's index of dominance (C)as applied to size class evenness (Shackleton *et al*. 2005). The permutation index indicates the absolute distance between the expected and real location of all size classes, ignoring relative frequency (Wiegand *et al*. 2000). A population with a discontinuous size class distribution would have a high index, while an 'ideal' population with a continuous size class distribution would have a lower index. The equation is shown below.

$$P = \sum_{i=1}^{k} |J_i - i| ; \quad J_i = 1, 2, ..., k$$

where J_i is the rank of size class i (i = 1 for smallest trees), with the highest rank (J_i = 1) given to the most frequent size class.

The Simpson's index indicates the evenness of size classes occupation, in other words the probability of two trees drawn at random belonging to the same size class. An index above 0.1 describes a population

with a steep size class frequency that declines exponentially. A value below 0.1 describes a population with evenly distributed size classes. The equation is shown below.

$$C = 1/N(N-1) \sum_{i=1}^{k} N_i (N_i - 1)$$

where N is the total number of trees, Ni the number of trees in class i, and k is the number of classes.

The spatial grain of forest species were calculated according to Everard *et al.* (1995) and Obiri *et al.* (2002). This method describes the spatial scale of forest dynamics, in particular, comparisons between understory tree regeneration (circumference = 5-20 cm) and number of individuals in the canopy level. A species can be described as fine-grained, coarse-grained or intermediate. This was calculated by plotting the density of subcanopy individuals (circumference = 5-20 cm) against canopy individuals (circumference > 20 cm). A straight line of y = x was used as a divider where coarse grain species are below and fine grain species are above the line, as described in Obiri *et al.* (2002). The grain can be used as an indicator of shade tolerance and degree of regeneration where fine-grained species would be relatively shade tolerant and have advanced regeneration under the canopy, while coarse-grained species would be shade intolerant and mostly survive in forest gaps (Everard *et al*. 1995).

2.2.2. Population analysis of grassland species

The height or tuft diameter values of grassland species were categorized into size classes according to Condit *et al.* (1998) whereby size classes are defined so that they accommodate more individuals with increasing size. All measurements were rounded to the nearest centimetre, for example a plant with a 4.7 cm height fell into the 3-4 cm size class. The size classes are as follows: 1, 2, 3-4, 5-6, 7-8, 9-10, 11-13, 14-16, 17-19, 20-23, 24-27, 28-31, 32-25, 36-39, 40-43, 44-47, 48-51, 52-55, 56-59, ≥ 60 cm. The number of individuals in a size class is then divided by the width of the class to get the average number of individuals in that class. This definition of size classes was not used for tree species as the range of circumferences (> 200 cm circumference) recorded for trees was much larger than for grassland species. Linear regressions were calculated using size class midpoint transformed by its natural log (ln) as the independent variable, and the average number of individuals (Ni) in that class transformed by ln(Ni +1) as the dependant variable. However r^2 values for these regressions were very low and so were

presumed to be unreliable, therefore regressions were excluded from analysis of grassland species. Population stability of each grassland species was determined using the permutation index (P) and Simpson's index of dominance as applied to size class evenness. Calculations of these indices are described in the previous section.

3. Results

3.1. Dwesa-Cwebe Nature Reserve

Of the 30 species chosen as priority from all the community workshops, 18 were recorded in the Dwesa-Cwebe region. Eleven were forest species (nine tree species and two creepers/scrambles), five were grassland species and two were aquatic species. Seven of the top ten species chosen at the Dwesa-Cwebe workshop were recorded in the field which included *Cyperus textilis, Dioscorea dregeana, Juncus kraussii, Millettia grandis, Ptaeroxylon obliquum, Hyperacanthus amoenus* and *Protorhus longifolia* (refer to Chapter Three).

3.1.1. Population inventories of tree species

Of the priority tree species found only *Zanthoxylon capensis* was not recorded outside of the reserve while *Rauvolfia caffra* was not recorded inside. Statistical analysis show that for *R. caffra* the mean circumference ($p = 0.0035$) and density of adult trees per hectare ($p = 0.017$) are significantly different inside compared to outside the reserve (Table 5). Both adult tree density ($p = 0.0018$) and sapling density ($p = 0.0004$) are significantly higher inside the reserve for *H. amoenus*, as well as the mean circumference ($p = 0.00007$). The sapling density of *P. obliquum* is significantly higher ($p = 0.043$) outside than inside the reserve. *Millettia grandis* shows no significant differences for densities, but has a significantly higher mean circumference ($p = 0.0149$) inside. No saplings were found for *R. caffra*, *P. mooiensis* and *Z. capensis* inside or outside of the reserve.

Hyperacanthus amoenus is the most abundant species inside the reserve having an adult density of 392.6±366.35 individuals ha^{-1} and frequency of occurrence of 94.4 % (Table 5). *Vepris undulata* has the

same frequency of occurrence inside as *H. amoenus*, however has a lower adult density (145.8±158.58 individuals ha^{-1}), but the highest adult density outside the reserve (245.8±284.57 individuals ha^{-1}). In fact, *V. undulata* was found in all the outside transects making it the most abundant species outside. *Heywoodia lucens* has a high adult density both inside and outside the reserve, with by far the highest sapling density inside of 580.1±1272.09 individuals ha^{-1}. The frequency of occurrence for *H. lucens* inside is not high (66.7 %), and low outside (31.3 %). The species with the lowest adult density recorded inside is *P. longifolia* (3.2±9.61 individuals ha^{-1}) which has a similar adult density outside. The species *M. grandis*, *V. undulata* and *P. obliquum* have no significant difference in adult densities between the inside and outside of the reserve.

Table 5: Mean adult densities, sapling densities and frequency of occurrence of priority tree species inside and outside of Dwesa-Cwebe Nature Reserve (mean ± stdev). Unlike letters (a b, c d) represent significant differences ($p < 0.05$) between inside and outside the reserve, like letter (b b, d d) represent no significant differences.

Species	Density (adult stems ha^{-1})		Density (sapling stems ha^{-1})		Frequency of occurrence (%)	
	Inside	Outside	Inside	Outside	Inside	Outside
Hyperacanthus amoenus	392.6±366.35^{a}	129.2±194.51^{b}	210.2±30.610^{c}	21.9±47.03^{d}	94.4	62.5
Heywoodia lucens	391.7±575.61^{b}	232.3±492.63^{b}	580.1±1272.09^{d}	102.1±268.87^{d}	66.7	31.3
Millettia grandis	158.8±119.56^{b}	234.2±215.03^{b}	233.8±395.74^{d}	283.3±426.27^{d}	91.7	75.0
Vepris undulata	145.8±158.58^{b}	245.8 ± 284.57^{b}	105.1±252.98^{d}	67.7±105.67^{d}	94.4	100.0
Ptaeroxylon obliquum	19.0±25.56^{b}	99.0±244.46^{b}	10.7±27.07^{c}	64.6±153.58^{d}	55.6	62.5
Premna mooiensis	11.1±17.82^{b}	2.1±5.69^{b}	0.0^{d}	0.0^{d}	33.3	12.5
Zanthoxylon capensis	6.9±27.42^{b}	0.0^{b}	0.5±2.78^{d}	0.0^{d}	8.3	0.0
Protorhus longifolia	3.2±9.61^{b}	3.1±12.50^{b}	0.0^{d}	0.0^{d}	13.9	6.3
Rauvolfia caffra	0.0^{a}	10.4±25.73^{b}	0.0^{d}	0.0^{d}	0.0	25.0

The species *P. longifolia*, *Z. capensis* and *R. caffra* have been excluded from the regression analysis as there were too few individuals (< 15) counted. All species, except *P. mooiensis*, show reverse J-shaped SCD curves inside the reserve (Figure 9). Only three of these species show reverse J-shaped curves outside the reserve, which are *M. grandis*, *V. undulata* and *H. lucens*. The species *H. amoenus*, *M. grandis* and *V. undulata* are conspicuously reverse-J shaped inside the reserve with high SCD slope values (SCD > -1.30). The r^2 values for these species are also high, indicating that a large portion of the variation is described by the regression line (Table 6). These species also have low permutation indices

(P ≤ 30) and indices of dominance above 0.1 indicative of a stable population. *Premna mooiensis* has a SCD curve tending towards a unimodal shape, as well as a high permutation index (140) and a Simpson's index below 0.1 indicating deviation from a stable population. It is the only species that has a positive SCD slope (SCD = 0.14, r^2 = 0.071), however the points are very scattered around the regression line as indicated by a very low r^2 value (Table 6). *Ptaeroxylon obliquum* shows a less conspicuous reverse J-shaped SCD curve inside as it has no individuals between the 40.5 and 60.5 cm size classes. The Simpson's index is below 0.1, but the permutation is not exceedingly high (54) indicating a slight deviation from a stable population. Outside of the reserve *H. amoenus* and *P. obliquum* only have individuals in the smallest two size classes resulting in a truncated reverse J-shaped curve, while *P. mooiensis* has only a few large individuals.

Table 6: Regression analysis showing the size class distribution slope for tree species inside and outside of the Dwesa-Cwebe Nature Reserve. Species with less than 15 individuals recorded inside or outside the reserve were not included in the regression.

Species	Inside				Outside			
	Slope	t-value	r^2	p	Slope	t-value	r^2	p
Hyperacanthus amoenus	-1.59	7.24	0.93	$p < 0.05$	-1.62	3.57	0.73	$p > 0.05$
Millettia grandis	-1.36	21.66	0.87	$p < 0.05$	-1.32	12.37	0.91	$p < 0.05$
Vepris undulata	-1.31	14.69	0.90	$p < 0.05$	-1.22	15.23	0.88	$p < 0.05$
Heywoodia lucens	-1.03	17.57	0.85	$p < 0.05$	-0.74	8.26	0.62	$p < 0.05$
Ptaeroxylon obliquum	-0.82	7.93	0.81	$p < 0.05$	-1.33	2.85	0.78	$p > 0.05$
Premna mooiensis	0.14	1.60	0.07	$p > 0.05$	-	-	-	-

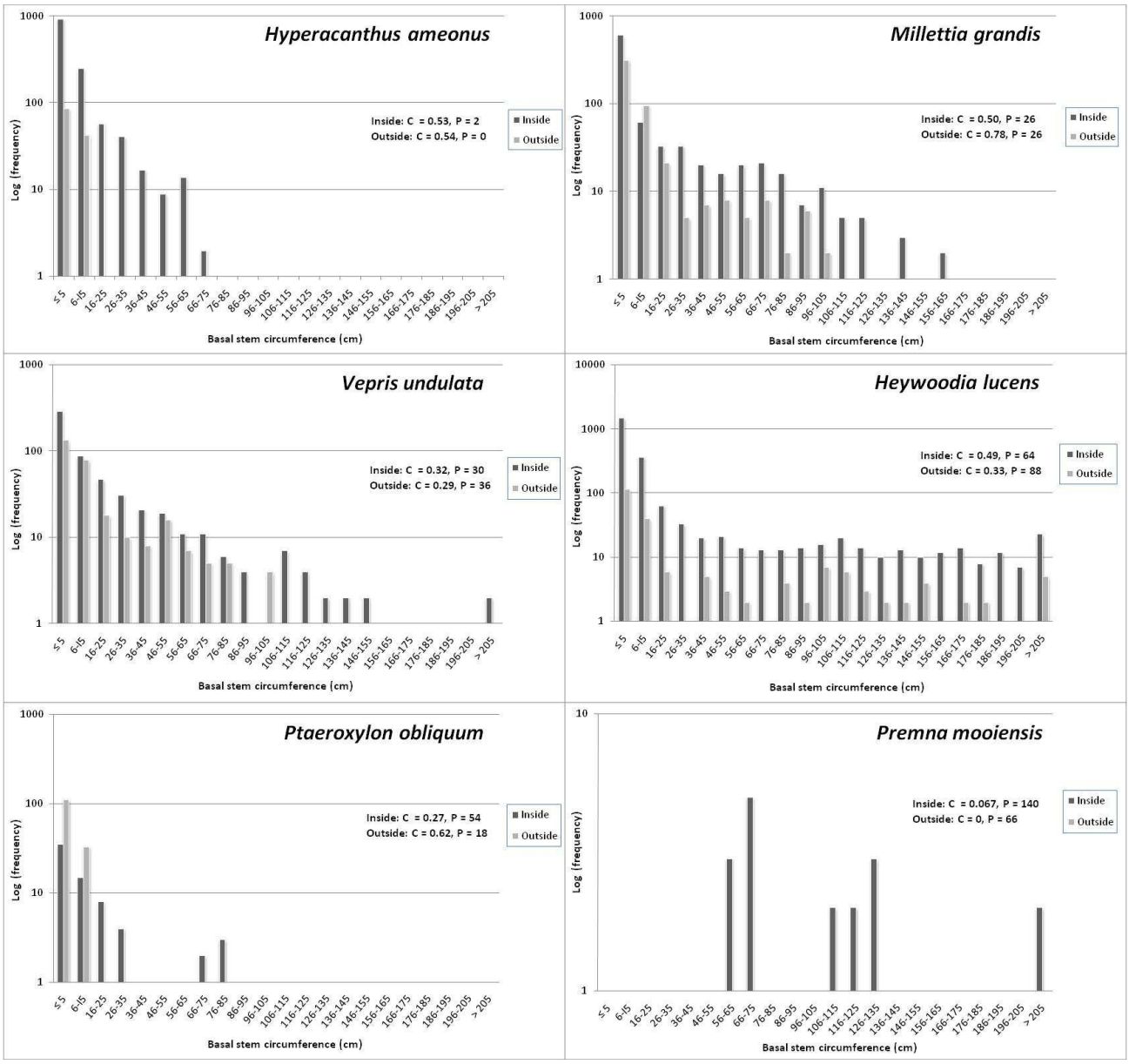

Figure 9: Size class distributions for six tree species inside and outside of the Dwesa-Cwebe Nature Reserve in order of decreasing SCD slopes (note the different y-axis scales for *H. lucens* and *P. mooiensis*). Simpson's index (C) and permutation index (P) are included.

Fine-grained species represented above the solid line in Figure 10 are *H. lucens*, *H. amoenus*, *M.grandis* and *V. undulata*. Both *H. lucens* and *H. amoenus* are distinctly fine-grained in comparison to *M. grandis* and *V. undulata* which are just above the intermediate line. *Ptaeroxylon obliquum* is intermediate having few individuals in both subcanopy and canopy levels. The species *P. mooiensis*, *Z. capensis*,

P. longifolia, and *R. caffra* in the bottom left corner of Figure 10 are coarse-grained having very few subcanopy individuals.

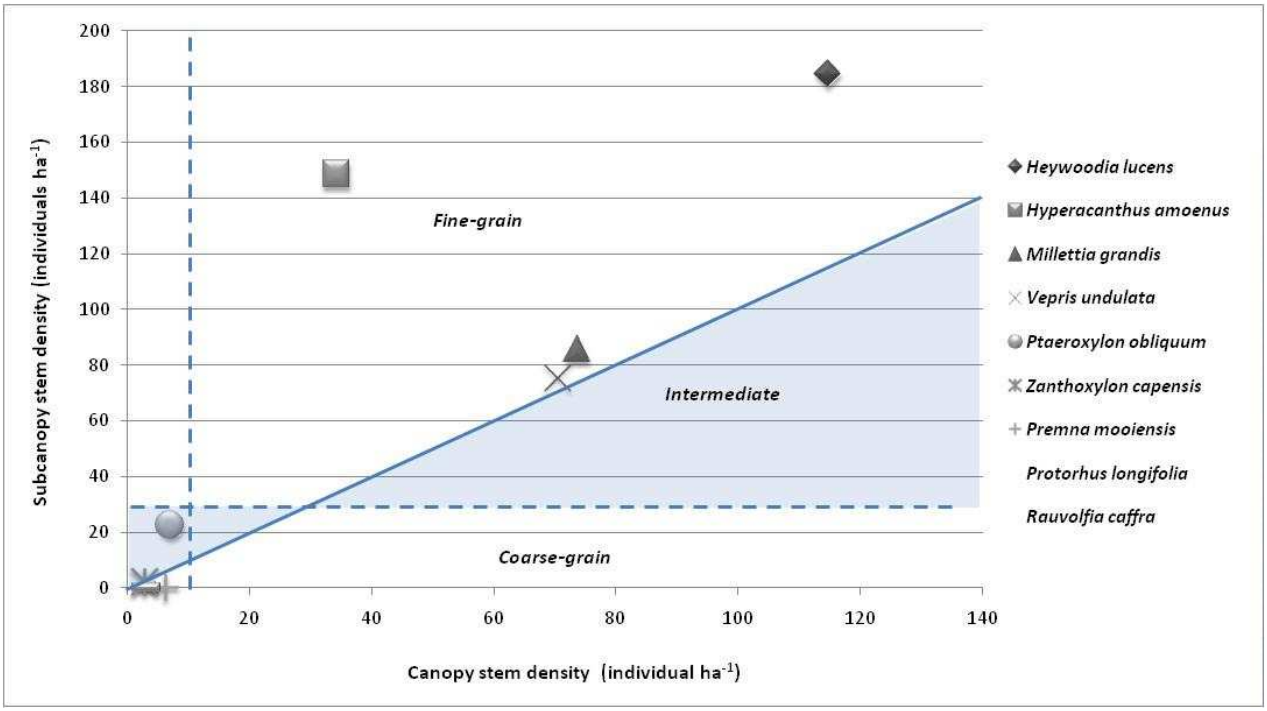

Figure 10: Theoretical representation of spatial scale or grain of regeneration of tree species (adapted from Obiri *et al*. (2002)) in Dwesa-Cwebe Nature Reserve.

3.1.2. Population inventories of herbaceous species

All target species recorded inside of Dwesa-Cwebe Nature Reserve were also found outside of the reserve. Only two grassland species were listed as being priority at the Dwesa-Cwebe workshop which includes *H. pendunculare* and *S. undulata* (Chapter 3), both of which were not recorded in the reserve. The mean percentage cover ($p = 0.037$) and density per m^2 ($p = 0.013$) for *H. odoratissimum* is significantly higher inside the reserve, while mean percentage cover ($p = 0.026$) and density ($p = 0.026$) for *H. hemerocollidea* is significantly lower inside the reserve (Table 7). Mean height for both species is also significantly different where *H. odoratissimum* is higher inside ($p = 0.032$) and *H. hemerocollidea* lower ($p = 0.043$). The mean height of *H. rigidula* is significantly higher ($p = 0.046$) inside as well as mean tuft diameter of *C. validus* ($p = 0.012$).

The most abundant species both inside and outside the reserve is *C. validus* which has the highest density of 1.2±1.21 and 0.9±1.66 individuals m^{-2}, mean percentage cover of 19.0±19.07 and 8.7±14.84 %, and frequency occurrence of 84 % and 68.8 %, respectively (Table 7). The species with the lowest density and frequency of occurrence is *A. campanulatus* which was recorded only once inside and once outside of the reserve. Both *H. odoratissimum* and *H. rigidula* are found in just over half the inside plots (56 %), however *H. rigidula* has a higher density than *H. odoratissimum* of 0.6±1.21 individuals m^{-2} as opposed to 0.1±0.24 individuals m^{-2}, respectively. All species, besides *H. hemerocollidea* and *A. campanulatus*, are found at higher densities inside the reserve than outside although this is only significantly different for *H. hemerocollidea* and *H. odoratissimum*. Three species have very low frequency of occurrence (4 %) inside the reserve which includes *A. campanulatus, H. hemerocollidea* and *R. multifidus*.

Table 7: Mean density and percentage cover of priority herbaceous species inside and outside of Dwesa-Cwebe Nature Reserve. Unlike letters (a b, c d) represent significant differences ($p < 0.05$) between the inside and outside of the reserve, like letter (b b, d d) represent no significant differences.

Species	Mean density (individuals m^{-2})		Mean cover (%)		Frequency of occurrence (%)	
	Inside	Outside	Inside	Outside	Inside	Outside
Cymbopogon validus	1.2±1.21^{b}	0.9±1.66^{b}	19.0±19.07^{d}	8.6±14.84^{d}	84.0	68.8
Hypoxis rigidula	0.6±1.21^{b}	0.3±0.88^{b}	1.2±1.79^{d}	0.4±0.98^{d}	56.0	25.0
Helichrysum odoratissimum	0.1±0.24^{a}	0.02±0.077^{b}	2.4±5.47^{c}	0.2±0.56^{d}	56.0	18.8
Ranunculus multifidus	0.03±0.133^{b}	0.02±0.062^{b}	0.1±0.28^{d}	0.1±0.16^{d}	4.0	18.8
Hypoxis hemerocollidea	0.004±0.0222^{a}	0.2±0.25^{b}	0.02±0.120^{c}	0.8±1.06^{d}	4.0	43.8
Agapanthus campanulatus	0.001±0.0044^{b}	0.001±0.0056^{b}	0.016±0.0800^{d}	0.006±0.0250^{d}	4.0	6.3

Size class distributions were preformed on all species except *A. campanulatus* as too few individuals were recorded (Figure 11). All the size class distributions inside and outside of the reserve show a unimodal or bell-shaped curve, except for *H. hemerocollidea* inside which only has very few individuals in two size classes. The Simpson's index for *C. validus*, *H. odoratissimum* and *H. hemerocallidea* inside were below 0.1 indicating populations with evenly distributed size classes rather than a SCD that is exponentially declining. These species also have high permutation indices indicative of a population

deviating from an 'ideal'. For all species the values of the Simpson's and permutation indices indicate more stable populations outside.

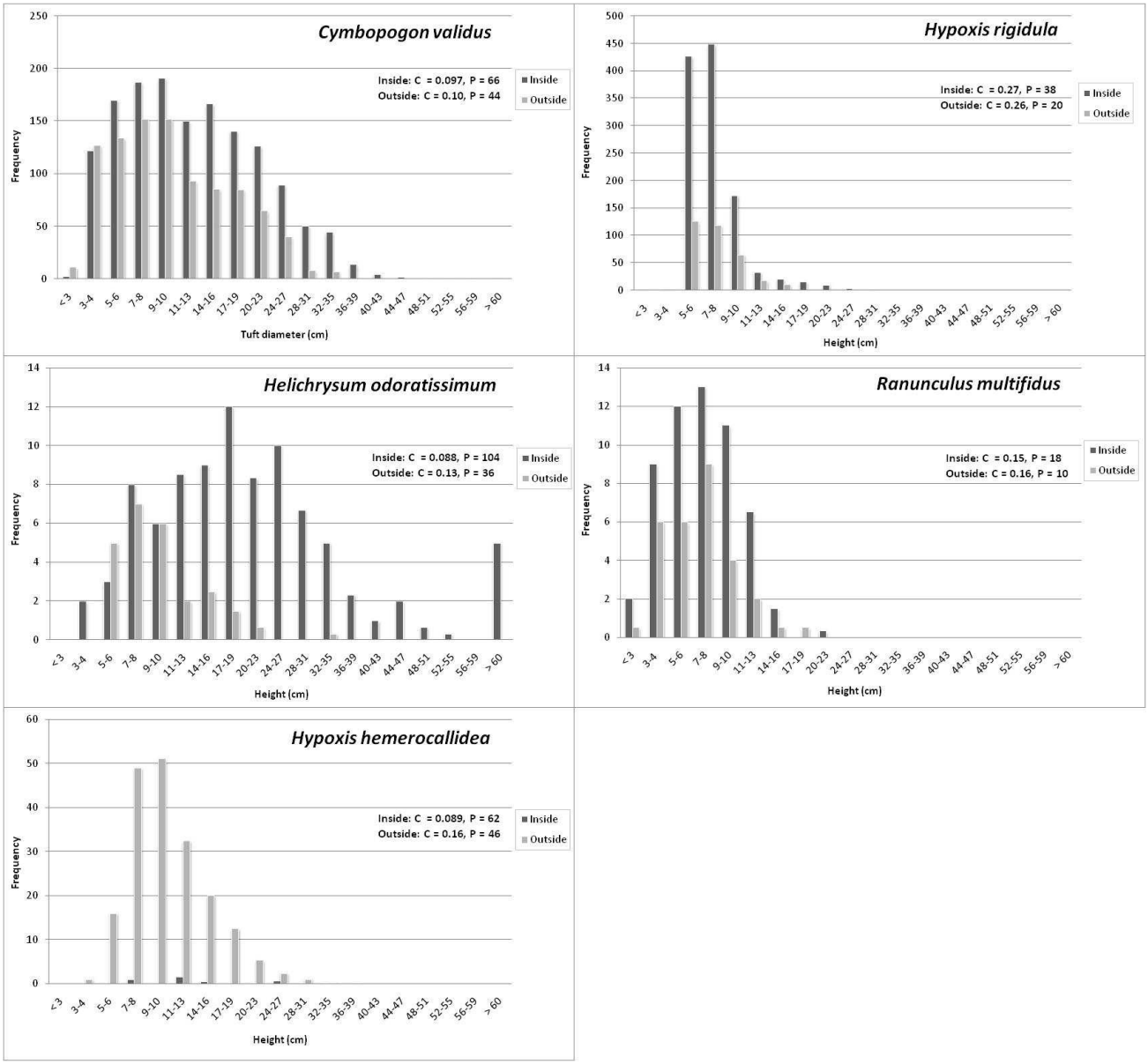

Figure 11: Size class distributions for five herbaceous species inside and outside of the Dwesa-Cwebe Nature Reserve in order of decreasing density (note difference in y-axis scales). Simpson's index (C) and permutation index (P) are included.

3.1.3. Population inventories of aquatic species

Of the two reed species analyzed in Figure 12, *J. kraussii* occupied the largest total area in the reserve of 99061 m^2 (0.099 km^2). *Cyperus textilis* had the most patches, but occupied a smaller total area in comparison of 8811 m^2 (0.009 km^2). From observation in the field, the percentage cover of *C. textilis* within a patch ranged from 80 % to 100 %, while cover of *J. kraussii* within a patch ranged from 60 % to 100 %.

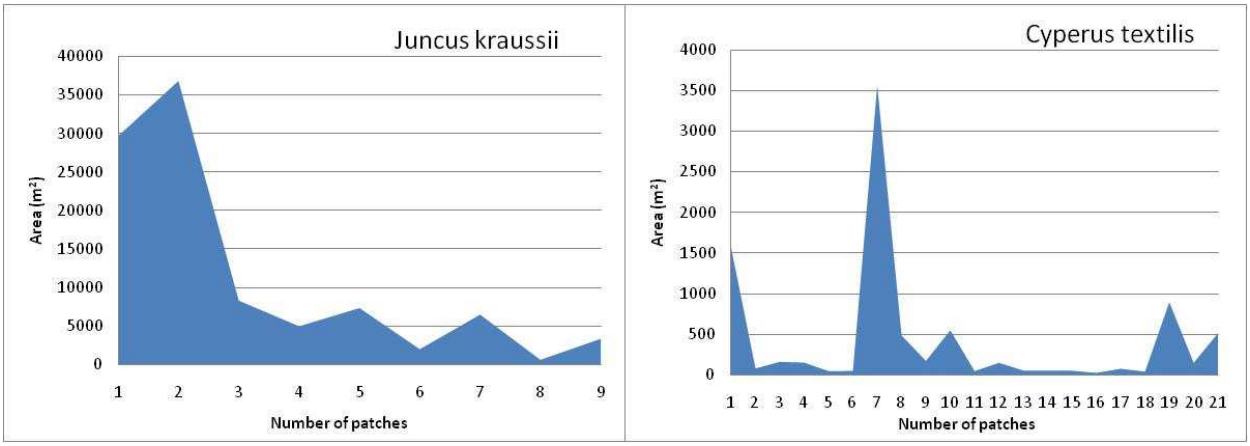

Figure 12: Area of reed patches in the Dwesa-Cwebe Nature Reserve for *Juncus kraussii* and *Cyperus textilis*. Note the different y-axis scales.

Figure 13 shows where reed populations where recorded. The majority of patches of *C. textilis* and *J. kraussii* where recorded on the Dwesa side of the reserve. These two reed species were often found in the same areas. Populations of *C. textilis* and *J. kraussii* outside the reserve were scarcely found in streams around Cwebe, in the Mendwane area and on Mbashe flood plains (Fay 1999). *Cyperus textilis* is also found outside, near Mpume.

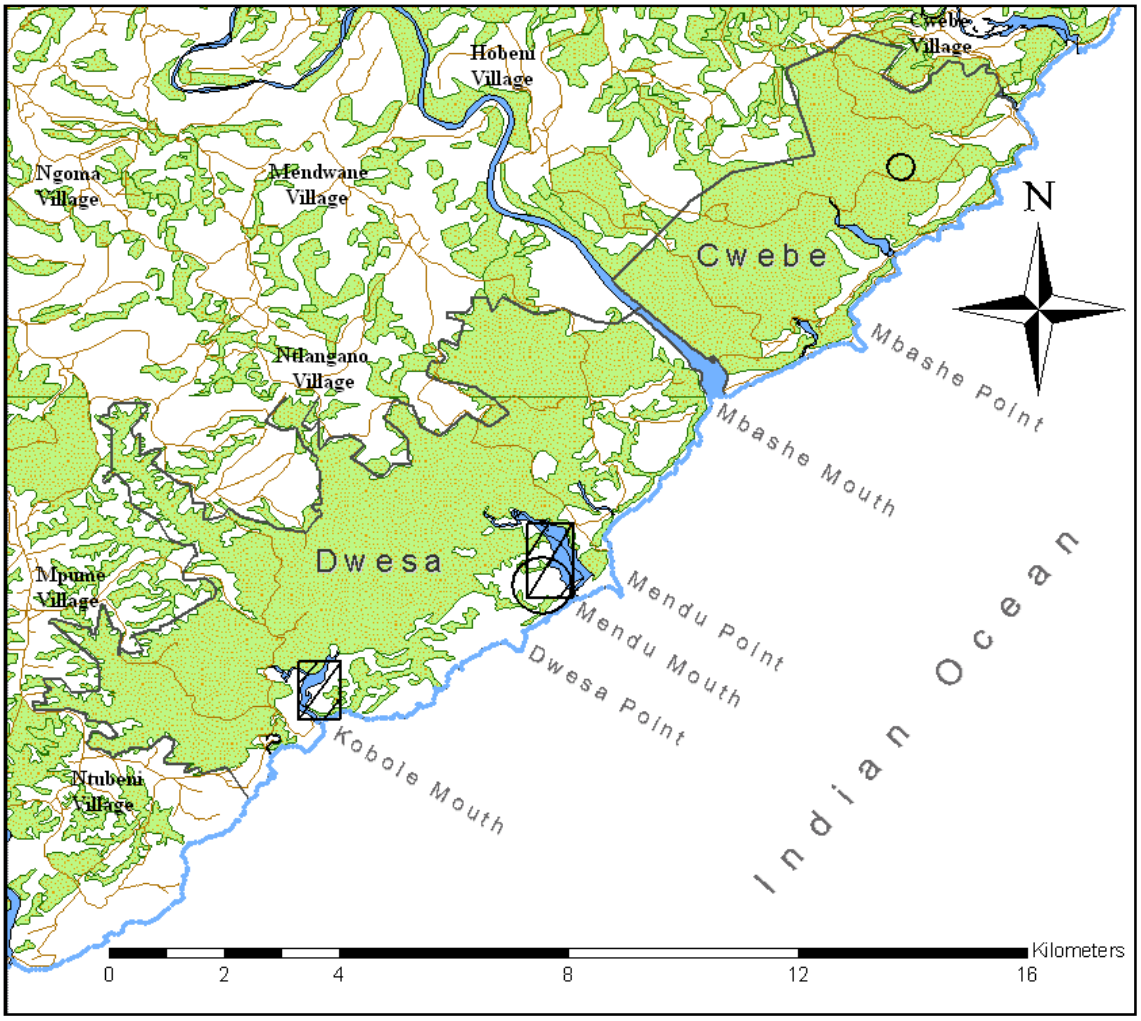

Figure 13: Location of reed populations in Dwesa-Cwebe Nature Reserve (Circles represent areas where *C. textilis* was found and squares represent areas where *J. kraussii* was found).

3.2. Mkambati Nature Reserve

Of the 30 species chosen as priority from all the community workshops, 12 were recorded in the Mkambati region. This included six forest species (all of which were tree species) and six grassland species. No large populations of aquatic species were located. Of the species recorded, five were among the top ten chosen at the Mkambati workshop, which included *Hypoxis rigidula, Helichrysum odoratissimum, Vepris undulata, Protorhus longifolia* and *Osteospermum imbricatum* (refer to Chapter Three).

3.2.1. Population inventories of tree species

Forest plots were not recorded outside as no accessible forest patches greater than 100 m in width were found within a 2 km distance from the reserve boundary. Therefore, T-tests were not necessary. Of the six priority tree species found in the reserve only *H. amoenus* had no saplings recorded, while only saplings and no adults of *P. obliquum* were recorded.

No species were found in large densities in the Mkambati Nature Reserve (Table 8) in comparison to Dwesa-Cwebe. By far the most abundant species is *P. longifolia* with an adult density of 84.4±229.13 individuals ha^{-1}, and sapling density of 172.0±503.43 individuals ha^{-1}. It is also the most frequently occurring species (68.8 %) with other species occurring at relatively low frequencies (< 31.3 %). Other species densities range from 28.1 to 4.2 individuals ha^{-1} for adult tees and 31.3 to as low as 1.0 individuals ha^{-1} for saplings.

Table 8: Mean adult densities, sapling densities and frequency of occurrence of priority tree species inside the Mkambati Nature Reserve.

Species	Density (adult stems ha^{-1})	Density (sapling stems ha^{-1})	Frequency of occurrence (%)
Protorhus longifolia	84.4±229.13	172.0±503.43	68.8
Vepris undulata	28.1±59.85	30.2±69.71	25.0
Hyperacanthus amoenus	25.0±47.53	0.0	31.3
Rauvolfia caffra	12.5±36.26	0.0	12.5
Zanthoxylon capensis	4.2±16.67	31.3±125.00	6.3
Millettia grandis	6.3±18.13	12.5±38.73	12.5
Ptaeroxylon obliquum	0.0	1.0±4.17	6.3

The species not included in the regression analysis were *R. caffra* and *P. obliquum* as they had too few individuals (< 15 individuals). Four of the size class distributions (Figure 14) show, to some extent, a reverse J-shaped curve. *Hyperacanthus amoenus*, however, has more of a unimodal shape, although it has an index of dominance above 0.1 (0.21) and low permutation index (12) indicative of a stable population. Also it has a positive SCD value but a low r^2 value (SCD = 0.21, r^2 = 0.084) (Table 9). *Vepris undulata* and *P. longifolia* have reverse J-shaped SCD curves, however *V. undulata* is truncated as it does not have individuals larger than the 30.5 cm circumference size class, and *P. longifolia* has no individuals

between the 50.5 and 90.5 cm circumference size classes. The permutation index for *V. undulata* is zero while *P. longifolia* has a high index (P = 104) indicating some instability (Figure 14). Both *M. grandis* and *Z. capensis* have very few to no individuals after the first size class.

Table 9: Regression analysis showing the size class distribution slope for tree species inside the Mkambati Nature Reserve.

Species	**Inside**			
	Slope	t-value	r^2	p
Protorhus longifolia	-0.95	7.55	0.65	$p < 0.05$
Vepris undulata	-0.91	18.08	0.98	$p < 0.05$
Zanthoxylon capensis	-0.64	2.65	0.37	$p > 0.05$
Millettia grandis	-0.41	5.24	0.52	$p < 0.05$
Hyperacanthus amoenus	0.21	0.65	0.08	$p > 0.05$

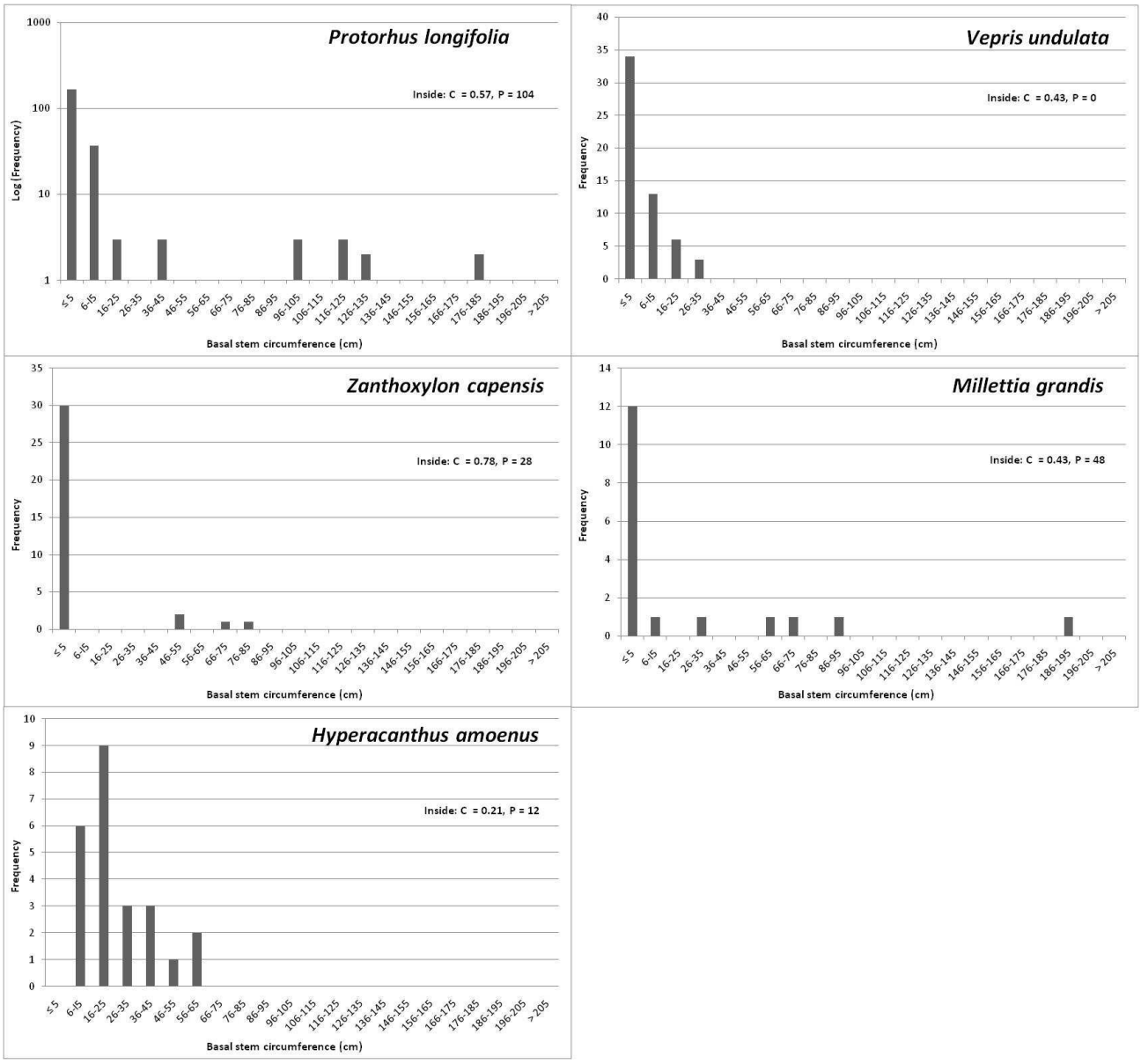

Figure 14: Size class distributions for five tree species inside of the Mkambati Nature Reserve in order of decreasing SCD slopes (note difference in y-axis scales). Simpson's index (C) and permutation index (P) are included.

The theoretical representation of spatial scale indicated *Protorhus longifolia* as fine-grained (Figure 15). *Vepris undulata* is intermediate having few individuals in both subcanopy and canopy levels. The species *M. grandis*, *R. caffra* and *Z. capensis* are coarse-grain having almost no individuals in the subcanopy with

very few in the canopy level. The tree *H. amoenus* is just within the coarse-grained zone marginally below the intermediate line (Figure 15).

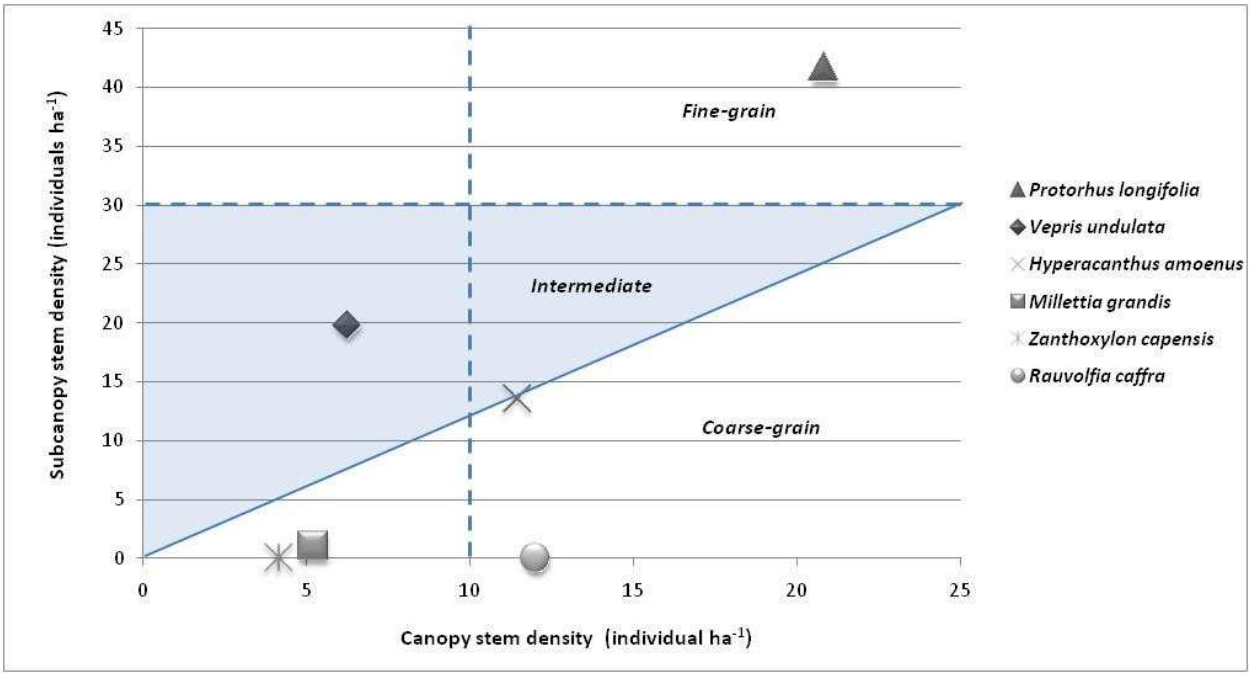

Figure 15: Theoretical representation of spatial scale or grain of regeneration of tree species (adapted from Obiri *et al*. (2002)) in the Mkambati Nature Reserve.

3.2.2. Population inventories of herbaceous species

Of the grassland species recorded inside the Mkambati Nature Reserve only *O. imbracatum* was not recorded outside, however this is not significantly different. The density and percentage cover of *H. odoratissimum* ($p = 0.014$ and $p = 0.017$), *H. pendunculare* ($p = 0.000003$ and $p = 0.002$) and *H. rigidula* ($p = 0.0005$ and $p = 0.0014$) are significantly higher outside the reserve (Table 10).

The most abundant species inside of the reserve is *C. validus* with a mean density of 0.2±0.31 individuals m^{-2} and a mean cover of 3.7±8.83 % (Table 10). Although this species is most abundant inside it did not frequently occur (42.5 %) in comparison with *H. rigidula* (87.5 %). *Hypoxis rigidula* is the most abundant species outside of the reserve with a density of 0.3±0.30 individuals m^{-2} and a high frequency of

occurrence (90.0 %), however *H. pendunculare* has the highest mean cover of 1.6±1.46 % and a higher frequency of occurrence (95.0 %) outside than *H. rigidula*. Both *O. imbracatum* and *X. involucratum* have very low densities inside and outside the reserve.

Table 10: Mean density, percentage cover and frequency of occurrence of priority herbaceous species inside and outside of the Mkambati Nature Reserve. Unlike letters (a b, c d) represent significant differences ($p < 0.05$) between the inside and outside of the reserve, like letter (b b, d d) represent no significant differences.

Species	Mean density (individuals m^{-2})		Mean cover (%)		Frequency of occurrence (%)	
	Inside	Outside	Inside	Outside	Inside	Outside
Cymbopogon validus	0.2 ± 0.31^{b}	0.1 ± 0.09^{b}	3.7 ± 8.83^{d}	0.8 ± 0.83^{d}	42.5	70.0
Hypoxis rigidula	0.1 ± 0.15^{a}	0.3 ± 0.30^{b}	0.4 ± 0.54^{c}	1.04 ± 1.111^{d}	87.5	90.0
Helichrysum pendunculare	0.1 ± 0.11^{a}	0.2 ± 0.17^{b}	0.5 ± 1.15^{c}	1.6 ± 1.46^{d}	30.0	95.0
Helichrysum odoratissimum	0.004 ± 0.0156^{a}	0.1 ± 0.17^{b}	0.1 ± 0.28^{c}	0.6 ± 1.12^{d}	7.5	45.0
Osteospermum imbracatum	0.0008 ± 0.00389^{b}	0.0^{b}	0.0050 ± 0.02207^{d}	0.0^{d}	5.0	0.0
Xysmalobium involucratum	0.0003 ± 0.00176^{b}	0.0006 ± 0.00248^{b}	0.0025 ± 0.01581^{d}	0.0050 ± 0.02236^{d}	2.5	5.0

Although density and cover is higher outside, the heights of all three species mentioned are significantly higher inside of the reserve (Figure 16). Size class distributions were preformed on four of the six species as too few individuals were recorded for *O. imbracatum* and *X. involucratum*. The SCD curves in Figure 16 show that all species, except *H. odoratissimum* and *H. rigidula* inside, have a unimodal shape. The only species with a Simpson's index below 0.1 and a high permutation index (P = 154) is *H. rigidula* inside which has a flat SCD. This is indicative of an unstable population with discontinuous SCD. *Helichrysum odoratissimum* inside has very few individuals that are all in the larger size classes and has a high permutation index (P = 132). Species appear to be more abundant outside of the reserve with exception to *C. validus*.

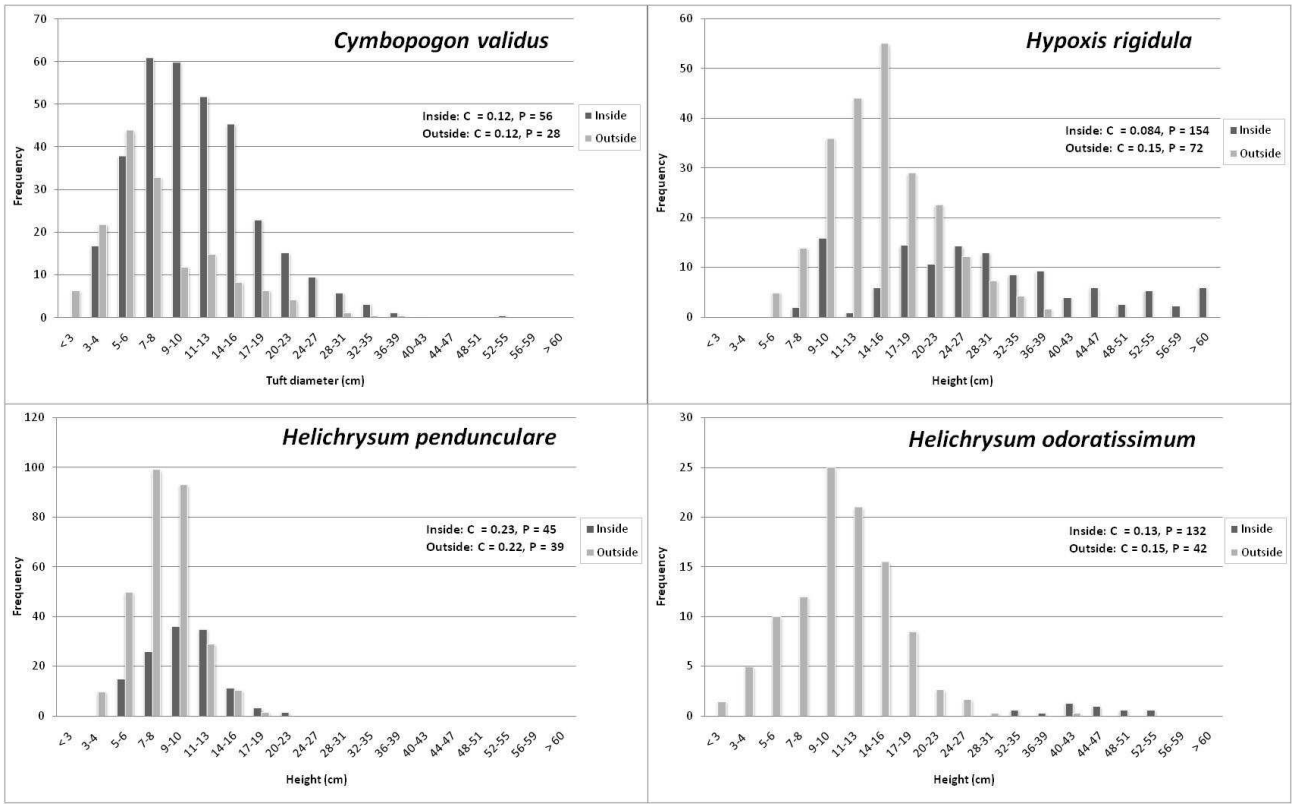

Figure 16: Size class distributions for four herbaceous species inside and outside of the Mkambati Nature Reserve in order of decreasing density (note difference in y-axis scales). Simpson's index (C) and permutation index (P) are included.

3.3. Silaka Nature Reserve

Of the 30 species chosen as priority at all the community workshops, 17 were recorded in the Silaka region. Ten forest species (nine tree species and one creeper), six grassland species and one aquatic species were found. Five of the top ten species chosen at the Silaka workshop where recorded in the field which included *Ranunculus multifidus, Xysmalobium involucratum, Rauvolfia caffra, Helichrysum odoratissimum* and *Nymphaea nouchali*.

3.3.1. Population inventories of tree species

Of the nine priority tree species found only *R. caffra* was not recorded outside of the reserve, while *P. mooiensis* was not recorded inside of the reserve. No saplings were recorded for *H. lucens*, *P. mooiensis*, *R. caffra* and *H. amoenus*. Mean adult density for *H. amoenus* is significantly higher ($p = 0.00019$) outside the reserve however the mean circumference is significantly ($p = 0.00019$) larger inside (Table 11). *Premna mooiensis* has a significantly higher density outside however no individuals were recorded inside. The mean adult density of *V. undulata* is also significantly higher ($p = 0.019$) outside the reserve. There are no significant differences for sapling density.

Table 11: Mean adult densities, sapling densities and frequency of occurrence of priority tree species inside and outside of Silaka Nature Reserve (mean ± stdev). Unlike letters (a b, c d) represent significant differences ($p < 0.05$) between the inside and outside of the reserve, like letter (b b, d d) represent no significant differences.

Species	Density (adult stems ha^{-1})		Density (sapling stems ha^{-1})		Frequency of occurrence (%)	
	Inside	Outside	Inside	Outside	Inside	Outside
Millettia grandis	80.4±135.18^{b}	70.0±71.92^{b}	39.9±122.03^{d}	103.3±115.68^{d}	73.9	70.0
Heywoodia lucens	55.8±87.56^{b}	58.3±80.60^{b}	0.0^{d}	0.0^{d}	43.5	40.0
Vepris undulata	37.0±39.23^{a}	75.0±43.92^{b}	17.4±45.64^{d}	21.7±32.44^{d}	65.2	90.0
Protorhus longifolia	25.4±86.44^{b}	46.7±83.07^{b}	3.6±10.00^{d}	41.7±84.71^{d}	30.4	50.0
Zanthoxylon capensis	19.6±35.41^{b}	10.0±31.62^{b}	15.9±76.46^{d}	5.0±11.25^{d}	39.0	20.0
Ptaeroxylon obliquum	10.1±24.48^{b}	18.3±29.87^{b}	1.5±6.95^{d}	36.7±70.62^{d}	21.7	60.0
Rauvolfia caffra	3.6±8.64^{b}	0.0^{b}	0.0^{d}	0.0^{d}	17.4	0.0
Hyperacanthus amoenus	2.2±5.74^{a}	16.7±19.25^{b}	0.0^{d}	0.0^{d}	13.0	50.0
Premna mooiensis	0.0^{a}	3.3±7.03^{b}	0.0^{d}	0.0^{d}	0.0	20.0

The density of tree species in Silaka NR are not high (< 100 individuals ha^{-1}) for both adult trees and saplings in comparison to the Dwesa-Cwebe Nature Reserve. The most abundant species inside the reserve is *M. grandis* with the highest adult density of 80.4±135.18 individuals ha^{-1}, and the highest sapling density of 39.9±122.03 individuals ha^{-1}(Table 11). It is also the most frequently occurring species inside (73.9 %), while *V. undulata* is the most frequently occurring species outside (90.0 %). *Vepris undulata* also has the highest density of adult trees (75.0±43.92 individuals ha^{-1}) outside but a comparatively lower sapling density (21.7±32.44 individuals ha^{-1}). *Millettia grandis* has by far the highest

sapling density outside the reserve of 103.3±115.68 individuals ha^{-1}. *Hyperacanthus amoenus* and *P. mooiensis* had the lowest adult trees densities of 2.2±5.74 and 3.33±7.027 individuals ha^{-1} respectively, while *P. obliquum* and *P. longifolia* had the lowest sapling densities of 1.5±6.95 and 3.6±10.00 individuals ha^{-1} respectively.

For the regression analysis the species *R. caffra*, *H. amoenus* and *P. mooiensis* were left out as they had too few individuals (< 15). *Millettia grandis* and *V. undulata* have reverse J-shaped curves (Figure 17) inside and outside the reserve. Both these species have high SCD slope values and r^2 values inside the reserve (SCD = -0.89, r^2 = 0.81; SCD = -0.84, r^2 = 0.85 respectively) with slightly lower SCD slope values outside (SCD = -0.76, r^2 = 0.68; SCD = -0.72, r^2 = 0.81 respectively) (Table 12). *Protorhus longifolia* has the highest SCD value outside of -0.92 as well as a high r^2 value of 0.9. This species has a truncated reverse J-shaped distribution. All species have negative SCD slope values except for *H. lucens* which has a positive slope of 0.41 inside and 0.39 outside, although the r^2 values are relatively low. The shapes of the SCD curves for *H. lucens* inside and outside are unimodal. Simpson's and permutation indices are below 0.1 and very high, respectively, indicating an unstable discountinuous SCD. *Zanthoxylon capensis* displays a truncated reverse J-shape inside the reserve. Outside, along with *P. obliquum*, it has an ambiguously shaped SCD curve, however conform to a flat SCD, while *P. obliquum* has a slightly bimodal shape both inside and outside.

Table 12: Regression analysis showing the size class distribution slope for tree species inside and outside of the Silaka Nature Reserve.

Species	Inside				Outside			
	Slope	t-value	r^2	p	Slope	t-value	r^2	p
Millettia grandis	-0.89	11.43	0.81	$p < 0.05$	-0.76	8.22	0.68	$p < 0.05$
Vepris undulata	-0.84	13.71	0.85	$p < 0.05$	-0.72	14.48	0.81	$p < 0.05$
Protorhus longifolia	-0.76	5.48	0.70	$p < 0.05$	-0.92	7.02	0.90	$p < 0.05$
Zanthoxylon capensis	-0.54	7.85	0.42	$p < 0.05$	-	-	-	-
Ptaeroxylon obliquum	-0.38	6.85	0.31	$p < 0.05$	-0.56	3.87	0.53	$p < 0.05$
Heywoodia lucens	0.41	2.57	0.43	$p < 0.05$	0.39	1.55	0.38	$p < 0.05$

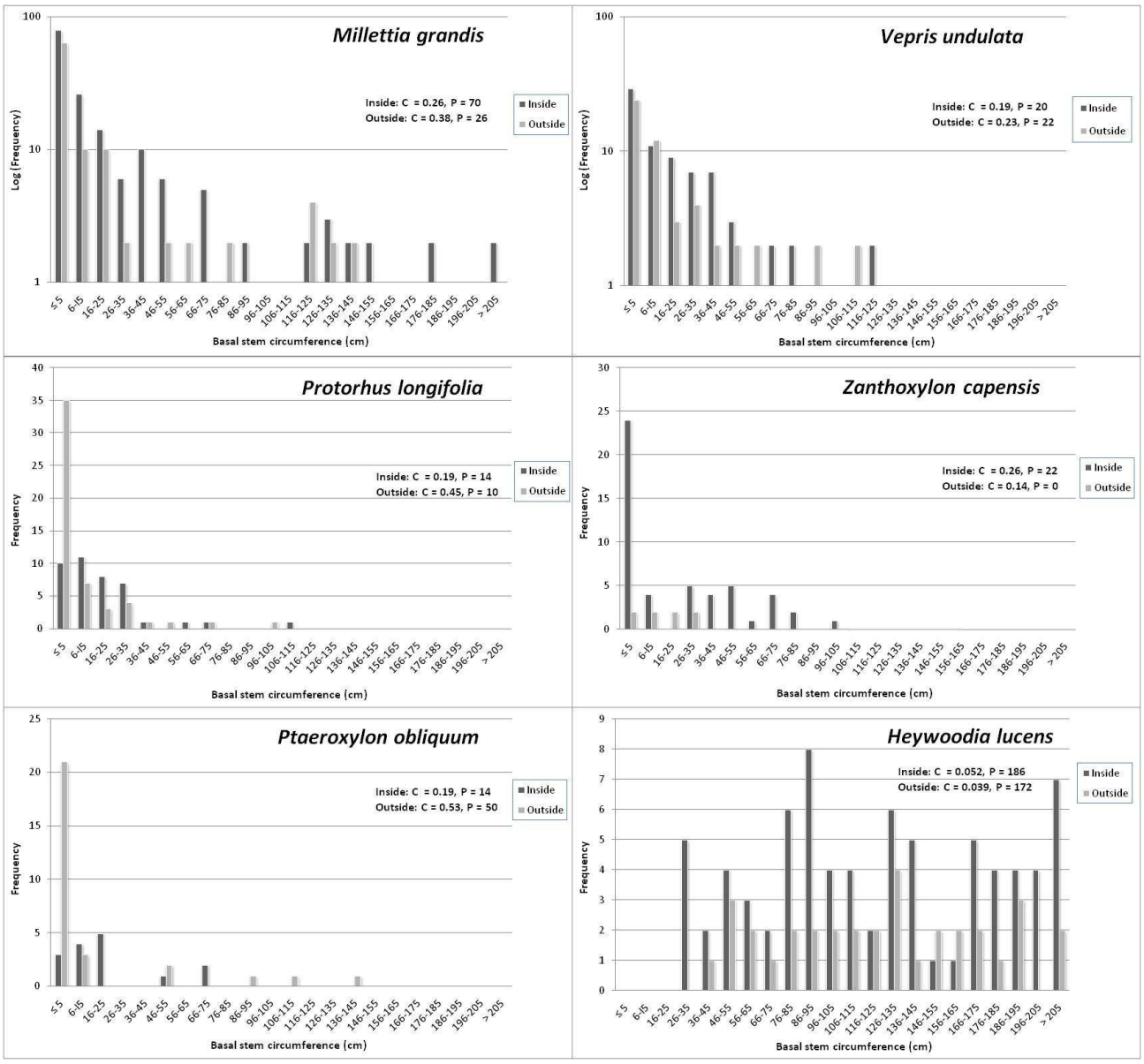

Figure 17: Size class distributions for six tree species inside and outside of the Silaka Nature Reserve in order of decreasing SCD slopes (note difference in y-axis scales). Simpson's index (C) and permutation index (P) are included.

All species in Figure 18, except *P. longifolia,* are coarse-grained having few individuals in the subcanopy level compared to the canopy level. *Heywoodia lucens* only has canopy individuals. *Protorhus longifolia* is intermediate having a similar amount of subcanopy and canopy individuals. Both *R. caffra* and *H. amoenus* have no individuals in the subcanopy level and very few in the canopy. *Millettia grandis* and

V. undulata display a more even distribution of canopy and subcanopy individuals compared to the other coarse-grained species.

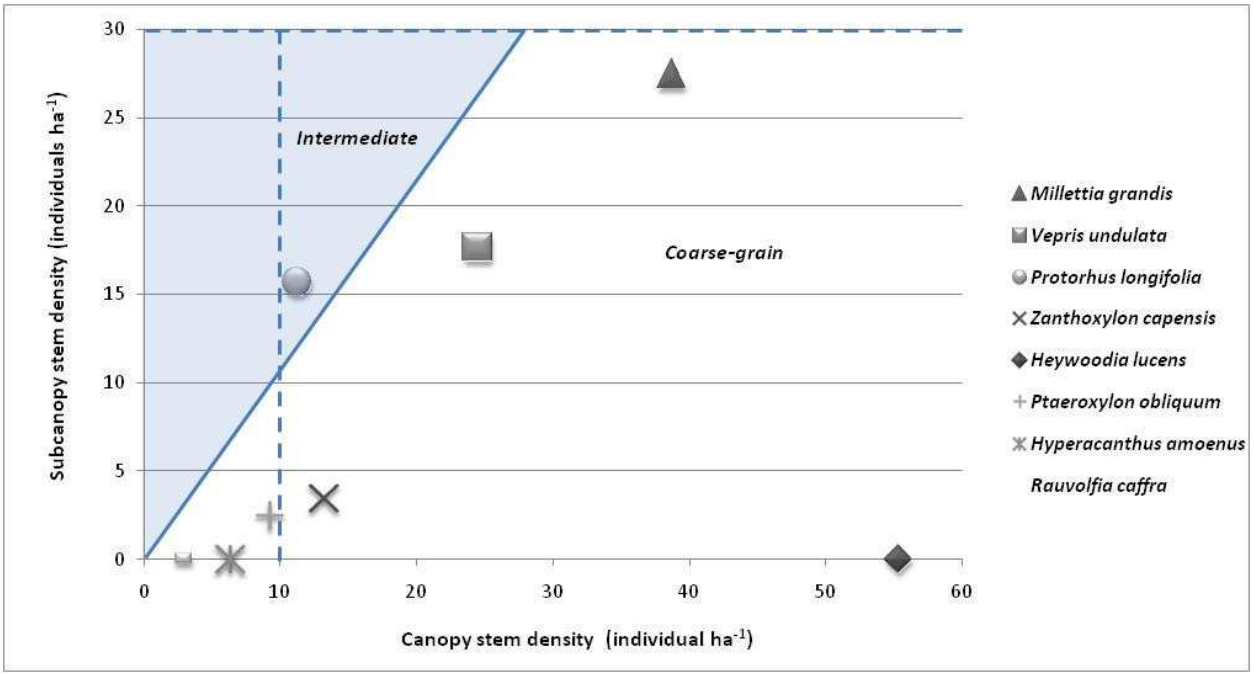

Figure 18: Theoretical representation of spatial scale or grain of regeneration of tree species (adapted from Obiri *et al*. (2002)) in the Silaka Nature Reserve.

3.3.2. Population inventories of herbaceous species

Of the species recorded at the Silaka NR *H. odoratissimum* and *R. multifidus* were not recorded inside while *S. undulata* and *X. involucratum* were not recorded outside (Table 13). Of these species only *X. involucratum* has a significant difference for mean density ($p = 0.023$), cover ($p = 0.022$) and height ($p = 0.0092$). The grass *C. validus* has a significantly higher density ($p = 0.0001$) and cover ($p = 0.00004$) inside the reserve. While *H. hemerocollidea* has a significantly higher cover ($p = 0.043$) inside, it also has a higher mean height inside ($p = 0.015$).

The most abundant species inside and outside of the reserve is the grass *C. validus* with a mean density and cover inside of 1.6±0.81 individuals m^{-2} and 24.6±10.16 % respectively, and outside of 0.2±0.33

individuals m^{-2} and 4.4±6.27 %, respectively. It is found in all plots (100 %) inside the reserve with the highest frequency of occurrence outside of 70 % (Table 13). *Hypoxis hemerocollidea* also has a high frequency of occurrence (70 %) inside the reserve with a relatively high mean density of 0.1±0.17 individuals m^{-2}. The density of other recorded species range from 0.04±0.072 to as low as 0.004±0.0078 individuals m^{-2} (Table 13).

Table 13: Mean density, percentage cover and frequency of occurrence of priority herbaceous species inside and outside of Silaka Nature Reserve. Unlike letters (a b, c d) represent significant differences ($p < 0.05$) between the inside and outside of the reserve, like letter (b b, d d) represent no significant differences.

Species	Mean density (individuals m^{-2})		Mean cover (%)		Frequency of occurrence (%)	
	Inside	Outside	Inside	Outside	Inside	Outside
Cymbopogon validus	$1.6±0.81^{a}$	$0.2±0.33^{b}$	$24.6±10.16^{c}$	$4.4±6.27^{d}$	100	70
Hypoxis hemerocollidea	$0.1±0.17^{b}$	$0.02±0.045^{b}$	$1.6±2.30^{c}$	$0.1±0.41^{d}$	70	20
Silene undulata	$0.04±0.072^{b}$	0.0^{b}	$0.6±0.98^{d}$	0.0^{d}	30	0
Xysmalobium involucratum	$0.02±0.020^{a}$	0.0^{b}	$0.08±0.101^{c}$	0.0^{d}	50	0
Ranunculus multifidus	0.0^{b}	$0.01±0.028^{b}$	0.0^{d}	$0.04±0.127^{d}$	0	10
Helichrysum odoratissimum	0.0^{b}	$0.004±0.0078^{b}$	0.0^{d}	$0.045±0.0832^{d}$	0	30

Size class distributions were not preformed for *H. odoratissimum*, *R. multifidus* and *X. involucratum* since too few of these three species were recorded (<15 individuals). All species except *S. undulata* have unimodal shaped SCD slopes inside the reserve (Figure 19). Outside *C. validus* has a less conspicuous unimodal SCD slope, as well as *H. hemerocallidea*, however this species has very few individuals. *Silene undulata* was not found outside the reserve and has a fairly flat SCD with a peak in frequency in the second size class. This is also the only species to have a very high permutation index (P = 122) and a Simpson's index below 0.1 (C = 0.078) indicating a population with a discontinuous SCD.

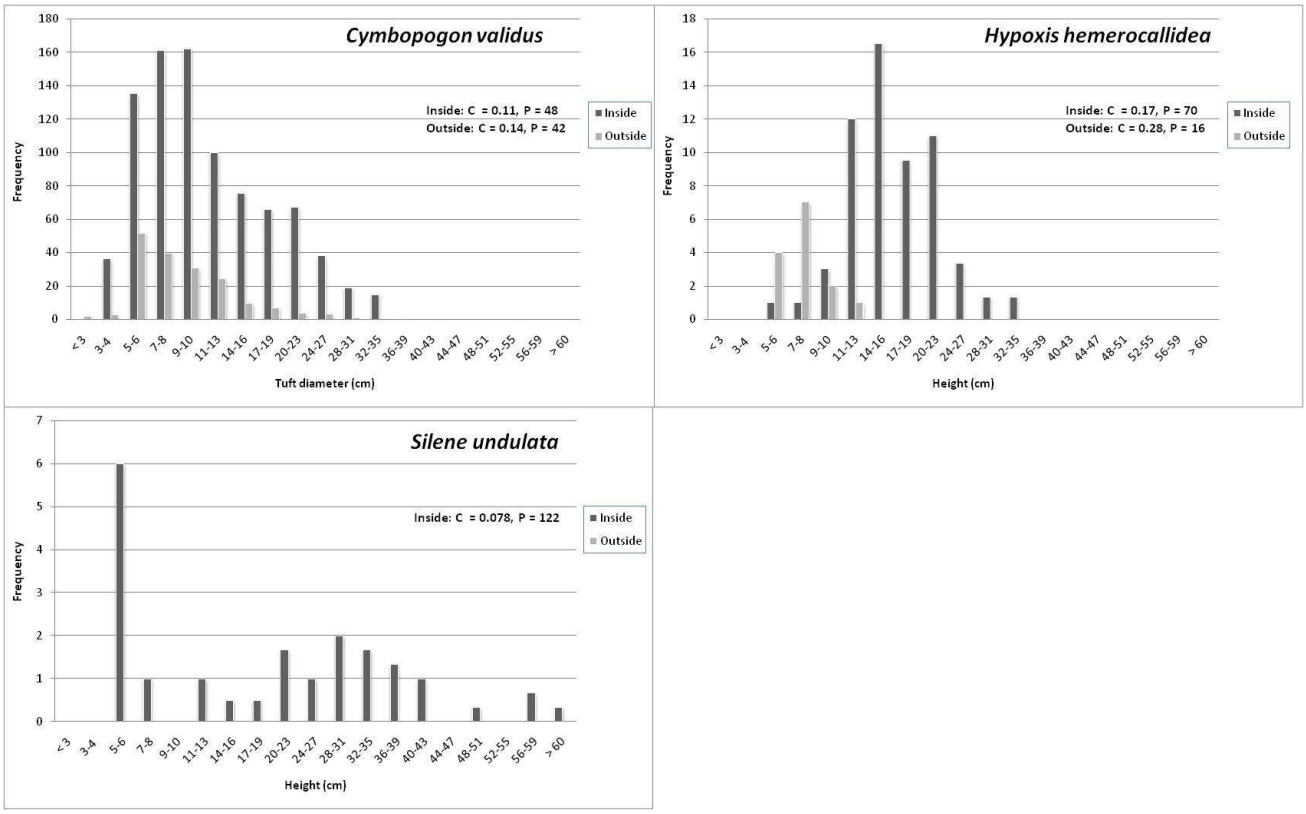

Figure 19: Size class distributions for three herbaceous species inside and outside of the Silaka Nature Reserve in order of decreasing density (note difference in y-axis scales). Simpson's index (C) and permutation index (P) are included.

4. Discussion

Findings that can be highlighted in the DCNR and further discussed are that 1) there is a notably higher density (almost two-fold) of *C. validus*, *H. amoenus* and *H. lucens,* and an exceptionally high density of *H. lucens* saplings (580.1 individuals. ha^{-1}) inside the reserve in comparison to other species, 2) all species except *P. mooiensis* have a reverse J-shape distribution, however the low densities of more than half the species recorded and four of the nine species having very low recruitment, suggests that most tree species have an unstable population status, 3) all grassland species have a unimodal SCD which may be a result of fast growth rates or disturbances such as fire, 4) there are fewer larger individuals outside the reserve but overall there are few significant differences between the inside and outside of the reserve, and 5) large reed populations where found in this reserve but not in the others.

In the MNR significant findings are that 1) densities of tree species in MNR are lower than in DCNR, 2) grassland species are more abundant outside, with the exception to *C. validus*, 3) there is a lower diversity of tree species with only seven species recorded as opposed to nine in the DCNR and SNR, and 4) the low sapling recruitment of all species but *P. longifolia*, and the lack of individuals in the larger size classes indicate that tree species populations are unstable.

Findings highlighted for the SNR are that 1) densities of tree species are much lower than in DCNR but overall are higher than in MNR, 2) the grass *C. validus* is by far the most abundant species in comparison to other grassland species as well as being more abundant than in the other two reserves, 3) the inside and outside of the reserve is very similar in both stem densities and SCDs for tree species, however SCDs were not similar for grassland species, 4) six of the nine tree species have very little recruitment, including *H. lucens* which had the highest abundance of saplings in DCNR. Also there is a lack of individuals in larger size classes indicating that populations are unstable, and 5) *Ptaeroxylon obliquum* has the same SCD as in DCNR where intermediate size classes are missing.

4.1. Abundance and population status of key tree species across the reserves

Highly abundant species were only found in the DCNR which includes *H. lucens*, *H. amoenus*, *M. grandis* and *V. undulata*. All four species showed distinct reverse J-shaped distributions with high SCD values indicating good recruitment and an abundance of seedlings and saplings. As found by Lykke (1998), a strong negative correlation between regeneration density and SCD slope indicates that abundant regeneration is a good strategy for species survival and rejuvenation. They were also characterized as fine-grained indicating shade tolerance with good regeneration under the canopy, and well represented in the understory and canopy levels (Obiri *et al.* 2002). This is indicative of healthy population inside the reserve. Two species, *H. lucens* and *H. amoenus,* are dominant relative to other species recorded within the DCNR forest (density of adult trees > 390 individuals ha^{-1}). However, this is not true outside of the reserve where, although all four species previously mentioned are abundant, but with lower densities, it is *M. grandis* and *V. undulata* that are most abundant. This difference may be due to intensified disturbances outside such as harvesting or due to forested areas becoming patchy rather than continuous. As documented by Grundy *et al.* (1993), although species richness decreased with closer

proximity to rural villages in Zimbabwe, other species that favour disturbance may become dominant. Increased species dominance and loss of other species with increasing disturbance was also noted by Rao *et al*. (1990). Forests that become patchy in community areas such as in the Dwesa-Cwebe region may be favorable to certain species such as those that prefer to grow on forest margins, such as *M. grandis* which does not occur more than 50 m from the forest margin (Obiri 1997). In the case of *H. amoenus* only small size classes were recorded outside which may be due to larger size classes being harvested. With increased intensity of disturbance, such as distance to rural communities, there is seen a decrease in woody stem density, seedling density and recruitment and the loss of larger size classes as found in the studies by Childes and Walker (1987) and Shackleton *et al*. (1994). Obiri *et al*. (2002) found that of the 20 high-valued tree species analyzed in their study, all were found in the protected State Forest and only 11 in the Community Forest. The nine absent species were described as most used by the communities. *Millettia grandis* and *H. amoenus* had significantly higher mean circumferences inside the DCNR than outside. A similar result was found by Botha *et al*. (2004a) where the basal diameter of two species in unharvested populations where significantly higher than for harvested population in Mpumalanga Lowveld, South Africa.

Selective harvesting, especially of understory individuals, can potentially change tree dynamics as well as species composition by affecting the normal progression of growth from one size class to another (Boudreau *et al*. 2005). *Ptaeroxylon obliquum* has a bimodal distribution where the intermediate sized individuals are absent. This is the same in both the DCNR and SNR and may be a consequence of selective harvesting or a recruitment bottleneck sometime in the past. This absence was also seen for *P. obliquum* in the study by Obiri *et al.* (2002) in the coastal Pondoland forests, and is suggestive of a declining population caused by some form of disturbance (Obiri *et al*. 2002). This observation in the coastal Pondoland forests may be a result of intense harvesting of *P. obliquum* in the past (King 1941, Obiri *et al*. 2002). From a report by von Breitenbach in the forests of Transkei in 1976 the dominant species seen in the coastal forests were *Millettia*, *Heywoodia, Protorhus*, *Rauvolfia* and *Macaranga*, among others. Of the species mentioned by von Breitenbach, *Millettia* and *Heywoodia* are still dominant species in this study, while *Rauvolfia* and *Macaranga* appear to be rare. *Protorhus* was found, but cannot be considered as a dominant species in this study. This comparison suggests over utilization of *Protorhus*, *Rauvolfia* and *Macaranga* over the 34 years since von Breitenbach's observation. *Millettia grandis* and *V. undulata* are two of the more abundant species in SNR as well as in DCNR, and were also

of the few species found in MNR. These were the only two trees to show consistency between the reserves and are perhaps indicative of adaptive or resilient species with broad ecological niches.

Species with positive SCD slopes are *P. mooiensis* in the DCNR, *H. lucens* in SNR and *H. amoenus* in MNR. While it is most abundant in DCNR it has very little recruitment and appears to be a declining population. *Premna mooiensis* has very low recruitment and is represented by only large individuals. It was also found outside SNR however very rare having only a few large individuals. This species was defined as coarse-grained, being characteristic of a shade intolerant tree that is unable to coppice. *Heywoodia lucens* in SNR is a contradiction to the same species in DCNR as it is shown to have very little recruitment, while having a very high sapling density (580 individuals ha^{-1}) in DCNR. Also this species was defined as fine-grained in DCNR but coarse-grained in SNR. Again, as with *P. obliquum*, this may be due to past harvesting activities which have had a negative affect on reproductive success. Certainly this species appears to be on the decline in SNR when looking at comparisons between reserves. It is unlikely that a species population level can be maintained with so few young individuals as more saplings than adult trees are required to maintain a relatively constant population (Lykke 1998). No saplings were found for *H. lucens* in SNR and its SCD slope value was positive. These findings are similar to those of Obiri *et al.* (2002) in the State and Community Forests of the Eastern Cape where *H. lucens* saplings were rare and its SCD slope did not differ significantly from zero. Obiri *et al.* (2002) accounted this to its poor seedling establishment and inability to produce coppice stems.

Life-history attributes such as coppicing, re-sprouting and growth rates are important in determining regeneration capabilities, especially under the canopy and with disturbances. Coppice regrowth is defined as a plant's ability to rapidly resprout from the remaining stump or base following a disturbance (Kaschula *et al*. 2005). Fine-grained species typically have advanced regeneration such as coppicing while coarse-grained do not (Obiri *et al*. 2002). An interesting attribute that was examined by Poorter *et al*. (2006) in a tropical moist forest of Bolivia is tree architecture. Light demanding species, described as coarse-grained by Everard *et al*. (1995), are characterized by orthotropic stems and branches, large leaves and a monolayer leaf arrangement. Shade-tolerant species are characterized as having wide and long crowns and many long-lived leaves, as well as dense wood. Poorter *et al*. (2006) found that there is a close correlation between wood density and leaf life span with shade tolerance. Dense wood increases plant survival in the understory, making a tree less vulnerable to breakage (Niklas 1994). Interestingly, *V.*

undulata, *M. grandis*, and *H. lucens* described as shade-tolerant species in DCNR have hard wood, and the species *P. longifolia* and *R. caffra* described as shade intolerant have soft wood and large leaves (Palgrave 1977). The abundance of *H. amoenus* in DCNR may be a result of it being a small species. Small species often reproduce at smaller size classes than larger species resulting in a larger number of saplings and more reproducing individuals (Poorter *et al*. 2006).

Species that were rarely found, so much so that analysis could not be preformed, may naturally have a low abundance, or may be a result of harvesting pressure or other disturbances. Low abundance due to natural features of a species could be true for *Curtisia dentata, Capparis sepiaria var. citrifolia* and *Polygala myrtifolia* that where consistently not found, as well as *Macaranga capensis* where only two trees were seen in SNR but none in the sample plots. The environment may not be conducive to a particular species. For example, Obiri *et al.* (2002) observed that large *P. obliqumm* trees and saplings were restricted to forest edges and gaps. *Polygala myrtifolia* is also a marginal species as well as *M. capensis* and *R. caffra* which are also strongly associated with water sources such as streams and rivers (Palgrave 1977). This was however considered when laying out sample sites as transects were placed near rivers, roads and deep forest. Species that are in the process of elimination fail to reproduce which is perhaps contributed to a lack of advanced regeneration (Condit *et al*. 1998). This may be the case for *H. lucens* and *H. amoenus* which are most abundant in DCNR but rare in SNR and MNR. The geographical distribution of species is also important in determining why a species may not be found in one area but found in another as some species may not extend as far up or down the Wild Coast as others.

It is not surprising that species have very different population statuses between reserves as the forested areas are geologically different. The indigenous forests of DCNR are large covering 68.5 %, with the Dwesa side alone almost 80 % forest (Palmer 2003, Timmermans 2004, Shackleton *et al*. 2007), and has greater mean densities of tree species than MNR and SNR. The MNR is almost 80 % grassland with few small patches of forest (Shackleton 1989). Many populations are isolated from one another and species are found in very low densities. Small forest patches allows people to have greater access to resources as it lacks the sanctuary of deep forest which is difficult to access. For example, open access to harvesting in small forest patches in South Africa resulted in local extinction of fine-grained species while similar harvesting intensities in larger forests did not have the same result (Obiri *et al*. 2002, Boudreau *et al*. 2005). Species also risk genetic isolation and gradual decline where they are confined to

small ‘islands’ that are secluded from one another (Dudley *et al*. 2005). The proximity of households to the reserve and density of human populations can also affect harvesting intensity (Boudreau *et al*. 2005). Silaka has a higher human population density living in close proximity than does MNR or DCNR. Silaka is almost entirely forested, has a hilly terrain and is very small. The forest surrounding the reserve is very similar to the inside and is extensive. Low abundance and little recruitment here may be because of the reserve size that allows for easy access to resources throughout the reserve, or the steep terrain which may be unfavorable to some species. A tropical dry forest in India studied by Sukumar *et al.* (1992) had few juveniles which led them to believe that many species may be persisting there through episodic recruitment. However, the reason behind the lack of recruitment cannot be pin-pointed to an event such as this and ultimately needs further investigation.

4.2. Abundance and population status of key grassland species across the reserves

Almost all grassland species showed unimodal distributions with low recruitment in the small size classes and frequency of individuals peaking at intermediate size classes. This type of SCD cannot be clearly interpreted as can that of woody plants. A unimodal distribution would typically describe a species with low recruitment, indicting a declining population. However, herbaceous species have very different growth rates compared to trees. Herbaceous species grow fast especially in warm and humid environments such as the Wild Coast. This ability allows them to grow and reproduce quickly when conditions are favourable such that once a seedling is established it may become hard to distinguish from adult plants. This may result in the lack of a ‘sapling’ stage which is seen for woody species. The average rainfall for the Wild Coast is between 1 100 and 1 400 mm per annum peaking in summer (Shackleton 1989, Cousins & Kepe 2002, Fielding *et al*. 2006). The majority of the fieldwork was conducted from June to mid August before the rainy summer season. Seedlings may not have begun to sprout before the summer months when fieldwork was conducted and most would have transitioned to the larger size classes since the last rainy months.

Frequent and widespread disturbances of fire and herbivory can also effect species composition and population size distribution profiles (Keeley *et al*. 1981). It must be noted here that roughly three months prior to fieldwork in DCNR and SNR fires had occurred in large isolated areas of the grassland. Fires may kill off seeds and small individuals that have not established a proper rooting system or

underground supply such as tubers, which allows for re-growth in post-fire conditions. Keeley *et al*. (1981) observed that in the first year following a fire in herbaceous flora of Southern California, 26 of 28 herbaceous perennials were represented entirely by resprouts. Fire is a natural disturbance in African grasslands and occurs annually or biennially on the Wild Coast. Many species within grasslands are adapted to regenerate after fire and often have high enough densities that populations are maintained. Grasses and geophytes have adaptations such that they allocate nutrients and carbohydrates to below ground tissues (Dzerefos & Witkowski 2001), which allows for effective regrowth in post-fire conditions giving species such as *C. validus* and *Hypoxis* an advantage. *Cymbopogon validus* is the most abundant grassland species in all three reserves with *Hypoxis* secondly abundant. In contradiction to what was mentioned previously, *C. validus* can become dense were fire and grazing is absent such that it 'strangles' other species. However, it occurs in isolated patches of varying sizes, which according to Shackleton and Shackleton (1994), is due to it occurring on nutrient-rich clay soil and not on sandy soils, thus giving it an advantage in such conditions but not others. Half the grassland species in MNR had significantly higher cover outside the reserve where *C. validus* cover was lower. This may be a consequence of high herbivory and trampling intensities outside where numerous cattle were observed to be grazing, and thus preventing *C. validus* from becoming dense. As described by Belsky (1992), in areas that were protected from grazers certain species can become so dense that seeds of other species are unable to germinate in the shade of the dense foliage, or hinders species that expand vegetatively. In the SNR the two species *S. undulata* and *X. involucratum* were not found outside the reserve which may also be a consequence of heavy cattle activity. Thus, depending on severity of a disturbance there may be a positive or negative effect on species survival.

Another reason for the lack of recruitment may be sampling error. Herbaceous seedlings are small and may go unnoticed in dense grassland. Although we did sample as carefully as possible, the likelihood of missing a herbaceous seedling is greater than a woody sapling. This scenario would reflect a false SCD rather than one affected by biological factors. This is a plausible cause, however probably unlikely due to sound fieldwork and previously discussed causes.

4.3. Abundance and population status of key aquatic species across the reserves

Cyperus textilis is a water dwelling sedge that can grow up to three meters high and is highly desirable as a weaving fiber to local communities (Makhado & Kepe 2006). It requires adequate water to survive and occurs in patches ranging from 3 563 m^2 to 22 m^2 in the DCNR near the Mendu Mouth. This species was fairly abundant, especially on the Dwesa side, but was not found in the other two reserves. The sedge may be found higher inland of the MNR however this area is mostly inaccessible on foot. There are few areas in the SNR suitable for this sedge to grow as most of the reserve is covered in forest all the way up to the coast line. *Cyperus textilis* was described as being resilient, taking root easily and regrowing prolifically when cut (Pereira *et al*. 2006). This indicates that *C. textilis* populations in the DCNR are healthy, however may not be widely distributed across the reserve as it is restricted to water sources. The rush, *Juncus kraussii*, had larger populations in the DCNR ranging from as large as 29 610 m^2 to 566 m^2 which are predominantly found on the river banks of Mendu Mouth and Kobole Mouth on the Dwesa side. Both sedge and rush are scarcely found outside DCNR but were described as existing in gardens maintained by the local residents along streams and in well watered gardens. Gardens ranged from 10 m^2 to 65 m^2 (Makhado and Kepe 2006). Similarly with *C. textilis*, large populations of *J. kraussii* were not found in the other two reserves.

The water lily *Nymphaea nouchali* was observed outside the SNR but not inside it. Roughly 30 individual plants were counted in May during the community workshops. These plants where counted in the Buldla Dam north of Silaka and were scattered evenly around the edges making it easy to identify a single plant. When returning in late June the damn had dried up consequently leaving only three plants present.

5. Conclusion

Thorough ground truthing and sound ecological data are crucial in developing accurate population inventories of key species in not only protected areas, but within rural community landscapes as well. This data, although static, gives a starting estimate of population levels and their current status that can be used in the development of conservation strategies. Comparison between vegetation in protected areas and those subjected to human related disturbances can be used as indicators of future vegetation

change where conservation is lacking. Such changes between the inside and outside of the DCNR are that there is higher adult tree densities and recruitment inside the reserve, similarly observed by Obiri *et al*. (2002), with the exception of *M. grandis*, *V. undulata* and *P. obliqumm*, two of which are forest margin species. Human activities such as harvesting create more openings in the forest canopy and cause forested areas to become patchy. This is clearly noticed in DCNR where the forest remains continuous in the reserve and patchy outside. This change may be advantageous to marginal species such as *M. grandis* and *P. obliqumm*. It is consequently important to consider such disturbances as they can drastically change vegetation composition, especially in grasslands. Population inventories of grassland species are not as straightforward as for tree species and in this study the density, size and cover was relied on to give an accurate account of population levels. However these species SCDs are complicated by events such as fire, rainfall and grazing activity to a much greater level than for tree species that have slower growth rates and larger growth forms.

Species attributes such as advanced regeneration, shade tolerance, growth forms, adaptations strategies and reproductive capabilities are reflected in its population status. These attributes are important in determining a species survival in disturbance events such as fire or tree falls, and also in determining whether a species can be sustainably harvested and at what rate. It was assumed from this study that population levels are to some extent affected by the geographies of the reserve such as size, terrain and density of human populations near the reserve boundary. No tree species showed a marked similarity between reserves in density of adults or saplings. The only species to show a consistent pattern between all three reserves was the grass *C. validus*. In conclusion, the survey of these highly desirable species proved vital in determining that most species in both forest and grassland vegetation have unstable populations, and this is particularly true for the MNR forests.

CHAPTER FIVE: Harvesting potential and conservation priority of key species in the Wild Coast reserves

1. Introduction

There is an urgent need for sustainable use of natural resources on the Wild Coast and ultimately the need for conservation. This is a result of deforestation due to urban and rural expansion, conversion of land for grazing and agriculture and the increasing commercial demand on medicinal species (Kepe 2002, Mangwale 2010). Natural resources play a large role in rural livelihoods as a source of sustenance and as a safety net during difficult times (Cocks *et al*. 2004, Shackleton *et al*. 2004, Gyan & Shackleton 2005, Shackleton *et al*. 2007). With the existing poverty in the Wild Coast it would seem impractical not to use available natural resources in an effort to alleviate poverty. However, these resources must be used sustainably to avoid instabilities of harvested populations, or local extinctions of valuable species (Aanes *et al*. 2002). The term 'sustainable use' is defined as the removal of natural resources without exhausting it or compromising its ability to regenerate (Struhsaker 1998). In many developing areas subsistence harvesting in forests is not well managed and sustainable use is mostly determined by the short-term needs of the consumer, the size of the consumer community, availability of suitable trees and the size and accessibility of forests (Boudreau *et al*. 2005). Indeed, in South Africa there is a regulatory vacuum regarding management of natural resources (Shackleton 2009). A management system that does not severely reduce recruitment or biomass of the standing crop, and that does not greatly alter the natural demography of a population should be strived for when designing sustainable methods of utilization (Lawes *et al*. 2004, Boudreau *et al*. 2005).

To develop a sustainable harvesting system the dynamics of a population, as well as its ecosystem, should be understood. Ideally this should be investigated where it is not harvested as it is difficult to develop a level of utilization where such information is lacking (Everard *et al*. 1995, Aanes *et al*. 2002). Dynamic processes within an ecosystem such as disturbances (e.g. fire, drought and grazing), and demographic information of a single species population are essential in determining harvesting guidelines that are beneficial to local communities and the future conservation of biodiversity. The level to which species are available and harvested, as well as the plant parts that are harvested and their regeneration potential, should be considered when designing and implementing sustainable harvesting

systems (Boot & Gullison 1995, Obiri *et al*. 2002). However, species responses to harvesting, their distributions and densities in South Africa are not well studied (Dzerefos & Witkowski 2001). The harvesting potential of species can be determined using population inventories which describe population levels, spatial scale of recruitment and size class distributions. Such information highlights a species' ability to regenerate and its current status within a defined area, such as a reserve, which can be used in determining its harvesting potential. Using methods such as those of Obiri *et al*. (2002) and Lykke (1998) enables species to be categorized according to their harvesting potentials and thus be more easily incorporated into management plans.

It is important to consider alternatives to harvesting in protected areas, especially where wild populations cannot support sustainable harvesting. One such alternative are 'home gardens' where households propagate species they require such as medicinal plants, reeds used for weaving or fruit trees (Dzerefos & Witkowski 2001, Makhado & Kepe 2006). Also, woodlots of favorable species can be established and managed by communities (Ellery *et al*. 2000). As suggested by Dzerefos and Witkowski (2001), seeds and plant material that can be propagated can be taken from reserves if necessary and used in home gardens or woodlots. Other alternatives include designating certain areas of the reserve as harvesting and non-harvesting zones and the use of exotic species such as gum trees and wattles as a substitute. For example, alien trees in or around protected areas to provide constant timber and fuelwood for local people (Viisteensaari *et al*. 2000, Kasolo & Temu 2008). The above methods will accommodate both the users and conservation efforts and creates the possibility of sanctuaries for harvestable species and insures that certain areas remain relatively undisturbed by human activities. Increasing the yield of utilized species using methods such as coppice harvesting, timing of harvests, rotating between harvesting areas and restricting which plant parts are harvested is another way of sustainably utilizing natural resources (Ellery *et al*. 2000, Dzerefos & Witkowski 2001, Kaschula *et al*. 2005).

The aim of this chapter is to categorize species according to their harvesting potential based on population levels, spatial scale of recruitment and size class distributions as calculated in Chapter Four and to further investigate a species conservation priority according to its level of utilization and importance to local communities. This chapter also looks at the distribution of species across the reserves and groundings for harvesting zones.

2. Methods

2.1. Harvesting potential of key species

2.1.1. Ecological categorization of tree species

Tree species were grouped into four categories based on the densities of adults and saplings, size class distribution (SCD) slope values, shape of the SCD curves, and spatial grain as calculated in the Methods section of Chapter Four. The categories below are adapted from Obiri *et al*. (2002) and Lykke (1998).

Category 1 – strict conservation**:** Species which were listed with high priority at their respective community workshops, but are not found inside of the reserve. This category may include species found at very low densities (adult stem density < 10 individuals ha^{-1}) so much so that analysis cannot be preformed as there are too few individuals. It is recommended that these species be monitored closely over an extended period and conservation zones be setup where these species are found.

Category 2 – no use**:** Adult tree density < 80 individuals ha^{-1}, and sapling density < 100 individuals ha^{-1}. SCD slope value may be negative (SCD value < 0.9), positive or approaching zero and the shape may be unimodal, flat or reverse J-shaped. Species is coarse-grained or intermediate. These species have very few saplings which indicate poor or very episodic rejuvenation and seedling establishment. This category is termed 'intermediate' being between the rare and abundant categories. It is strongly recommended that these species be conserved and not harvested. Conservation zones should incorporate areas where these species are found.

Category 3 – limited use**:** Densities are high for adult trees (80 - 200 individuals ha^{-1}) and saplings (100 - 250 individuals ha^{-1}). Value of the SCD slope is negative (SCD value ≥ 0.8). The shape of the SCD curve is reverse J-shape. Species are fine-grained. These species have potential for harvesting, but require careful management and controlled harvesting.

Category 4 – unrestricted use**:** Densities are high for adult trees (≥ 200 individuals ha^{-1}) and saplings (≥ 250 individuals ha^{-1}). Value of SCD slope is highly negative (SCD value ≥ 1.0). The shape of the SCD curve

is steeply reverse J-shaped. Species is fine-grained. These species have abundant seedling and sapling recruitment and may be subjected to harvesting with management guidelines and monitoring. Also, harvesting zones should be setup where these species are abundant.

2.1.2. Ecological categorization of grassland species

Grassland species were grouped into four categories based primarily on mean density with percentage cover and frequency of occurrence as supporting values. The percentage cover was not a very descriptive value as it varied greatly between species due to different sizes but is useful when looking at a single species. The frequency of occurrence gave an indication of distribution across each reserve. Size class distributions were also used as an indicator of population stability. Categories and their management implications are described below.

Category 1 – strict conservation**:** Species that are not found in the reserve but were listed as priority at their respective community workshops, or found at low densities outside the reserve. These species are rare, and it is recommended that further studies be carried out on these species.

Category 2 – no use**:** Mean density is < 0.1 individuals m^{-2}. Percentage cover < 1 % for herbs and geophytes. These species must be conserved and not harvested. Conservation zones should incorporate areas where these species are found.

Category 3 – limited use**:** Mean density is ≥ 0.1 and < 1.0 individuals m^{-2}. Percentage cover ≥ 1 % for herbs and geophytes. Species should have an adequate distribution (frequency of occurrence ≥ 40 %). SCD curve is most likely unimodal. These species have potential for sustainable harvesting but require careful management and monitoring with limited harvesting.

Category 4 – unrestricted use**:** Mean density is ≥ 1.0 individuals m^{-2}. Species should be found in majority of the sample sites (frequency of occurrence ≥ 80 %). Mean percentage cover for grass species is ≥ 18 % and ≥ 5 % for herbs and geophytes. SCD curve is unimodal or reverse J-shape. Species may be subjected to harvesting with management guidelines and monitoring. Harvesting zones should be setup where these species are abundant.

2.1.3. Rating system based on ecological and social data

This method of rating was developed by Mander *et al.* (1997) and adapted from methods used by Dzerefos and Witkowski (2001) on medicinal plants in the Abe Bailey Nature Reserve, South Africa. A conservation priority score was calculated based on density of a species within a defined area (i.e. nature reserve), the risk of harvesting according to what part of the plant is removed, the frequency of harvesting, the importance of a plant to local communities and the diversity of use. The conservation score was calculated to support categorization based on ecological findings in the field as described in the previous section (Chapter Four), such that the importance of conserving a species can be rated. The value of this score gives an indication of management requirements based on three categories. The first category includes species with a conservation priority score ≥ 90 - these species have high conservation priority and should not be harvested but rather conserved and monitored. The second category includes species with a score between 65 and 90 - these species have medium conservation priority and potential for controlled harvesting with monitoring. The last category includes species scoring < 65 - these species have low conservation priority and potential for high impact harvesting.

Density was scored based on the frequency of individuals inside the reserve. Sapling densities for tree species were excluded as it skewered densities of harvestable individuals. Density scoring is shown in Table 14. Density of tree species were scored per 100 m^2 as opposed to 1 m^2 for grassland species as density is much lower for tree species than for grassland species. A biological score was calculated using the score for density as follows:

Biological score = density x 10

A utilization risk score was calculated using harvesting risk (Har), frequency of collection (Col), and importance to local people (Loc) or diversity of use (Div) scores (score with highest value for either Loc or Div is used) as follows:

Utilization score = (0.5xHar) + (0.5xCol) + (0.5xLoc or Div) x 100

Information about harvesting risk and number of uses was gathered from literature most of which was from Huthings *et al.* (1996). Harvesting risk was scored on the bases that the severity of harvesting such as the removal of a tuber or whole plant would have a much greater effect on a plant's survival and reproductive success than the removal of leaves or fruits (Ticktin 2004, Ticktin & Shackleton in press). Diversity of use was scored based on how many uses a plant has, such that a point is added for each use out of a total of ten. The importance of a species to local people and the frequency of collection were scored using data collected from local people via the community workshops in Chapter Three. For both importance and frequency of collection, species were put in one of three categories. Occasionally collected species scored 4, these species were collected several times a year. Commonly collected species scored 7, these species were collected several times a month. Often collected species scored 10, these species were collected several times a week. Important species scored 4, very important species scored 7, and most important species scored 10. Species that were not mentioned scored 1. Either the local importance or diversity of use was used to provide a safety margin. A conservation score was then calculated using the biological and utilization risk scores as follows:

Conservation score = 0.5(biological score) + 0.5(utilization risk score)

Table 14: Scoring criteria based on Mander *et al.* (1997) and modified from Dzerefos and Witkowski (2001). Criteria include density, harvesting risk, frequency of collection, local importance and diversity of use.

Criterion	Score
Density in reserve (individuals m^{-2} or 100 m^{-2})	
Not recorded to very low (0-1)	10
Low (1 < 3.5)	7
Medium (3.5 < 7)	4
High (≥ 7)	1
Harvesting risk	
Destructive harvesting of entire plant ,bulb and corms or overexploitation of rhizomes, roots, bark and tubers.	10
Removal without causing individual mortality of perennial structures such as bark and roots.	7
Removal of aerial permanent structures such as leaves, stems and sap effecting survival and reproductive success.	4
Aerial structures such as flowers and fruits removed unaffecting the plant.	1
Frequency of collection	
Often collected (several times a week)	10
Commonly collected (several times a month)	7
Occassionally collected (several times a year)	4
Not collected	1
Local importance	
Most important (cannot live without this species)	10
Very important	7
Important	4
Not important	1
Diversity of use	
A point is added for each use. Total out of 10.	1-10

Conservation has already been suggested for species with strict conservation (cat 1) and no use (cat 2), and so inevitably have high conservation priority. Therefore, the conservation priority score is primarily used in determining harvesting levels for species with limited use (cat 3) and unrestricted use (cat 4). Harvesting of species with high conservation priority should be more strictly limited than harvesting a species with a medium conservation priority, while those with a low conservation priority are of a lesser

concern than the prior. This creates a gradient of harvest potential as shown in Table 15. Species with limited use and high conservation priority can only be used under exceptional circumstances such as for traditional ceremonies. Species with limited use and medium conservation priority have restricted quota after the development of scientific guidelines. Species with unrestricted use and medium or low conservation priority can be harvested with unrestricted quota guided by adaptive learning and management.

Table 15: Harvesting potential based on ecological categories and conservation priority.

Ecological category		Conservation priority	Harvesting potential
1	Strict conservation	High	No use
		Medium	
		Low	
2	No use	High	
		Medium	
		Low	
3	Limited use	High	Exceptional circumstance (i.e. for traditional ceremonies)
		Medium	Restricted quota after development of scientific guidelines
		Low	Limited use wih adaptive learning and management
4	Unrestricted use	High	Limited use with adaptive learning and management
		Medium	Current unrestricted use with adaptive learning and management
		Low	Current unrestricted use with adaptive learning and management

2.2. Distribution of priority species across the reserve

Distribution maps of species across the reserve, as well as outside, where constructed using the GIS program ArcMap 9. Sample sites where plotted on reserve maps from GPS coordinates recorded at each transect. At each sample site the total density (individuals ha^{-1}) of category 3 and 4 species combined (blue, harvestable), and category 1 and 2 species combined (red, non-harvestable), were represented as circles. The size of the circle increased with increasing density. These densities were then used to identify harvesting and non-harvesting zones. Harvesting zones were delimited where blue circles with high densities were frequent, and where red circles were mostly absent or had low densities. The remaining areas are proposed as conservation zones, with no harvesting. This method of selection aims at avoiding species that need conserving and where harvestable species have most sustainable populations. The next criterion was proximity to neighboring communities as well as to access roads within the reserve.

3. Results

3.1. Harvesting potential of key species in the Dwesa-Cwebe Nature Reserve

3.1.1. Categorization of tree species

Category 1 includes the species *P. longifolia*, *R. caffra* and *Z. capensis*, as well as the shrub *C. sepaiaria var. citrifolia* as it was listed as priority at the Dwesa-Cwebe workshop, but was not found inside or outside of the reserve. These species have very low densities, almost no recruitment and are coarse-grained. Category 2 includes *P. mooiensis* that has a slightly positive SCD slope, has no saplings and is coarse-grained, as well as *P. obliquum* that has very few saplings and adult trees and is spatially defined as intermediate. Category 3 includes *M. grandis* and *V. undulata*. These species have a good representation of both sapling and adult individuals and were both fine-grained with a reverse J-shape curve. Category 4 includes the species *H. amoenus* and *H. lucens*. These two species have very high densities of adult trees and saplings, are fine-grained and have high SCD slope values (Table 16).

Both category 4 species have a medium conservation priority score (Table 16). These are *H. lucens* and *H. amoenus* both of which have a low density score and frequency of collection. *Hyperacanthus amoenus* has a greater local importance and thus scored a higher conservation priority score (80) than *H. lucens* (65). Both these species have a high harvesting risk score since the wood is used which may involve the removal of the entire plant (i.e. for poles and beams). The two category 3 species have a high conservation priority score, both of which scored a high density and frequency of collection. These are *V. undulata* and *M. grandis*. All other species have a high conservation priority score, scoring a high density, frequency of collection and local importance score.

Table 16: Ecological and conservation priority criteria of tree species in the Dwesa-Cwebe Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Adult density (individuals.ha^{-1})**	**Sapling density (individuals.ha^{-1})**	**Slope**	**Shape**	**Grain**	**Category**
Hyperacanthus amoenus	392.6±366.35	210.2±299.61	-1.59	Reverse J-shape	Fine	4
Heywoodia lucens	391.7±575.61	580.1±1272.09	-1.03	Reverse J-shape	Fine	4
Millettia grandis	158.8±119.56	233.8±395.74	-1.36	Reverse J-shape	Fine	3
Vepris undulata	145.8±158.58	105.1±252.98	-1.31	Reverse J-shape	Fine	3
Ptaeroxylon obliquum	19.0±25.56	10.7±27.07	-0.82	Reverse J-shape	Intermediate	2
Premna mooiensis	11.1±17.82	0	0.14	Flat	Coarse	2
Zanthoxylon capensis	6.9±27.42	0.5±2.78	-	-	Coarse	1
Protorhus longifolia	3.2±9.61	0	-	-	Coarse	1
Rauvolfia caffra	0	0	-	-	-	1
Capparis sepaiaria var. citrifolia	0	0	-	-	-	1

Conservation priority criteria								
Species	**Density (plants.100 m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Heywoodia lucens	3.92	4	10	4	4	1	65	Medium
Hyperacanthus amoenus	3.93	4	10	4	10	2	80	Medium
Premna mooiensis	0.11	10	10	4	4	2	95	High
Vepris undulata	1.46	7	7	7	10	3	95	High
Millettia grandis	1.59	7	10	7	10	2	103	High
Protorhus longifolia	0.03	10	7	7	10	2	110	High
Ptaeroxylon obliquum	0.19	10	7	7	10	6	110	High
Zanthoxylon capensis	0.07	10	7	7	10	10	110	High
Capparis sepaiaria var. *citrifolia*	0.00	10	7	7	10	4	110	High
Rauvolfia caffra	0.00	10	7	7	10	5	110	High

3.1.2. Categorization of grassland species

Category 1 species includes *H. pendunculare* and *S. undulata* which are not found in the reserve (Table 17). Category 2 includes *R. multifidus*, *H. hemerocallidea* and *A. campanulatus* which have very low densities and mean cover and are only found in 4 % of the sampled area. Category 3 included *H. rigidula* and *H. odoratissimum* which are both found in over half the sample plots (frequency = 56.0 %). *Hypoxis rigidula* has a high density (0.6±1.21 individuals m^{-2}) while *H. odoratissimum* has a high cover (2.4±5.47 %). Both species have a unimodal SCD. The only species in category 4 is *C. validus* which has a very high density (1.2±1.21 individuals m^{-2}), percentage cover (19.0±19.07 %) and frequency (84.0 %).

Table 17: Ecological and conservation priority criteria of grassland species in the Dwesa-Cwebe Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Density (individuals.m^{-2})**	**Mean cover (%)**	**Frequency of occurrence (%)**	**Shape**	**Growth form**	**Category**
Cymbopogon validus	1.2±1.21	19.0±19.07	84.0	Unimodal	Perennial grass	4
Hypoxis rigidula	0.6±1.21	1.2±1.79	56.0	Unimodal	Geophyte	3
Helichrysum odoratissimum	0.1±0.24	2.4±5.47	56.0	Unimodal	Perennial herb	3
Ranunculus multifidus	0.03±0.133	0.1±0.28	4.0	Unimodal	Perennial herb	2
Hypoxis hemerocallidea	0.004±0.0222	0.02±0.120	4.0	-	Geophyte	2
Agapanthus campanulatus	0.001±0.0044	0.016±0.0800	4.0	-	Geophyte	2
Helichrysum pendunculare	0	0	0.0	-	Perennial herb	1
Silene undulata	0	0	0.0	-	Perennial herb	1

Conservation priority criteria								
Species	**Density (plants.m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Hypoxis hemerocollidea	0.0044	10	10	1	1	3	85	Medium
Hypoxis rigidula	0.5653	10	10	1	1	3	85	Medium
Ranunculus multifidus	0.0267	10	7	1	1	6	85	Medium
Cymbopogon validus	1.2164	7	4	7	10	2	88	Medium
Agapanthus campanulatus	0.0009	10	10	1	1	4	88	Medium
Helichrysum pendunculare	0.0000	10	4	4	10	3	95	High
Helichrysum odoratissimum	0.0893	10	4	7	10	5	103	High
Silene undulata	0.0000	10	10	7	10	3	118	High

Of the harvestable species in category 3 and 4 only *H. odoratissimum* has a high conservation priority score (103) (Table 17). The two species in category 1 also have a high conservation priority due to high local importance, collection and density scores. The only other species that has a high conservation priority score that is not category 1 is *R. multifidus* (93), which although has a low collection and local importance score, has a high diversity of use and harvesting risk score (removal of entire plant) in comparison to most other species in Table 17. The only species to have a high frequency of collection and local importance score was *C. validus*, *H. odoratissimum* and *S. undulata*. However, *C. validus* has low density and harvesting risk scores and its category (4) and medium conservation priority score makes it the species of least conservation concern.

3.2. Harvesting potential of key species in the Mkambati Nature Reserve

3.2.1. Categorization of tree species

Category 1 includes the species *P. obliquum* that has only a few saplings, as well as *P. mytifolia* and *M. capensis* as they were listed as priority at the Mkambati workshop but were not found inside or outside of the reserve. Category 2 includes *H. amoenus* whose SCD slope is positive (0.21) and has a unimodal SCD, as well as *M. grandis, Z. capensis* and *V. undulata* all of which have reverse J-shaped SCDs but very low sapling and adult tree densities. Only *P. longifolia* is included in category 3. This species has high sapling density with a moderate adult density. It is fine-grain and has a reverse J-shape SCD. No species were grouped into category 4 as densities were too low (Table 18).

Table 18: Ecological and conservation priority criteria of tree species in the Mkambati Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Adult density (individuals.ha^{-1})**	**Sapling density (individuals.ha^{-1})**	**Slope**	**Shape**	**Grain**	**Category**
Protorhus longifolia	84.4±229.13	172.0±503.43	-0.93	Reverse J-shape	Fine	3
Vepris undulata	28.1±59.85	30.2±69.71	-0.85	Reverse J-shape	Intermediate	2
Zanthoxylon capensis	4.2±16.67	31.3±125.00	-0.63	Reverse J-shape	Coarse	2
Millettia grandis	6.3±18.13	12.5±38.73	-0.41	Reverse J-shape	Coarse	2
Hyperacanthus amoenus	25.0±47.53	0	0.21	Unimodel	Coarse	2
Rauvolfia caffra	12.5±36.26	0	-	-	Coarse	1
Ptaeroxylon obliquum	0	1.0±4.17	-	-	-	1
Polygala mytifolia	0	0	-	-	-	1
Macaranga capensis	0	0	-	-	-	1

Conservation priority criteria								
Species	**Density (plants.100 m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Hyperacanthus amoenus	0.25	10	10	1	1	1	80	Medium
Millettia grandis	0.06	10	10	1	1	2	83	Medium
Zanthoxylon capensis	0.04	10	7	1	1	7	88	Medium
Rauvolfia caffra	0.13	10	7	1	10	5	95	High
Vepris undulata	0.28	10	7	7	10	1	110	High
Protorhus longifolia	0.84	10	7	7	10	2	110	High
Macaranga capensis	0.00	10	7	7	10	2	110	High
Ptaeroxylon obliquum	0.00	10	7	7	10	3	110	High
Polygala mytifolia	0.00	10	10	7	10	2	118	High

The only species with potential for harvesting is *P. longifolia*, however this species has a high conservation priority score (110) (Table 18). Three of the eight species have medium conservation priority scores, which include *H. amoenus*, *M. grandis* and *Z. capensis* which all have low collection, local importance and diversity of use scores. However, *H. amoenus* and *M. grandis* have high harvesting risks as these two species are used for their wood which may often involve removing the whole plant. All other species have high conservation priority having high collection and local importance scores.

3.2.2. Categorization of grassland species

Category 1 includes species not found in the reserve but listed as key species at the Mkambati community workshop which are *A. campanulatus*, *L. corymbosa* and *R. multifidus*. All other species besides *C. validus* are category 2. The species *H. odoratissimum*, *O. imbracatum* and *X. involucratum* have very low densities and percentage cover and occur in less than 10 % of the study plots. Both *H. rigidula* and *H. pendunculare* in category 2 have a density of 0.1 individuals m^{-2}, however have low percentage covers of 0.4±0.54 % and 0.5±1.15 %, respectively. *Hypoxis rigidula* has the highest frequency (87.5 %) and has a flat SCD (Table 19). Category 3 includes *C. validus* which has the highest density (0.2±0.31 individuals m^{-2}) and percentage cover (3.7±8.83 %).

All category 1 species have a high conservation priority of above 100. These three species are of the highest conservation concern, while *C. validus* is of the lowest scoring low harvesting risk and frequency of collection scores (Table 19). *Xysmalobium involucratum* and *H. pendunculare* are the only category 2 species with medium conservation priority scores (80), both scoring low frequency of collection and local importance scores. These were particularly low for *X. involucratum* as it was not mentioned at the Mkambati community workshop. However, it has a high harvesting risk as its tubers are used as well as its roots and leaves, while *H. pendunculare* has a low harvesting risk score.

Table 19: Ecological and conservation priority criteria of grassland species in the Mkambati Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Density (individuals.m^{-2})**	**Mean cover (%)**	**Frequency of occurrence (%)**	**Shape**	**Growth form**	**Category**
Cymbopogon validus	0.2±0.31	3.7±8.83	42.5	Unimodal	Perennial grass	3
Hypoxis rigidula	0.1±0.15	0.4±0.54	87.5	Flat	Geophyte	2
Helichrysum pendunculare	0.1±0.11	0.5±1.15	30.0	Unimodal	Perennial herb	2
Helichrysum odoratissimum	0.004±0.0156	0.1±0.28	7.5	-	Perennial herb	2
Osteospermum imbracatum	0.0008±0.00389	0.0050±0.02207	5.0	-	Perennial herb	2
Xysmalobium involucratum	0.0003±0.00176	0.0025±0.01581	2.5	-	Tuberous	2
Agapanthus campanulatus	0	0	0.0	-	Geophyte	1
Lotononis corymbosa	0	0	0.0	-	Perennial herb	1
Ranunculus multifidus	0	0	0.0	-	Perennial herb	1

Conservation priority criteria								
Species	**Density (plants.m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Cymbopogon validus	0.1461	10	4	1	10	2	68	Medium
Helichrysum pendunculare	0.0506	10	4	4	4	3	80	Medium
Xysmalobium involucratum	0.0003	10	10	1	1	1	80	Medium
Osteospermum imbracatum	0.0008	10	7	1	10	1	95	High
Helichrysum odoratissimum	0.0039	10	4	7	10	5	103	High
Agapanthus campanulatus	0.0000	10	10	4	10	4	110	High
Hypoxis rigidula	0.0856	10	10	7	10	3	118	High
Lotonis corymbosa	0.0000	10	10	7	10	3	118	High
Ranunculus multifidus	0.0000	10	7	10	10	6	118	High

3.3. Harvesting potential of key species in the Silaka Nature Reserve

3.3.1. Categorization of tree species

Category 1 includes the species *R. caffra* and *H. amoenus* both of which have no saplings, and *P. mooiensis* that was only found outside at a very low density. Also included in this category are *C. sepaiaria var. citrifolia*, *C. dentata* and *M. capensis* as they were listed as priority at the Silaka workshop, but were not found inside or outside of the reserve. Category 2 includes *H. lucens* whose SCD slope is slightly positive and has a unimodal distribution, and the species *P. obliquum*, *Z. capensis*, *P. longifolia* and *V. undulata* all of which have very low sapling and adult densities. *Millettia grandis* was also included in category 2 although it has fairly high adult density its sapling density is very low and is coarse-grained (Table 20). No species are grouped as category 3 and 4 due to low densities.

Table 20: Ecological and conservation priority criteria of tree species in the Silaka Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Adult density (individuals.ha^{-1})**	**Sapling density (individuals.ha^{-1})**	**Slope**	**Shape**	**Grain**	**Category**
Millettia grandis	80.4±135.18	39.9±122.03	-0.89	Reverse J-shape	Coarse	2
Vepris undulata	37.0±39.23	17.4±45.64	-0.84	Reverse J-shape	Coarse	2
Protorhus longifolia	25.4±86.44	3.6±10.00	-0.76	Reverse J-shape	Intermediate	2
Zanthoxylon capensis	19.6±35.41	15.9±76.46	-0.54	Reverse J-shape	Coarse	2
Ptaeroxylon obliquum	10.1±24.48	1.5±6.95	-0.38	Reverse J-shape	Coarse	2
Heywoodia lucens	55.8±87.56	0	0.41	Unimodal	Coarse	2
Rauvolfia caffra	3.6±8.64	0	-	-	Coarse	1
Hyperacanthus amoenus	2.2±5.74	0	-	-	Coarse	1
Premna mooiensis	0	0	-	-	-	1
Capparis sepaiaria var. citrifolia	0	0	-	-	-	1
Curtisia dentata	0	0	-	-	-	1
Macaranga capensis	0	0	-	-	-	1

Conservation priority criteria								
Species	**Density (plants 100.m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Protorhus longifolia	0.25	10	7	1	1	2	75	Medium
Hyperacanthus amoenus	0.02	10	10	1	1	1	80	Medium
Rauvolfia caffra	0.04	10	7	1	10	5	90	Medium
Vepris undulata	0.37	10	7	4	7	1	95	High
Premna mooiensis	0.00	10	10	4	4	2	95	High
Zanthoxylon capensis	0.20	10	7	7	7	7	103	High
Ptaeroxylon obliquum	0.10	10	7	7	10	3	110	High
Capparis sepaiaria var. *citrifolia*	0.00	10	7	7	10	4	110	High
Macaranga capensis	0.00	10	7	7	10	2	110	High
Heywoodia lucens	0.56	10	10	7	10	1	118	High
Millettia grandis	0.80	10	10	7	10	2	118	High
Curtisia dentata	0.00	10	7	10	10	5	118	High

Of the 12 species in Table 20, only three have medium conservation priority while the others have high conservation priority. These three include *P. longifolia* and *H. amoenus* due to their low collection and local importance scores, and *R. caffra* due to its low frequency of collection score. However, *R. caffra* is most important to the local communities. The majority of species have a conservation priority score above 100. *Millettia grandis* and *H. lucens* have very high conservation priority scores due to their high harvesting risk, frequency of collection and local importance.

3.3.2. Categorization of grassland species

Category 1 includes four species that were not found in the Silaka Nature Reserve but mentioned as key species at the Silaka community workshop. These are *H. odoratissimum*, *R. multifidus*, *C. miniata* and *T. caffrum* (Table 21). Category 2 includes *S. undulata* and *X. involucratum* which have very low densities. Category 3 includes *H. hemerocallidea* which has a density of 0.1±0.17 individuals m^{-2}, a percentage cover of 1.6±2.30 % and a high frequency (70.0 %). This species also has a unimodal SCD. *Cymbopogon validus* is the only species in category 4 as it has a very high density (1.6±0.81 individuals m^{-2}), percentage cover (24.6±10.16 %) and is found in all sample plots.

Table 21: Ecological and conservation priority criteria of grassland species in the Silaka Nature Reserve. Den = density, Har = harvesting risk, Col = collection frequency, Loc = local importance and Div = diversity of use.

Ecological criteria						
Species	**Density (individuals.m^{-2})**	**Mean cover (%)**	**Frequency of occurrence (%)**	**Shape**	**Growth form**	**Category**
Cymbopogon validus	1.6±0.81	24.6±10.16	100.0	Unimodal	Perennial grass	4
Hypoxis hemerocallidea	0.1±0.17	1.6±2.30	70.0	Unimodal	Geophyte	3
Silene undulata	0.04±0.072	0.6±0.98	30.0	Flat	Perennial herb	2
Xysmalobium involucratum	0.02±0.020	0.08±0.101	50.0	-	Tuberous	2
Helichrysum odoratissimum	0.0	0.0	0.0	-	Perennial herb	1
Ranunculus multifidus	0.0	0.0	0.0	-	Perennial herb	1
Clivia miniata	0.0	0.0	0.0	-	Geophyte	1
Talinum caffrum	0.0	0.0	0.0	-	Tuberous	1

Conservation priority criteria								
Species	**Density (plants.m^{-2})**	**Den**	**Har**	**Col**	**Loc**	**Div**	**Conservation priority score**	**Category**
Cymbopogon validus	1.5867	7	4	4	10	2	80	Medium
Silene undulata	0.0400	10	10	1	1	3	85	Medium
Ranunculus multifidus	0.0000	10	7	1	10	6	95	Medium
Hypoxis hemerocollidea	0.1344	10	10	10	7	3	118	High
Helichrysum odoratissimum	0.0000	10	4	7	10	5	103	High
Xysmalobium involucratum	0.0156	10	10	1	10	1	103	High
Talinum caffrum	0.0000	10	7	7	10	2	110	High
Clivia miniata	0.0000	10	10	10	10	6	125	High

Three species have medium conservation priority which includes *C. validus*, *S. undulata* and *R. multifidus*. Both *S. undulata* and *R. multifidus* have low collection and local importance scores as they were not mentioned at the Silaka community workshop. *Cymbopogon validus* has a high local

importance score but low collection, density and harvesting risk scores. It is also the species with the least conservation concern while the three species in category 1 with a high conservation priority (*H. odoratissimum*, *Clivia miniata* and *Talinum caffrum*) are of most conservation concern.

3.4. Distribution of harvestable and non-harvestable species within and around the reserves and position of harvesting zones

3.4.1. Dwesa-Cwebe Nature Reserve

The majority of non-harvestable species (Category 1 and 2) are found on the Cwebe side of the reserve while higher densities of harvestable species (Category 3 and 4) are found on the Dwesa side (Figure 20). The combined densities of harvestable tree species range from 3 267 individuals ha^{-1} to 50 individuals ha^{-1}, while non-harvestable tree species range from 1 017 individuals ha^{-1} to 17 individuals ha^{-1}. Category 4 species such as *H. amoenus* is found at high densities and is widely distributed across the Dwesa side, but is scarcely found in high densities on the Cwebe side. *Heywoodia lucens*, the other category 4 species, is not widely distributed but is found at higher densities than any other species. The category 3 species, *M. grandis* and *V. undulata*, are widely distributed across both sides of the reserve but do not have high densities where they are found. Of the non-harvestable species, *P. obliquum* is most widely distributed and found on both sides but at low densities. *Protorhus longifolia* was also found on both sides however its distribution is limited. *Premna mooiensis* was not sampled on the Cwebe side and *Z. capensis* was not sampled on the Dwesa side. *Rauvolfia caffra* appears to have a small distribution, only being found outside the reserve. Combined densities of harvestable grassland species range from 12.6 individuals m^{-2} to 0.01 individuals m^{-2} while non-harvestable grassland species range from 0.8 individuals m^{-2} to 0.02 individuals m^{-2}. The category 4 species *C. validus* has the widest distribution across both sides of the reserve while the two category 3 species, *H. rigidula* and *H. oddoratissimum*, have distributions limited mostly to the Dwesa side. The non-harvestable species have very limited distributions with none found on the Dwesa side except for one individual of *A. campanulatus*. *Ranunculus multifidus* appears to be restricted to the Cwebe side and found scarcely outside while *H. hemerocallidea* appears to be found only outside on the Cwebe side.

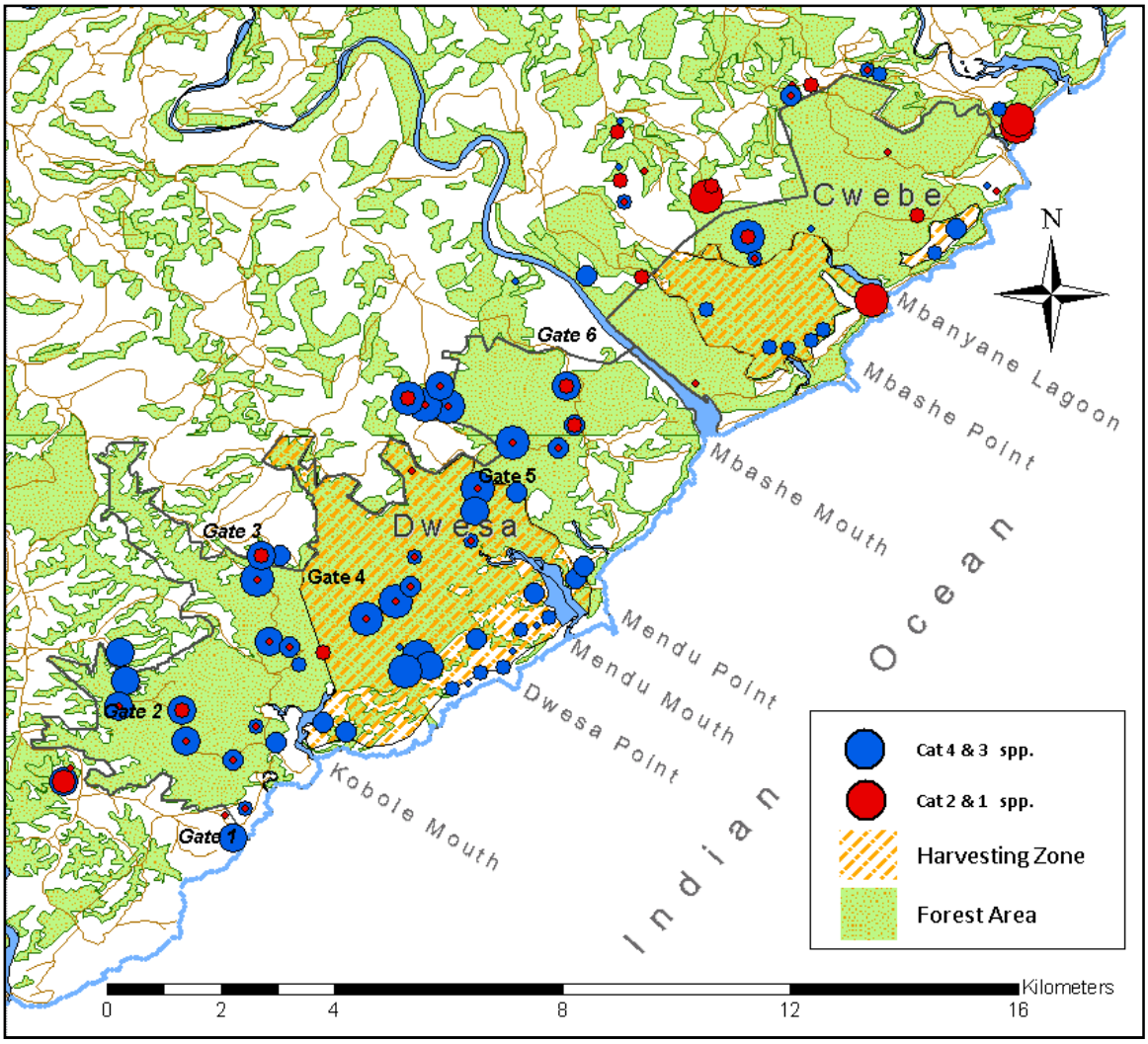

Figure 20: Distribution of harvestable (category 4 and 3) and non-harvestable (category 2 and 1) tree and grassland species in the Dwesa-Cwebe Nature Reserve. Blue and red circles represent densities (individuals ha^{-1}). Harvesting zones are included.

The proposed harvesting zone on the Dwesa side is centrally positioned between gate 4 and 5 where there is a high density of harvestable species and few non-harvestable species. The harvesting zone covers approximately 33 % of the reserve area. The road from gate 4 to Kobolo Mouth on the west and the road down from gate 5 to Mendu Point on the east were used as boarders between the harvesting and conservation zones (Figure 20). This makes it easy to define which area can be accessed and which cannot. The coastal region was excluded from the harvesting zone as harvesting in the coastal forests

should be discouraged as this is a rare biome. Also, the marine area must not be confused as being a harvestable area. Mendu Mouth was included in the harvesting zone so that reeds can be accessed by harvesters. The Cwebe side has two harvesting zones, one for the forest and another for the grassland. The forest harvesting zone is located between the road from the main gate to the Haven Hotel, and the road travelling east from the second gate to the Mbanyane Lagoon. The harvest zone constitutes approximately one-third of the Cwebe area. The grassland harvesting zone is located in the opening on the north-eastern side of the reserve above the Mbanyane Lagoon (Figure 20). The woodlots have been included in the harvesting zones as removal of non-indigenous species should be encouraged.

3.4.2. Mkambati Nature Reserve

The only harvestable species in the Mkambati Nature Reserve is *C. validus* which has a density ranging from 1.2 individuals m^{-2} to 0.01 individuals m^{-2}. It does not have a wide distribution across the reserve but has high densities on the west side of the reserve and is also found sparsely outside (Figure 21). The combined densities of non-harvestable grassland species ranges from 1.3 individuals m^{-2} to 0.01 individuals m^{-2}. Of these non-harvestable grassland species, *H. rigidula* is the most widely distributed across the reserve however it has low densities where it is found. *Helichrysum pendunculare* is mostly found outside with a distribution limited to the eastern side of the reserve cross the Mkambati River. The other *Helichrysum* species, *H. oddoratissimum*, is found mostly outside and scarcely inside on the west side of the Daza River. Both *X. involucratum* and *O. imbracatum* are found very sparsely inside the reserve near the coastal area. The distribution of tree species is limited, and the densities of non-harvestable tree species range from 283 individuals ha^{-1} to 17 individuals ha^{-1}. The most widely distributed tree specie across the reserve that is also harvestable, is *P. longifolia* which has an adult stem density ranging from 933 individuals ha^{-1} to 17 individuals ha^{-1}. Other species are sparsely scattered across the reserve within forest patches with *R. caffra* limited to swamp forests.

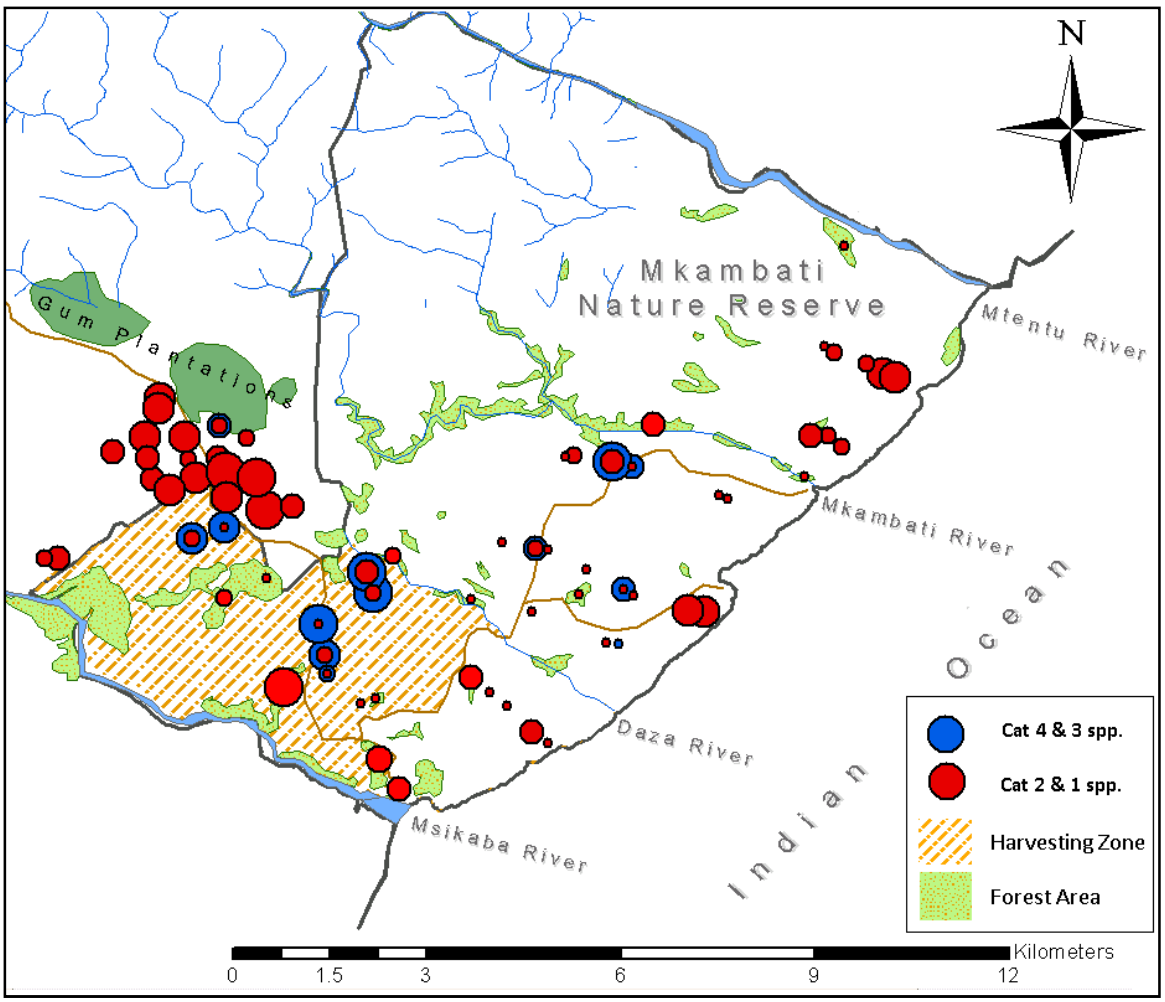

Figure 21: Distribution of harvestable (category 4 and 3) and non-harvestable (category 2 and 1) grassland species as well as distribution of tree species in the Mkambati Nature Reserve. Blue and red circles represent densities (individuals ha^{-1}). Harvesting zones are included.

The proposed harvesting zone is situated in the grassland on the western side of the reserve between the Msikaba River and Daza River, and covers approximately 16 % of the reserve area (Figure 21) where there is the highest density of the harvestable species *C. validus,* and a low abundance of non-harvestable species. Forest patches should be regarded as conservation zones because the densities of priority use tree species are too low within the forest patches. Even though *P. longifolia* was described as harvestable, its distribution is limited to small forest patches, which makes it a vulnerable species, and is also an A category species of high conservation priority.

3.4.3. Silaka Nature Reserve

All tree species in the Silaka Nature Reserve should be considered as non-harvestable. Their combined adult stem densities range from 541 individuals ha^{-1} to 13 individuals ha^{-1}. *Millettia grandis* is the most widely distributed species across the reserve while *V. undulata* is widely distributed both inside and outside of the reserve (Figure 22). *Heywoodia lucens* is not as widely distributed but has high adult stem densities where it is found. The species *H. amoenus*, *P. obliquum*, *P. longifolia* and *Z. capensis* are sparsely distributed across the reserve and are also found sparsely outside. *Rauvolfia caffra* and *P. mooiensis* have limited distributions to the inside of the reserve and outside, respectively. The combined densities of harvestable grassland species range from 2.7 individuals m^{-2} to 0.01 individuals m^{-2} while non-harvestable grassland species range from 0.2 individuals m^{-2} to 0.01 individuals m^{-2}. *Cymbopogon validus* is the most widely distributed harvestable species across the reserve and has high densities where it is found. *Hypoxis hemerocallidea* is not as widely spread and is sparse outside. Of the non-harvestable species, X. *involucratum* is most widely distributed species inside the reserve but is not found outside. *Silene undulata* is also limited to the inside of the reserve while *H. oddoratissimum* and *R. multifidus* are found sparsely outside only.

The harvesting zone is positioned in the south-west of the reserve in the grassland which covers approximately 14 % of the reserve area (Figure 22). The forested area is a conservation zone as all forest species are category 1 or 2. The small section of grassland in the upper west side of the reserve has been marked as harvesting zones as locals were observed to be currently harvesting *C. validus* in that area.

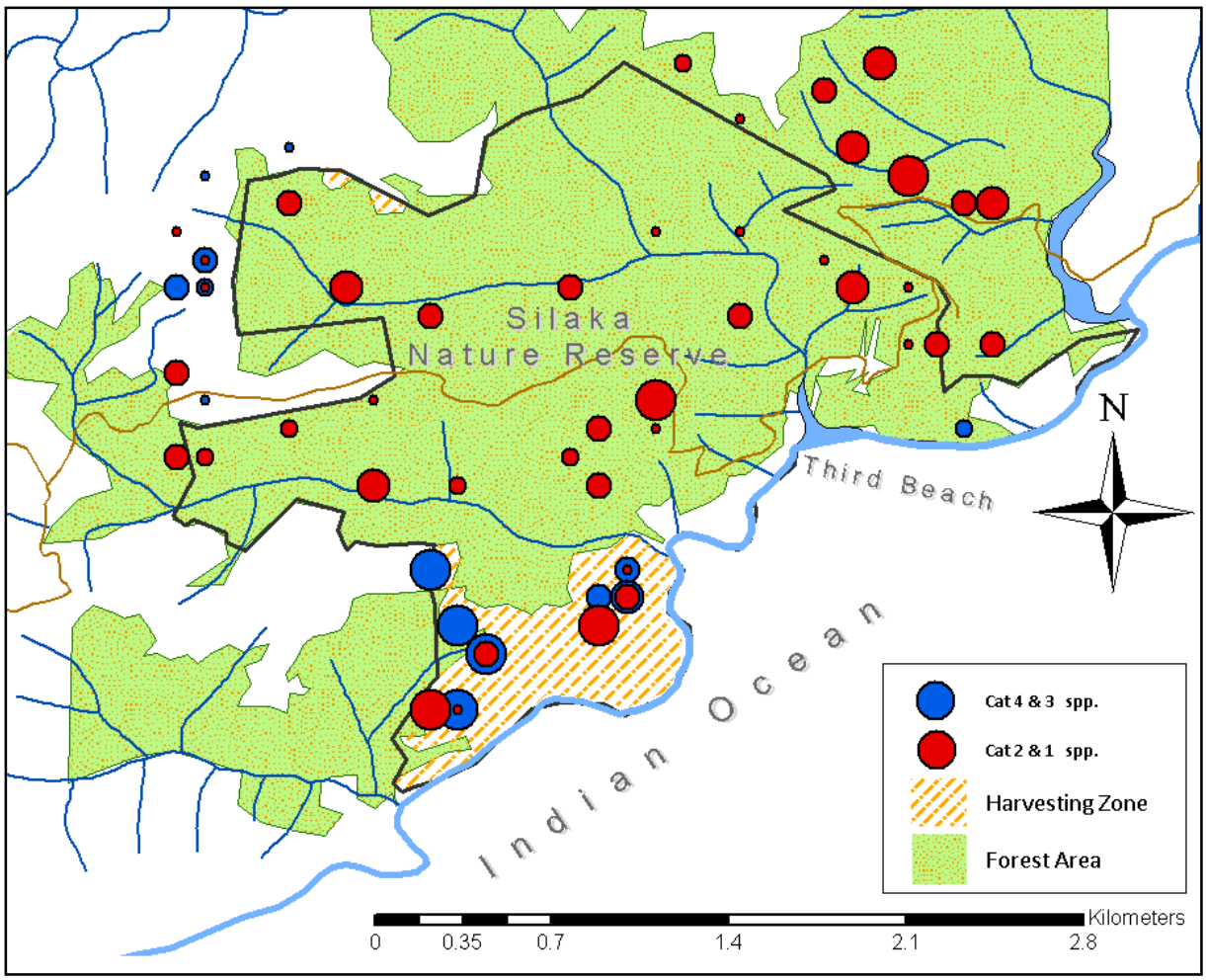

Figure 22: Distribution of harvestable (category 4 and 3) and non-harvestable (category 2 and 1) tree and grassland species in the Silaka Nature Reserve. Blue and red circles represent densities (individuals ha^{-1}). Harvesting zones are included.

4. Discussion

Tree species classified as harvestable in this study are those that display a high level of recruitment, are shade tolerant and have a fine scale of regeneration (fine-grained). The ability to coppice or the capacity to regenerate from rootstock is also displayed by some of these species and are important attributes. Although these species appear to have sufficient regeneration and densities to support harvesting it must be noted that without careful management of abundant species, resource depletion may result, as has been documented before in African forests (Burgess *et al*. 2000, Boudreau *et al*. 2005). Most harvestable grassland species in this study are those that have advanced regeneration abilities such as under ground tubers (*Hypoxis* spp.), adaptations to coping with fire or herbivory, or are able to vegetatively grow such as the grass species *Cymbopogon validus* which was harvestable in all three reserves. The Dwesa-Cwebe Nature Reserve (DCNR) has the highest potential for sustainable harvesting out of the three reserves studied. Of the fifteen key tree and grassland species found inside and around the reserve just under half have potential for harvesting which includes four tree species and three grassland species. Results from the Mkambati Nature Reserve (MNR) indicated only one harvestable species, which was the grass *C. validus*. Although the tree *Protorhus longifolia* was categorized as having limited harvesting potential in the MNR, it cannot currently be sustainably harvested at a viable level due to its high conservation priority and limited distribution due to forest habitats being small and mostly isolated. No trees were classified as harvestable in the Silaka Nature Reserve (SNR), and only two grassland species can be considered harvestable (*C. validus* and *Hypoxis hemerocallidea*). One of which has a limited harvesting potential and high conservation priority which makes harvesting of this species highly restricted.

The two category 4 tree species in DCNR were observed to have high regeneration potentials such as sprouting from roots of adult plants, as well as coppicing as shown by *H. amoenus*, and a high proportion of seedlings and saplings as shown by *H. lucens* indicating a large seedling bank. These were the only two species not in category A indicating a lower conservation priority score in comparison to other tree species. Although they are both harvested for construction material and have a high harvesting risk score, they are not harvested frequently, while *H. lucens* is also not highly valued by the local communities. The two category 3 species, *M. grandis* and *V. undulata*, both have lower adult stem densities than the category 4 species. The lower density of mature trees decreases sexual reproductive

potential of a population by lowering seed production. The loss of sexual reproduction could also lead to lowered genetic diversity which negatively affects long-term persistence (Botha *et al*. 2004b). Both species have high conservation priority with high local importance and frequency of collection scores indicating a higher harvesting pressure on these species than for *H. amoenus* and *H. lucens*. *Millettia grandis* is also harvested for construction wood which has a higher impact on population stability than harvesting of fruits or leaves (Boot & Gullison 1995). *Vepris undulata* has a slightly lower conservation priority score as only its leaves and roots are harvested which has less of an impact on species survival. *Protorhus longifolia* and *Ptaeroxylon obliquum* are harvested for their bark which can be fatal if harvesting is not controlled. Harvesting of bark can cause wounds which leaves the tree susceptible to infections which could result in reduction in vigor or even stem mortality (Botha *et al*. 2004b, Shackleton *et al*. 2005).

The use of leaves for medicinal purposes instead of bark is of growing interest as the same compounds found in the bark are often found in the leaves as well (Geldenhuys 2004). This could be an extremely beneficial method of harvesting in terms of sustainable use as it would reduce tree mortality and provide a greater amount of medicinal material for users. Another potential method of sustainable use worth examining, although only really studied in savanna ecosystems, is coppice stem harvesting. This method holds many advantages for heavily utilized species as coppice regrowth is more rapid than other forms of regeneration (Kaschula *et al*. 2005). The harvestable species, *H. amoenus* and *M. grandis*, displayed coppice regrowth. As these trees are also desirable as construction materials it makes them potential candidates for this form of harvesting. This method is also useful for firewood harvesting and in reducing soil erosion, but is dependant on the ability of a species forming suitably sized and shaped coppice stems (Kaschula *et al*. 2005). The study by Kaschula *et al*. (2005) resulted in only two of ten tree species, mentioned by informants in the Bushbuckridge region of South Africa, as being suitable for this type of harvesting. Moreover, if coppice regrowth is managed through thinning, regrowth rates can be sustainably increased and so harvesting intervals can be decreased (Shackleton 2001).

An example of sustainable management systems described by Boot and Gullison (1995) is the harvest of brazil nuts in the Amazon basin. Although demographic data is lacking, the absence of regeneration in exploited forests has led to the idea that planting of these trees will be required to maintain current densities. Through experimentation it was shown that seedling and sapling growth is enhanced in open

areas however with their low growth rates some form of monitoring is necessary to ensure establishment (Boot & Gullison 1995). Reproductive success of certain species and the survival and growth of seedlings is positively influenced by gaps such as those created by tree-fall (West *et al*. 2000). In the Hluhluwe-Umfolozi Park in South Africa, West *et al*. (2000) suggested that only shade-tolerant, fine-grained species be utilized. Because shade-intolerant species, like coarse-grained species, need sufficient light through the canopy to successfully regenerate, focusing harvesting to certain patches and thus generating gaps in the canopy may aid in the recruitment of these species (Midgley *et al*. 1995, West *et al*. 2000). Having knowledge of the grain of a forest can aid forest management, so that disturbance regimes can be implemented as a tool to maintain species diversity (Obiri *et al*. 2004). The grain of the forest is linked to the scale at which regeneration processes occur. In a fine-grained forest these processes occur on a small scale which suggests that small patches of forest may be treated as separate sustainable zones. In coarse-grained forests regeneration processes occur over a large scale and thus only large patches of forest can be sustainably used (Everard *et al*. 1995). The majority of tree species in the SNR are coarse-grained, and with its small sized forest, most tree species cannot currently be sustainably harvested in viable quantities. The MNR also has mostly coarse-grained species, and with its forest already divided into small isolated patches, viable sustainable harvesting of tree species seems unlikely. Genetic isolation and gradual population decline are risks to species trapped in 'islands', such as forest patches that become cut off from the remaining forests (Dudley *et al*. 2005). The DCNR appears to have intermediate forests with similar abundance of coarse- and fine-grained species. Fine-grained harvestable species in this reserve are well distributed with dense populations within the harvesting zone. The harvesting zones have small and sparse populations of non-harvestable species, which are also mostly described as coarse-grained. This suggests that small patches of forest can be sustainably harvested, which may also aid in the regeneration of coarse-grained species such as *P. mooiensis* and *P. obliquum*.

Tolerance to harvesting varies with life-history of a plant such that perennial herbs can withstand higher levels of harvesting than trees because of their high growth and maturation rates (Ticktin 2004). The way in which plants are cut can alter the growth rate of the population, and selective harvesting of preferred sizes may result in missing size classes and collapse in the progression of growth from one size class to another. Also, harvested populations that become too small are vulnerable to demographic stochastic events such as individual mortality and reproduction (Lande *et al.* 1997). These are important

considerations when designing an effective management plan. An example of a harvesting management plan, which was ill-suited to the mahogany trees in Bolivia, is the minimum-diameter cutting limit. All mahogany trees within the 80 diameter size class were harvested leaving behind individuals with diameters below this limit, and a small amount of seed producing trees for the future harvest. However, these trees showed eposidic regeneration occuring after disturbance events which resulted in most individuals being in the same size classes where disturbance events were infrequent. Under circumstances of limited regeneration, the majority of individuals may consequently be within the harvesting limit which could be detrimental if all reproductive individuals are removed from the population (Boot & Gullison 1995).

Another important consideration is the influence of climatic and environmental conditions on plant reproductive potential (Botha *et al*. 2004b). Harvesting of herbaceous species may be more beneficial after the rainy season once mature individuals have flowered and reproduced, thus increase harvesting intensities by increasing annual yield (Freckleton *et al*. 2003). Harvesting periods should therefore be dependant on rainfall and flowering or fruiting season. As suggested by Dzerefos and Witkowski (2001), harvesting should be restricted to dormant periods to maintain plant vigor and recruitment. Geophytes, such as *Hypoxis,* are more resilient to removal of above ground structures as they have starch storage in underground corms. However, *Hypoxis* is harvested for its corms, which is highly destructive as the whole plant is removed. In the SNR *Hypoxis hemerocallidea* has a high conservation priority because the entire plant is removed and because it is frequently harvested, indicating that quotas must be restricted to dormant periods after the rainy season when reproduction has taken place. Species that are harvested for aboveground structures, particularly those that do not have underground storage such as *Helichrysum* species, should also be limited to certain periods of the year. Continuous harvesting of aboveground structures that hold or produce seed decreases the amount of seeds produced (Dzerefos & Witkowski 2001). Grasses also allocate carbohydrates to belowground tissues, as well as produce a high biomass of stems making them resilient to harvesting (Shackleton 1990, Dzerefos & Witkowski 2001). These species do not need strict harvesting limitations, but it is suggested that harvesting is not confined to one area but rather rotated between numerous areas thus giving adequate time for regrowth and seedling establishment. Brown (1997) suggested that grass bundles be physically carried out of the reserve rather than transported by vehicle in order to facilitate seed dispersal. Reed species such as *Cyperus textilis* and *Juncus kraussii* are also resilient to harvesting and a similar strategy such as rotating

between reed patches is suggested. At the St Lucia Estuary and Umlalazi Estuary rotating harvesting between zones generally occurs on a biennial basis (Taylor 1996). The future use of *J. kraussii* relies on the continuous supply of sustainable culms. With its scattered distribution and desirability it is crucial that stands be managed sustainably (Traynor 2008).

Management efficiency is evaluated through the monitoring of harvested species, and can be further investigated by studying endangered and indicator species as well as changes in populations and habitat (Gibbs *et al*. 1999). Identifying existing and potential threats and the ability to determine whether current management efforts are able to deal with these threats is an important component of a successful monitoring plan (Gibbs *et al*. 1999). Potential threats in the Wild Coast reserves include poaching, illegal harvesting and livestock damage through grazing, browsing and trampling. Grazing can alter nutrient dynamics and erode top soils where there is constant movement of cattle, while browsing by goats can affect re-growth and decrease perennial cover as well as assist the growth and spread of invasive species (Yates *et al*. 2001, Belsky & Blumenthal 2002, Thapa & Chapman 2010). Goats from households adjacent to the reserve fences have free access to the surrounding forests and numerous cattle where observed in the DCNR having access to the reserve through broken fences suggesting that the amount of cattle inside the reserve is not being monitored. From a report by Fay (1999) most residents of the Dwesa-Cwebe region do not have a demand for grazing inside the reserve as there is adequate grazing outside, but may need access during drought years. However, communities living adjacent to Cwebe have a serious shortage of grazing which has led to numerous demands for access to grazing in the reserve. Cattle that are brought inside of the reserve may remain unsupervised for weeks and generally do not move far from where they were put, thus increasing pressure on vegetation in those areas. To reduce excessive cattle damage and manage livestock entering the reserve fences need to be maintained and patrolled at regular intervals to ensure that they have not been tampered with. The prevention of illegal harvesting and poaching may also require regular patrolling and additional rangers to police. As described by Thapa and Chapman (2010), the reduction in law enforcement and reduced patrolling in some of the protected areas in Nepal over the five-year period of the Maoist insurgency lead to an increase in poaches and trespassers. As observed in both the DCNR and SNR, local men poach with the aid of up to twelve or more dogs. Another activity associated with poaching is burning of grassland which helps poachers to better see animals and also attracts wild herbivores to the

new grass. Uncontrolled burning of grasslands outside of the usual burning periods can be destructive to certain species if too frequent, and can potentially change grassland composition (Kepe 2005).

Using certain areas of the reserve as harvesting zones allows for easier monitoring as harvesting becomes concentrated, and creates sanctuaries in the remaining areas. The harvesting zone in the MNR, which is the biggest reserve, has been located in the proximity of administrative buildings which allows rangers to more easily monitor harvesting activities. Zonation allows for comparisons between the harvested and non-harvested zones which may provide useful data on whether the management plan is suitable or needs to be changed. The forest areas of MNR and SNR have been zoned as a conservation area until further studies have been carried out on remaining species. In the DCNR, forest harvesting zones have been established primarily where there is a high density of *H. amoenus* and *H. lucens*. *Hyperacanthus amoenus*, *M. grandis* and *V. undulata* have wide distributions outside of this zone while *H. lucens* does not indicate that a solid monitoring strategy is needed to ensure this species is not over-harvested. Assisting harvesters into the forest may be a good strategy to ensure that no illegal harvesting is taking place and that harvesters keep to their quota. The entire grassland area of the SNR has been zoned as harvestable leaving no grassland areas as conservation zones. To ensure that protected species such as *X. involucratum* and *S. undulata* remain undisturbed, harvesters should be assisted by reserve rangers. It should also be noted that communities already reap benefits from the coastal area as recreational fishing is allowed in the SNR with a permit. Using reserve rangers to monitor harvesting in the field can be useful in determining what the commonly utilized species are, what quantity of material is taken out, and whether harvesting is becoming destructive to the habitat being utilized. An emerging approach to monitoring is the use of local people who have little formal education but abundant knowledge of their land (Danielsen *et al.* 2007). Data would be collected by local people, and individuals be given charge of monitoring certain species in certain areas. In most part this is an untested method of monitoring but holds some value in incorporating local communities into conservation efforts.

Alternatives to the use of natural resources in protected areas are important in the long-term and especially where there is little potential for viable sustainable use. Such an alternative is the use of home gardens where households propagate their own plants. On a survey in South Africa it was found that traditional healers (n = 400) support propagation of medicinal plants and would use cultivated material

(Cunningham & Davis 1997). Also, as studied by Makhado and Kepe (2006), just over half the respondents (n = 52) interviewed in Pondoland South Africa, owned *Cyperus textilis* gardens. Woodlots of valuable tree species can also be established near the homesteads. Extracting plant material and seeds of valuable species such as *P. obliquum*, *C. textilis* and *Hypoxis* from reserves can be used to supplement home gardens and woodlots as well as provide benefits to the local communities (Dzerefos & Witkowski 2001). In the study by Thapa and Chapman (2010) in Nepal, the collection of natural resources by local communities from neighboring parks caused a lower disturbance where villagers had access to community forests in comparison to those that had access to only a few. Exotic species may also be used as an alternative for construction materials and firewood.

5. Conclusion

From this study it was seen that species with the highest potential for sustainable harvesting are trees that display a high level of recruitment, are shade tolerant and fine-grained, and grassland species that have advanced regeneration such as underground tubers, adaptations to coping with fire or herbivory, or are able to vegetatively grow. Practices such as controlled harvesting of fine-grained species may aid the regeneration of shade-intolerant, coarse-grained species by creating gaps in the canopy. The DCNR appeared to be the only reserve with the potential for this kind of harvesting due to the size of its forests. Another aspect of management discussed is increasing the yield of utilized species. This may include the use of coppice harvesting and rotating harvesting between numerous areas. It is also important to consider that a plants reproductive potential is influenced by climatic and environmental conditions, and so harvesting periods should be dependent on rainfall and flowering or fruiting season as well as restricted to dormant periods to maintain plant vigor and recruitment (Dzerefos & Witkowski 2001, Botha *et al*. 2004b). The plant parts that are harvested should also be controlled to a certain extent and perhaps the use of leaves instead of bark encouraged. Providing and exploring alternatives to natural resources is also an important component of an effective management program.

In conclusion, using effective management practices and putting into place an effective monitoring program to evaluate management efficiency is vital to using natural resources sustainably. Also, local communities should be included in conservation efforts wherever possible not only to raise awareness, but also to gain support for conservation. The options for sustainable harvesting differed greatly

between the reserves for important species, which may have implication for the sustanaible use or conservation of these species. Bearing this in mind, despite the obvious similarities between the reserves, each may need its own management plan.

CHAPTER SIX: Management of sustainable natural resource harvesting and scope for beneficial community harvesting in Wild Coast reserves

1. Introduction

Numerous land claims in South Africa have affected protected area since 1994, and have set many challenges for the government when reconciling land reform and conservation policies (Kepe 2004). The national government has committed to integrating sustainable rural development and nature conservation in accordance with the national environmental and biodiversity policies (Kepe *et al.* 2000). The concept of community conservation focuses on promoting rural development through conservation, however it does not grantee sustainable use of natural resources (Palmer *et al.* 2002). Firm governance arrangements and institutions must be in place for community conservation as illegal activities and unmonitored over-harvesting of natural resources can greatly affect the preservation of biodiversity, as well as associated development activities and outcomes (Palmer *et al.* 2002). The Eastern Cape provincial conservation legislation states that the consumptive use of resources from protected areas is not allowed, however local people continue to illegally harvest plants and animals from these areas (Palmer *et al.* 2002). Residents surrounding the Mkambati Nature Reserve collect resources both legally and illegally by payments of cash or bribery of reserve officials (Kepe *et al.* 2000). In the Silaka Nature Reserve no formal agreement has been reached over resource harvesting, however *Acacia karroo* can be harvested for firewood from the reserve and harvesting of marine intertidal organisms and recreational fishing is allowed if a permit has been granted. Thatch grass is harvested from the reserve at no charge however a permit from the manager is needed (Fielding *et al*. 2006). In the Dwesa-Cwebe Nature Reserve local people had no rights to natural resources in protected areas until 1995. Local residents retained access to natural resources and grazing in Dwesa-Cwebe via a permit-based system after the protest action of 1993 to 1994 (Palmer 2003).

The land reform settlement agreement at Dwesa-Cwebe states that the reserve land is owned by the local communities, but must remain a protected area. This area is to be managed by an agency outside of the community, currently Eastern Cape Parks (ECP). The local communities opted for a lease agreement where the ECP leases the reserve from the community and keeps any profits made by the

reserve. However, the community must see benefits coming out of the reserve such as the use of natural resources. The Silaka Nature Reserve has no agreement yet as it is still being settled. The Mkambati Settlement Agreement is the same as that of Dwesa-Cwebe, however the community did not opt for a lease agreement but rather claimed a percentage of the profits made by the reserve. This seems to be a more beneficial arrangement for the local communities as communities are more pro-conservation than those in the Dwesa-Cwebe region. Whichever way it is important that the communities see benefits from the reserves. Management of these protected areas must therefore develop a sustainable harvesting plan for key resources. The ECP management plan includes an overall regional vision and plan for the Wild Coast region, along with a specific management plan for each protected area. The latter includes specific objectives and goals for each reserve, as well as an annual plan of action, i.e. implementation, along with the required budget. It is a five year term plan that is reviewed annually. Applicable issues are considered for each reserve and, if needed, a subsidiary management plan is implemented. This involves the use of experts from appropriate institutions. Also, it involves interaction with communities to swap ideas and get research aims across, and enables researches to integrate important issues that the community may have into the plan. This was done for the subsidiary plans for fire management and alien invasive control in the Wild Coast.

A management plan for each reserve can be developed and implemented using a top-down or a bottom-up approach. In the former, natural resource harvesting is handled in a managerial manner by ECP and benefits are provided for communities. With respect to a bottom-up approach the primary aspects of the plan and its implementation are derived through consultation with local communities. This includes aspects of what should be monitored, what species may be harvested, in what quantity, how they are used and what the objectives and tasks are. This approach is important in determining where a plan needs to be adapted, and in pointing out where changes are occurring. Lindenmayer and Likens (2009) argue that the key to good monitoring and environmental management is good science and sound research. Preliminary natural resource use guidelines were created by Venter (2008) for the Dwesa-Cwebe Nature Reserve which highlighted several mechanisms needed. First was to control access to the reserve. The second was to ensure that only local communities have access and that use is not for commercial purposes. Lastly, Venter (2008) stated that a monitoring plan should be implemented that will detect unsustainable use, and that management of biodiversity in the Wild Coast reserves must

incorporate and involve the communities who hold an interest in the reserve area. Also ex-situ propagation and tourism should be considered as subsidiary options.

2. Managing resource extraction from the Wild Coast reserves

The development of a sustainable management plan requires understanding of the dynamics of a species population and its ecosystem. Investigating species population in areas undisturbed by human activity is ideal when developing harvesting levels that are suited to that species dynamics (Everard *et al*. 1995, Aanes *et al*. 2002). In a dipterocarp forest in Western Malesia, South-east Asia, one method for the sustainable extraction of timber is the minimum cutting limit (Sist *et al*. 2003). Minimum diameter cutting considers the importance of reproductive trees for ecological sustainability, and aims at allowing the continuation of fruiting in dipterocarp species. This method does however run the risk of reducing seed set and seed predation exceeding seed production. It is important to develop a cutting limit that is based on species dynamics such that reproductive maturity is reached before extraction. Dipterocarp species reach reproductive maturity at a diameter of ≥ 50 cm diameter at beast height (dbh), and so the minimum cutting limit was set at > 60 cm dbh. To reduce the risks that come with this method of harvesting, larger trees (>80 cm) can be safeguarded to ensure the population remains fecund (Sist *et al*. 2003). For tropical palm trees it is recommended that 50 to 60 seed trees be maintained per hectare (Freckleton *et al*. 2003). The minimum cutting limit method is aimed at large scale timber extraction and so may be restricting to small scale harvesting where, for example, communities only need pole sized individuals. In this case, extraction of pole-sized trees should be limited to fine-grained species and, if possible, not selective towards preferred species as this can lead to depletions where management is weak, as documented by Boudreau *et al*. (2005). The sustainable management programme for tropical palm trees is based on population structure, growth rates and number of reproductive trees per hectare (Freckleton *et al*. 2003). This allows for the estimation of harvest length and offtakes. Further ecological data need to be collected on growth and recruitment rates and responses to harvesting and other disturbances (such as fire and grazing) in the Wild Coast reserves. This will allow for accurate estimations on how much material can be removed so that harvesting is sustainable. Also, an estimate of how much material (poles, construction wood, firewood, thatching, medicinal etc.) the community requires per year/month/season must be determined to assess the potential balance of supply and demand and whether or not limits would be required.

Ticktin (2004) argues that management practices can be described as having three levels. The first level deals with harvest-specific practices such as what plant parts are removed, the second with management practices such as methods of enhancing production, and the third deals with other uses for the land such as logging and agriculture. Within the first level, practices such as limiting what plant parts are removed can be debated with local communities and agreements set. However, agreements can be elusive because harvesting of some parts results in the death of the plant (e.g. bulbs), which is undesirable from a conservation perspective. This is especially common for plants that have medicinal uses such as *Hypoxis*. Therefore, different quotas would be required for species where the entire plant is killed or removed relative to those where it is not. In the case of medicinal trees, cutting can be prohibited as was the case in the Batang Ai National Park, Malaysia (Horowitz 1998). Medicinal trees, along with a species that provides food for fish and which has roots that help prevent riverbank erosion, were demarcated as protected species. In this case practices such as the use of leaves rather than bark should be encouraged for harvest of species, such as *Vepris undulata*, as this reduces the risk of mortality as well as increases the yield of medicinal material (Geldenhuys 2004a). The second level deals with methods of enhancing production, which may be aided by practices such as:

1. Timing of harvesting
2. Coppice harvesting
3. Pruning
4. Thinning
5. Creating canopy gaps
6. Planting seeds
7. Rotating between harvesting zones

The timing of harvest to post-reproduction periods or after the rainy season may increase production by ensuring that individuals reproduce and contribute to the next harvest season. As an example, tropical palms harvested post-reproduction where a constant proportion of plants are removed per year resulted in an annual offtake that exceeded 20 palms per plot as opposed to three palms per plot under pre-reproduction harvest (Freckleton *et al*. 2003). This indicates that high intensities of harvesting can potentially be sustained by populations harvested post-reproduction. However, intensity of harvest will vary with growth and recruitment rates. Timing of harvest is already the intention with the seasonal harvesting of thatch in Mkambati, where harvesting is allowed only after the plants have flowered and

the seed has set (Shackleton 1990). It is important to consider that local management practices are mostly based on cultural and socio-economic aspects as opposed to only ecological, and so practices such as seasonal harvesting may be impractical or impossible for local harvesters. The harvesting practices of local people should therefore be assessed and if necessary adapted upon (Ticktin 2004).

Coppice harvesting was suggested to be a potential management practice for the sustainable utilization of woodland resources in tropical savannas (Shackleton 2001, Kaschula *et al*. 2005). Coppice harvesting is not without its problems as, on a large scale, these systems are often in a fine balance. In established coppice plantations in northern temperate systems, management is accompanied by rigorous external control and nutrient replacement which is not ideal for communities with little resources. This practice should be down-scaled in the Wild Coast to a point where harvesters are encouraging to remove branches rather than whole stems when extracting timber and fuelwood. Species such as *H. amoenus* and *M. grandis* which display coppice regrowth can potentially be used in this way as they are also valued as construction materials. Coppice harvesting can coincide with pruning practices as it encourages regrowth and branching which may assist coppice harvesting. Indeed, coppice growth regrows faster than seedlings, and so it also helps in providing reduced harvest intervals. Thinning of coppice regrowth can accelerate regrowth rates even further (Shackleton 2001). Thinning can also be undertaken in areas where valuable species are known to grow but are now dominated by aggressive weeds or creepers. This will encourage growth of understory species and seedlings that may be suppressed where undesirable foliage is dense. It has been shown in recent studies that gaps in the understory are important to forest tree species regeneration (Connell *et al*. 1997, Boudreau *et al*. 2005). However, thinning methods such as understory clearing should not be taken lightly as it is likely to have a negative effect on ecological processes and biodiversity (Sist *et al*. 2003). For example, the habitat of natural pollinators for many species may be disrupted which will have undesirable consequences on reproductive success.

Creating gaps in the canopy is another method that may hold benefits in increasing forest diversity. Shade intolerant species need sufficient light to regenerate and so are often less common than shade tolerant species under the canopy. Managing gap formation through tree fall may be done by encouraging harvesters to remove common tree species. This may enhance growth of more valuable species, such as *Ptaeroxylon obliquum* and *Zanthoxylon capensis*, which are marginal species and may

benefit from gaps created in the canopy. Gaps tend to occur at low frequencies (1 % of forested area per year) in natural dipterocarp forests in South-east Asia. Often it is only one large tree fall, which seldom produces a gap that exceeds 200 m^2 (Sist *et al*. 2003). The number of canopy gaps created in a given time should not greatly exceed that of the natural frequency of tree fall as such human interventions can greatly change forest composition. Seeds of valuable trees can be planted in gap openings during the warm rainy seasons, although this has to be weighed against the broader conservation aims and approaches of the protected area. Seeding will inevitably alter the species composition of the forest over time. Consequently, seeding of useful species might be better encouraged in homestead plots or woodlots rather than with the protected area itself. Trees species that are easily germinated from seed and have fast growth rates such as *Rauvolfia caffra* (1.5 $m.year^{-1}$) and *Polygala myrtifolia* (1 $m.year^{-1}$) (Venter & Venter 1996) are good candidates for establishment from seed in homesteads. In the case of herbaceous and grass species, the dispersal of seeds can be encouraged during harvest. As suggested by Brown (1997), grass bundles should be carried out of the reserve rather than by vehicle in order to facilitate seed dispersal. Rotating harvesting between grassland areas within the harvesting zones on an annual or biannual basis may give sufficient time for the establishment and regrowth of valuable species. The Umlalazi Nature Reserve in KwaZulu-Natal has adopted a biannual rotational management regime for the harvest of *Juncus kraussii* (Traynor 2008). Although this regime seems to be sustainable, the effect of annual cutting in the long-term should be tested, as well as the impact of harvest on above-ground and below-ground structures.

Alternatives to the use of natural resources in the reserves have been incorporated into the third level as it deals with other uses of the land. Such considerations are important where natural populations cannot support viable sustainable harvesting, and in benefitting the community in the long term. Alternatives included:

1. Home gardens
2. Woodlots
3. Use of exotic species

Given that the protected areas on the Wild Coast have been formally legislated and proclaimed, the land which they contain cannot be put to alternative uses unless they are first deproclaimed. However, the ECP could take on board the spirit of what Ticktin (2004) meant, by encouraging conservation-minded

land uses external to the protected areas, and in so doing, promote use of resources that were previously sought within the reserves. For example, medicinal species and reeds can be propagated within the community by promoting home gardens. In recent research it was found that up to 82 % of urban-based traditional healers in the Eastern Cape are willing to make use of cultivated plants for medicinal purposes (Keirungi & Fabricius 2005). Problems associated with cultivation of medicinal plants are that feasibility often depends on the capabilities of communities, ease of cultivating these species and obtaining seeds, water requirements and the impact on vegetables and other garden plants such as 'shading out' and spacing (Keirungi & Fabricius 2005). Also it is believed by some that cultivated plants lose their effectiveness if not taken out of the wild. Tree species can be grown in the community by establishing a woodlot or around homesteads. Woodlots are typically fraught with governance issues (Ham & Theron 2001), and so planting within individual fields or around homesteads is preferred. Such planting of useful species also confers other benefits such as shade, perhaps fruits, carbon sequestration and so on. Whilst most rural households do plant some trees near the homestead, currently those in the Eastern Cape plant far less than communities elsewhere in the country (Paumgarten *et al*. 2005) and so there is room for increased planting. These gardens and woodlots can be supplemented using materials from the reserve. This method provides benefits from the reserve which may also act as an incentive to own a home garden or woodlot. Dzerefos and Witkowski (2001) suggested forming a nursery which also allows for horticultural skills to be passed to traditional healers, and provides a base for conducting harvesting trials for sustainable use. Materials from category 1 and 2 species can be acquired from the reserve and propagated in nurseries under strict supervision. The use of exotics species as a supplement to indigenous wood should be encouraged and extracted from the wild or from already established woodlots. However, there should be no additional planting of invasive exotic species.

It may be a good idea to limit extraction of resources to local uses that benefit the livelihoods of local residents, and not used for commercial purposes. Also, a limit to the quantity of material taken out per person could be imposed to ensure that people take only what they need. One way of achieving this would be to encourage the establishment of a harvesters association for different resources around each reserve, as was done in Umzimkulu forests for medicinal plant harvesting (Geldenhuys 2004b), and in the Bushbuckridge lowveld for woodcarvers (Shackleton & Steenkamp 2004). Only members of the association may have access to the reserve using identification cards issued by the reserve. This means that all harvesters are registered with the reserve. An association is also a good way for the communities

to communicate with the reserve managment about the pros and cons of the current management schemes (Shackleton & Steenkamp 2004). This also enables communities to communicate what resources are highly desired or needed and so set a basis for new population inventory assessments. Such an association can also assist in reporting of and dealing with transgressions, as it is their resource that they are protecting. That said, any species that has not been studied, and therefore its population status is not known, can be described as 'unknown'. These species should not be harvested until they have been assessed and their population status evaluated.

3. Monitoring of resource extraction

Management efficiency is evaluated through the monitoring of harvested species, and can be further investigated by studying endangered and indicator species as well as changes in populations and habitat (Gibbs *et al*. 1999). Monitoring requires the collection of long-term data which improves understanding of ecological systems, and allows for the evaluation of responses to disturbances and changes in ecosystem structure and function (Lindenmayer & Likens 2009). Ecological as well as social data allows for decision-making and adaptations of management strategies and allows managers to deal with site specific issues. Social data explore the underlying social variables associated with resource extraction which is important in long-term conservation, gaining communities support for conservation and making informed decisions (Thapa & Chapman 2010). The aim of monitoring is to instigate well informed management decisions based data and information (Danielsen *et al*. 2007). As described by Lindenmayer and Likens (2010), an effective monitoring program is characterized as having:

1. Good and evolving questions
2. A conceptual model that can be used to guide the development of questions
3. A good understanding of what entities to measure
4. Good statistical design
5. Well-developed partnership
6. Strong and dedicated leadership
7. On-going funding

A set of good questions form the foundations of an effective monitoring program. In other words, the management agency needs to be clear on its objectives and therefore what aspects of the system need

to be monitored. As described by Lindenmayer and Likens (2009), many monitoring programs, such as the Alberta Monitoring Biodiversity Program in Australia, fail largely because objectives and approaches are poorly thought-out or program managers take on the "collect data now and think of a good question later" approach. Objectives describe what management hopes to accomplish, and by doing so drives what entities should be measured and how often (Gibbs *et al*. 1999). The development of questions is guided with the help of a conceptual model of the ecosystem or entity in question. The conceptual model also allows for predictions about how an ecosystem might behave under a given circumstance. Using such predictions about ecosystem behavior and response helps to eliminate problems such as what to monitor, and focuses monitoring towards measuring appropriate entities. This problem stems from the debate over whether to monitor 'everything' or indicator species.

It is intuitive to have a proper statistical design if a monitoring program is to be successful, as well as a solid and well-developed partnership between people of different backgrounds and complementary skills. It is one thing to develop an effective monitoring program, and another to keep it going. Fundamental to this is strong and dedicated leadership and on-going funding which is often the biggest challenge (Lindenmayer & Likens 2010). Repeating long-term monitoring data collection can be time consuming as well as expensive. A survey preformed by Marsh and Trenham (2008) on current trends in monitoring plants and animals in Europe and North America showed that most respondents (30 %) surveyed monitoring sites once a year or two to five times a year (28 %). Permanent plots can be setup in harvesting zones, conservation zones and outside of the reserve to reduce time and effort. This allows for suitable comparisons between populations that are disturbed by harvesting and those that are protected. It is important to have some monitoring sites in the harvesting zones where extraction activities are high in order to measure ecological response to harvest regimes. Permanent plots, as opposed to plots that are shifted annually, also allow for the control of variability among sites and so enhance statistical power (Gibbs *et al*. 1999).

Involving local communities in conservation efforts holds value in gaining support for conservation and improving local peoples understanding of what conservation is. An emerging approach to monitoring is the use of local people who have little formal education but abundant knowledge of their land (Danielsen *et al.* 2007, Levrel *et al*. 2010). This can be used to compliment professional monitoring and is also cost effective relative to the use of professionals. Ways to involve the community in monitoring

include the formation of monitoring groups and the use of field diaries. Both methods require relatively little training and instruction. Community monitoring groups report to the reserve management agency on species populations, resource use, habitat conditions and potential threats. In the study by Danielsen *et al.* (2007), groups comprised of five to eight local residents who regularly collected information and reported to reserve staff on a quarterly basis. Members of the monitoring groups were identified as those most experienced hunters, forest product gatherers and fishermen in each village. Field diaries were used to record observations made by local people on species, habitat and resource. Observations are recorded by reserve rangers during patrols or at access gates. Along with the recorded observation, the name of the observer, location and date were recorded. The field diary approach includes all members of the communities and not only those that are experienced. Using local people's observations and collected information improves information available to decision-makers and allows for the identification of trends and potential concerns (Danielsen *et al.* 2007). Of course, volunteering to biodiversity monitoring may require some sort of incentive, such as rights to resource use. Also, analyzed results and proposed actions should be presented to the communities annually as a means of monitoring, communication and sharing. In addition, rangers should be educated about harvestable species and perhaps be provided with a handbook that has descriptions and illustrations of species, Xhosa names and extraction quantities.

4. Adaptive management and monitoring

It is important that a monitoring program be adaptive so it can evolve and develop in response to new questions and new information. This way of monitoring is termed 'adaptive monitoring', and incorporates questions, conceptual models, experimental design and data collection, analysis and interpretation into one iterative step (Lindenmayer & Likens 2010). Adaptive monitoring is becoming a pivotal concept in environmental management in dealing with areas of uncertainty. In short, is a systematic approach of adapting management to changes, and thus improving processes by learning from the outcomes of management practices and policies already in place (Gregory *et al*. 2006). Because adaptive monitoring is a new approach to long-term monitoring and research there is little literature, however, there is extensive literature on adaptive management. Adaptive management strives to generate feedback to managers of lessons learned from practices and policies already in place (Dallmeier *et al*. 2002). This means that management goals, actions and quota are adaptable to changes,

disturbances and needs of local communities. Adaptive management is useful for testing different management practices (such as coppice harvesting and thinning) in order to select those most suitable to a given circumstance. This is essentially trial and error, or learning by doing, which can often do more harm than good but is necessary to understand the alternatives.

Dallmeier *et al*. (2002) described an adaptive management framework as having four inter-related components which act as a cyclical series of steps that build on learned experiences of previous steps (Figure 23). These four primary steps are, 1) design management and monitoring objectives, 2) implement management, 3) assessment and monitoring and 4) evaluations and decision-making. The first step is defining the management and monitoring goals and objectives. The primary objective to guide the monitoring programmes in the Wild Coast reserves is to maintain harvested species population levels to an extent that is also beneficial to viable sustainable harvesting. Two supporting goals, described by Gibbs *et al.* (1999), are firstly to evaluate changes in species population, and secondly that management responds appropriately to those changes. Implementing management is the second step. This includes setting quota and season of harvest, as well as implementing harvesting practices such as coppice harvesting and rotational harvesting where appropriate. Once these strategies have been put into place the third step can commence, which is assessment and monitoring. Monitoring is essentially repeating sampling over time and comparing data to the baseline (Solari *et al*. 2002). This is where adaptive monitoring comes into play, and can be integrated into adaptive management as shown in Figure 23. It is important that objectives and questions be established at the beginning of the monitoring program, and monitoring approaches be carefully designed using conceptual models of the ecosystem. Lindenmayer and Likens (2010) strongly believe that effective adaptive monitoring is only achieved if it is based on carefully posed questions. Questions lead to discoveries which represent answers to questions, allowing monitoring approaches to adapt in response to new questions. New questions are often based on changes which emerge from long-term monitoring. Based on this study, some appropriate questions for adaptive monitoring in the Wild Coast Reserves are as follows:

1. Have species population levels changed?
2. Have species distributions across the reserve changed?
3. Are current harvesting levels sustainable?
4. Is frequency of harvest sustainable?

5. Are harvesting levels viable to local communities?

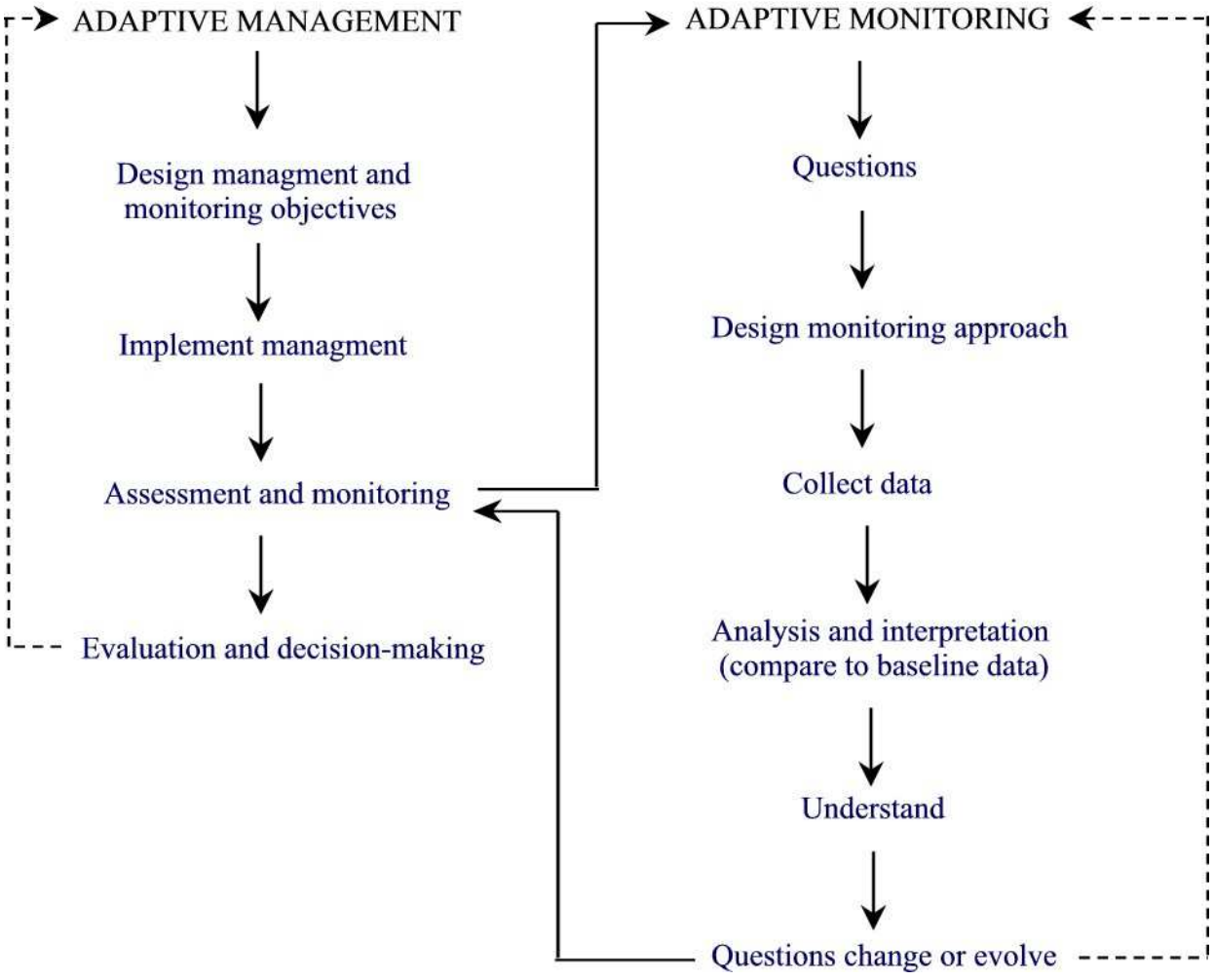

Figure 23: Integration of adaptive management with adaptive monitoring (adapted from Dallmeier *et al*. (2002) and Lindenmayer & Likens (2009))

Population inventories can be repeated every one to five years and compared to baseline inventories. Tree populations typically take five to ten years to respond to harvesting (Ellery *et al*. 2000). Comparisons with baseline data are useful for recognizing trends and changes and provide an expected norm against which future changes can be compared (Dallmeier *et al*. 2002, Havstad & Herrick 2003). Management strategies can be improved and refined with understanding of such trends and changes. Adjustment such as changing resource extraction rates and quotas, changing season of harvest or area

of harvest are example of management decisions based on long-term monitoring (1-5 years). Understanding also allows monitoring questions to change and adapt appropriately, and allows for alterations such as increasing monitoring frequency or monitoring sites. Short-term data collected every year are used to guide short-term management decisions on a seasonal or annual basis (Havstad & Herrick 2003). Producing an annual report of monitoring data helps to increase interest and enhance credibility by reviewing priorities and goals. Community monitoring can be useful in collecting data (such as species populations and habitat) that can be used in short-term management decisions and as a basis for forming new questions. However, casual observations, anecdotal reports and unreplicated case studies often result in unreliable information due to a lack of statistical experimental design (Wilhere 2002). For this reason, such information cannot be used alone, and so should be integrated into long-term monitoring to supplement ecological information.

5. Conclusion

In conclusion, this thesis has shown that based on a once-off inventory, that several species desired by local communities could most probably support some level of harvesting. However, such harvesting must be within sustainable limits, and so additional work is required to monitor the impacts of harvesting, as well as the basic autecology of the species concerned, which relate to growth rates, recruitment rates and responses to harvesting. Monitoring need not be the sole prevue of scientists, but rather needs to be adaptive and inclusive. Inclusion of local communities in monitoring represents and ideal opportunity for joint learning and promotion of conservation objectives, whilst saving costs and human-resources for the Eastern Cape parks. Any agreed harvesting programme can be implemented using a number of different models. But common ingredients across most controlled harvesting models for community benefit include (i) monitoring, (ii) adaptability, (iii) regular communication, (iv) trust between all parties, and (v) a commitment to sustainability and minimal impacts from the species to system levels. To be successful most of these require true partnerships between the different stakeholders based on equity and equal power relations (Ribot *et al*. 2006). The fact that successful community land claims have been lodged on the different Wild Coast reserves means that communities should be able to negotiate around the management objectives and strategies for the reserves as equal partners, thereby promoting both conservation and local development objectives.

REFERENCES

AANES, S., ENGEN, S., SÆTHER, B., WILLEBRAND, T. and MARCSTROM, V. 2002. Sustainable harvesting strategies of Willow Ptarmigan in a fluctuating environment. *Ecological Applications* **12**: 281-290.

ACOCKS, J.P.H. 1998. Veld types of South Africa. (Second edition). Government Printer, Pretoria.

ADAMS, W.M., AVELING, R., BROCKINGTON, D., DICKSON, B., ELLIOT, J., HUTTON, J., ROE, D., VIRA, B. and WOLMER, W. 2004. Biodiversity conservation and the eradication of poverty. *Science* **306**: 1146-1149.

ADAMS, W.M. and HULME, D. 2001. Changing narratives, policies and practices in African conservation. In: HULME, D. and MURPHREE, M. (eds). *African wildlife and livelihoods: the promise and performance of community conservation*. James Curry, Oxford. pp. 9-23.

ADAMS, W.M. and HUTTON, J. 2007. People, parks and poverty: political ecology and biodiversity conservation. *Conservation & Society* **5**: 147–183.

ALEXIADES, M.N. 1996. Selected guidelines for ethnobotanical research: a field manual. The New York Botanical Garden, New York, U.S.A. pp 53-96.

ARJUNAN, M., HOLMES, C., PUYRAVAUD, J-P. and DAVIDAR, P. 2006. Do developmental initiatives influence local attitudes towards conservation? A case study from the Kalakad-Mundanthurai Tiger Reserve, India. *Journal of Environmental Management* **79**: 188-197.

BALSLEV, H., KNUDSEN, T.R., BYG, A., KRONBORG, M. and GRANDEZ, C. 2010. Traditional knowledge, use and management of *Aphandra Natalia* (Arecaceae) in Amazonian Peru. *Economic Botany* **64**: 55-67.

BELSKY, A.J. 1992. Effects of grazing, competition, disturbance and fire on species composition and diversity in grassland communities. *Journal of Vegetation Science* **3**: 187-200.

BELSKY, A.J. and BLUMENTHAL, D.M. 2002. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior west. *Conservation Biology* **11**: 315-327.

BERKES, F., COLDING, J. and FOLKE, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* **10:** 1251-1262.

BERRY, M.G., ROBERTSON, B.L. and CAMPBELL, E.E. 1994. Impacts of informal settlements on South-Eastern Cape coastal vegetation (South Africa). *Global Ecology and Biogeography Letters* **4**: 129-139.

BHAT, R.B. and JACOBS, T.V. 1995. Traditional herbal medicine in Transkei. *Journal of Ethnopharmacology* **48**: 7-12.

BOND, W.J. and van WILGEN, B.W. 1996. *Fire and plants*. Population and Community Biology. Series 14, Chapman & Hall, London.

BOOT, R.G. and GULLISON, R.E. 1995. Approaches to developing sustainable extraction systems for tropical forest products. *Ecological Applications* **5**: 896-903.

BOTHA, J., WITKOWSKI, E.T.F. and SHACKLETON, C.M. 2004a. Harvesting impacts on commonly used medicinal tree species (Catha edulis and Rapanea melanophloeos) under different land management regimes in the Mpumalanga Lowveld, South Africa. *Koedoe* **47**: 1-18.

BOTHA, J., WITKOWSKI, E.T.F. and SHACKLETON, C.M. 2004b. The impact of commercial harvesting on Warburgia salutaris ('pepper-bark tree') in Mpumalanga South Africa. *Biodiversity and Conservation* **13**: 1675-1698.

BOUDREAU, S., LAWES, M.J., PIPER, S.E. and PHADIMA, L.J. 2005. Subsistence harvesting of pole-size understorey species from Ongoye Forest Reserve, South Africa: species preference, harvest intensity, and social correlates. *Forest Ecology and Management* **216**: 149-165.

BROCKINGTON, D. and IGOE, J. (2006) Eviction for conservation: a global overview. *Conservation & Society* **4**: 424–470.

BROWN, K. 1997. Plain tales from the grassland: extraction, value and utilization of biomass from the Royal Bardia National Park, Nepal. *Biodiversity and Conservation* **6:** 59-74.

BURGER, M. 1996. Report on a herpetofaunal survey conducted in the former Transkei region. Unpublished. Ministry of Economic Affairs, Environment & Tourism, Eastern Cape Nature Conservation, Grahamstown.

BURGESS, N.D., MATTHEWS, P., EVERS, Y. and WOODCOCK, K. 2000. Non-timber uses, threats and local attitudes. In: BURGESS, N.D. and CLARKE, G.P. (eds). *Coastal Forests of Eastern Africa*. IUCN, Cambridge. pp 281-302.

CAMPBELL, B.M., JEFFERY, S., KOZANAYI, W., LUCKERT, M.K., MUTAMBA, M. and ZINDI, C. 2002. *Household livelihoods in semi-arid regions: options and constraints*, CIFOR, Bogor.

CALSON, A.J., LINDGREN, P.M. and SULLIVAN, T.P. 2008. Comparison of potential non-timber forest products in intensively managed young stands and matured/old growth forests in south-central British Colombia. *Forest Ecology & Management* **256**: 1897-1909.

CAWE, S.G. and NTLOKO, S.S.T. 1997. Distribution, uses and exploitation patterns of *Flagellaria guineensis* Schumach. with particular reference to Port St Johns, South Africa. *South African Journal of Botany* **63**(4): 233-238.

CHE, B. and LENT, P.C. 2004. Traditional conservation practice and the use of indigenous forests in the Amatola mountains of the Eastern Cape Province. In: LAWS, M.E., SHACKLETON, C.M. and GEACH, B. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice.* University of KwaZulu-Natal Press, Pietermaritzburg. pp 253-256.

CHILDES, S.L. and WALKER, B.H. 1987. Ecology and dynamics of the woody vegetation on the Kalahari Sands in Hwange National Park, Zimbabwe. *Vegetatio* **72**: 111-128.

CLOETE, E.C. 2004. A Floristic Study of a Portion of the Pondoland Centre of Endemism, Port St Johns, South Africa. MSc thesis, Rhodes University.

COCKS, M.L., BANGAY, L., SHACKLETON, C.M. and WIERSUM, K.F. 2008. 'Rich man poor man' – inter-household and community factors influencing the use of wild plant resources amongst rural households in South Africa. *International Journal of Sustainable Development & World Ecology* **15**: 1-13.

COCKS, M.L. and DOLD, A.P. 2004. A new broom sweeps clean: the economic and cultural value of grass brooms in the Eastern Cape province, South Africa. *Forests, Trees and Livelihoods* **13**: 33-42.

COCKS, M.L., DOLD, A.P. and GRUNDY, I.M. 2004. The trade in medicinal plants from forests in the Eastern Cape Province. In: LAWS, M.E., SHACKLETON, C.M. and GEACH, B. (eds*). Indigenous forests and woodlands in South Africa: policy, people and practice.* University of KwaZulu-Natal Press, Pietermaritzburg. pp 473-492.

COCKS, M.L. and WIERSUM, K.F. 2003. The significance of biodiversity to rural households in Eastern Cape Province of South Africa. *Forests, Trees and Livelihoods* **13**: 39-58.

CONDIT, R., SUKUMAR, R., HUBBELL, S.P. and FOSTER, R.B. 1998. Predicting population trends from size class distributions: a direct test in a tropical tree community. *The American Naturalist* **152**: 495-509.

CONNELL, J.H., LOWMAN, MD. and NOBLE, I.R. 1997. Subcanopy gaps in temperate and tropical forests. *Austrailian Journal of Ecology* **22**: 163-168.

COUSINS, B. and KEPE, T. 2002. Decentralization when land and resource rights are deeply congested: a case of the Mkambati eco-tourism project on the Wild Coast of South Africa. Conference on Decentralization and the Environment, Programme for Land and Agrarian Studies, University of the Western Cape.

CUNNINGHAM, A.B and DAVIS, G.W. 1997. Human use of plants. In: COWLING, R.M., RICHARDSON, D.M. and PIERCE, S.M (eds). *Vegetation of Southern Africa.* Cambridge University Press, Cambridge. pp 474-506.

DALLMEIER, F., ALONSO, A. and JONES, M. 2002. Planning an adaptive management process for biodiversity conservation and resource development in the Camisea River Basin. *Environmental Monitoring and Assessment* **76**: 1-17.

DAVIDAR, P., ARJUNAN, M. and PUYRAVAUD, J-P. 2008. Why do local households harvest forest products? A case study from the southern western Ghats, India. *Biological Conservation* **141**: 1876-1884.

DANIELSEN, F., MENDOZA, M.M., TAGTAG, A., ALVIOLA, P.A., BALETE, D.S., JENSEN, A.E., ENGHOFF, M. and POULSEN, K. 2007. Increasing conservation management action by involving local people in natural resource monitoring. *Royal Swedish Academy of Sciences* **36**: 566-570.

DENNIS, J.G. and RUGGIERO, M.A. 1996. Biodiversity inventory: building an inventory from local to global. In: SZARO, R.C. and JOHNSTON, D.W (eds). *Biodiversity in Managed Landscapes*. Oxford University Press, New York. pp 149-156.

DEWEY, S.A. and ANDERSEN, K.A. 2004. Distinct roles of surveys, inventories, andmonitoring in adaptive weed management. *Weed Technology* **18**: 1449-1452.

DOLD, A.P. and COCKS, M.L. 2002. The trade in medicinal plants in the Eastern Cape Province, South Africa. *South African Journal of Science* **98**: 589-597.

DOVIE, D.B.K., SHACKLETON, C.M. and WITKOWSKI, E.T.F. 2007. Conceptualizing the human use of wild edible herbs for conservation in South Africa communal areas. *Journal of Environmental Management* **84**: 146-156.

DOVIE, D.B.K., WITKOWSKI, E.T.F. and SHACKLETON, C.M. 2008. Knowledge of plant resource use based on location, gender and generation. *Applied Geography* **28**: 311-322.

DUDLEY, N. BALDOCK, D. NASI, R. and STOLTON, S. 2005. Measuring biodiversity and sustainable management in forests and agricultural landscapes. *Philosophical Transactions of the Royal Society B* **360**: 457-470.

DZEREFOS, C.M. and WITKOWSKI, E.T.F. 2001. Density and potential utilization of medicinal grassland plants from the Abe Bailey Nature Reserve, South Africa. *Biodiversity and Conservation* **10**: 1875-1896.

ELLERY, W., BILL, C., MCKENZIE, A., MURPHY, M. and TOOLEY, J. 2000. *Sustainable use of natural hardwood resources in the Thukela Biosphere Reserve.* Department of Geographical and Environmental Sciences, University of Natal, Durban.

EVERARD, D.A., MIDGLEY, J.J. and VAN WYK, G.F. 1995. Dynamics of some forests in Kwa Zulu-Natal, South Africa, based on ordinations and size-class distributions. *Southern African Journal of Botany* **61**: 283-292.

EZEBILO, E.E. and MATTSSON, L. 2010. Contribution of non-timber forest products to livelihoods of communities in southeast Nigeria. *International Journal of Sustainable Development & World Ecology* **17**: 231-235.

FABRICIUS, C. 2002. Conservation and communities: learning from experience. In: PALMER, R., TIMMERMANS, H. and FAY, D. (eds). *From conflict to negotiation: natural-based development on South Africa's wild Coast.* Human Science Research Council, Pretoria. Chap. 11. pp 256-271.

FABRICIUS, C. 2004. The fundamentals of community-based natural resource management. In: FABRICIUS, C., KOCH, E., MAGOME, H. and TURNER, S. (eds). *Rights, resources, and rural development: community-based natural resource management in southern Africa*. Earthscan, London. pp. 3-43.

FAY, D. 1999. Unpublished. Local knowledge of grass and grassland management in Dwesa-Cwebe. Boston University Department of Anthropology.

FAY, D. 2009. Land tenure, land use and land reform at Dwesa-Cwebe, South Africa: Local transformations and limits of the State. *World Development* **37**: 1424-1433.

FIELDING, P., JACOBS, K. and HOLLAND, A. 2006. Reserve state of knowledge report: Silaka Nature Reserve. Eastern Cape Reserve Planning Consortium, Eastern Cape, South Africa.

FRECKLETON, R.P., SILVA MATOS, D.M., BOVI, M.L.A. and WATKINSON, A.R. 2003. Predicting the impacts of harvesting using structured population models: the importance of density-dependence and timing of harvest for a tropical palm tree. *Journal of Applied Ecology* **40**: 846-858.

GELDENHUYS, C.G. 2004a. Meeting the demands for Ocotea bullata bark: implications for the conservation of high-value and medicinal plant species. In: LAWES, M., EELEY, H., SHACKLETON, C.M. and GEACH, B. (eds). *Indigenous Forest and Woodlands in South Africa: Policy, People and Practice*. University of KwaZulu Natal Press, Pietermaritzburg. pp 517-552.

GELDENHUYS, C.G. 2004b. Bark harvesting for traditional medicines: from illegal resource degredation to participatory management. *Scadinavian Journal of Forest Research* **19**: 103-115.

GIBBS, J.P., SNELL, H.L. and CAUSTON, C.E. 1999. Effective monitoring for adaptive wildlife management: Lessons from the Galapagos Islands. *The Journal of Wildlife Management* **63**: 1055-1065.

GREGORY, R. OHLSON, D. and ARVAI, J. 2006. Deconstructing adaptive management: criteria for applications to environmental management. *Ecological Applications* **16**: 2411-2425.

GRUNDY, I.M., CAMPBELL, B.M., BALENEREHO, S., CUNLIFFE, R., TAFANGENYASHA, C., FERGUSSON, R. and PARRY, D. 1993. Availability and use of trees in Mutanda resettlement area, Zimbabwe. *Forest Ecology Management* **56**: 243-266.

GYAN, C.A. and SHACKLETON, C.M. 2005. Abundance and commercialization of Phoenix reclinata in the King Williamstown area, South Africa. *Journal of Tropical Forest Science* **17**: 325-336.

HAVSTAD, K.M. and HERRICK, J.E. 2003. Long-term ecological monitoring. *Arid Land Research and Management* **17**: 389-400.

HEBERLEIN, T.A. 1976. Some observations and alternative mechanisms for public involvement: the hearing, public opinion poll, the workshop and the quasi-experiment. *Natural Resource Journal* **16:** 197 – 212.

HOROWITZ, L.S. 1998. Intergrating indigenous resource management with wildlife conservation: a case study of Batang Ai National Park, Sarawak, Malaysia. *Human Ecology* **26**: 371-402.

KASCHULA, S.A., TWINE, W.E. and SCHOLES, M.C. 2005. Fuelwood species on a South African Common: utilizing scientific and indigenous knowledge in community based natural resource management. *Human Ecology* **33**: 387-418.

KASOLO, W.K. and TEMU, A.B. 2008. Tree species selection for buffer zone agroforestry: the case of Budongo Forest in Uganda. *International Forestry Review* **10**: 52-64.

KEELEY, S.C., KEELEY, J.E., HUTCHINSON, S.M. and JOHNSON, A.W. 1981. Postfire succession of the herbaceous flora in Southern California chaparral. *Ecology* **62**: 1608-1621.

KEIRUNGI, J. and FABRICIUS, C. 2005. Selecting medicinal plants for cultivation at Nqabara on the Eastern Cape Wild Coast, South Africa. *South African Journal of Science* **101**: 497-501.

KEPE, T. 2002. Grassland vegetation and rural livelihoods: a case study of resource value and social dynamics on the Wild Coast, South Africa. PhD thesis, University of the Western Cape.

KEPE, T. 2003. Use, control and value of craft material – *Cyperus textilis*: perspective from a Mpondo village, South Africa. *South African Geographical Journal* **85**: 152-157.

KEPE, T. 2004. Land restitution and biodiversity conservation in South Africa: the case of Mkambati, Eastern Cape Province. *Canadian Journal of African Studies* 38: 688-704.

KEPE, T., COUSINS, B. and TURNER, S. 2000. Resource tenure and power relations in community wildlife contexts: the case of the Mkambati area on the Wild Coast of South Africa. *IIED* 16: 1-26.

KEPE, T. and SCOONES, I. 1999. Creating grasslands: social institutions and environmental change in Mkambati area, South Africa. *Human Ecology* **27**: 29-52.

KEPE, T., WYNBERG, R. and ELLIS, W. 2002. *Reconciling land reform and biodiversity conservation in South Africa: do poor stand a chance?* Programme for Land and Agrarian Studies, University of the Western Cape.

KEPE, T., WYNBERG, R. and ELLIS, W. 2003. *Land reform and biodiversity conservation in South Africa: Complementary or conflict?* Programme for Land and Agrarian Studies, University of the Western Cape.

KILCHLING, P., HANSMANN, R. and SEELAND, K. 2009. Demand for non-timber forest products: Surveys of urban consumers and sellers in Switzerland. *Forest Policy & Economics* **11**: 294-300.

KING, N.L. 1941. The exploitation of indigenous forests in South Africa. *South African Journal of Botany* **48**: 455 – 480.

KIRSTENSEN, M. and BALSLEV, H. 2003. Perceptions, use and availability of woody plants amoung the Gourounsi in Burkina Faso. *Biodiversity Conservation* **12**: 1715-1739.

KOBOKANA, S. 2007. Reconciling poverty reduction and biodiversity conservation: the case of extended public works programme (EPWP) in Hluleka and Mkambati Nature Reserves, South Africa. Programme for Land and Agrarian Studies. MPhil thesis, University of the Western Cape.

KOZIELL, I. and SAUNDERS, J. 2001. *Living of biodiversity: exploring livelihoods and biodiversity*. IIED, London.

LANDE, R., SÆTHER, B. and ENGEN, S. 1997. Threshold harvesting for sustainability of fluctuating resources. *Ecology* **78**: 1341-1350.

LAWES, M.J., OBIRI, J.A.F. and EELEY, H.A.C. 2004. The uses and value of indigenous forest resources. In: LAWES, M.J., EELEY, H.C., SHACKLETON, C.M. and GEACH, B. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice*. University of KwaZulu-Natal Press, Pietermaritzburg. pp 227-276.

LINDENMAYER, D.B. and LIKENS, G.E. 2009. Adaptive monitoring: a new paradigm for long-term research and monitoring. *Trends in Ecology and Evolution* **24**: 482-486.

LINDENMAYER, D.B. and LIKENS, G.E. 2010. *Effective ecological monitoring*. EARTHSCAN, London and Washington DC.

LYKKE, A.M. 1998. Assessment of species composition change in savanna vegetation by means of woody plants' size class distributions and local information. *Biodiversity and Conservation* **7**: 1261-1275.

LYNAM, T., DE JONG, W., SHEIL, D., KUSUMANTO, T. and EVANS, K. 2007. A review of tools for incorporating community knowledge, preferences, and values into decision-making in natural resources management. *Ecology & Society* **12** [online: http//:www.ecologyand society.org/vol12/iss1/art5/]

MAGOME, H. and FABRICIUS, C. 2004. Reconciling biodiversity conservation with rural development: the Holy Grail of CBNRM? In: FABRICIUS, C., KOCH, E., MAGOME, H. and TURNER, S. (eds). *Rights, resources, and rural development: community-based natural resource management in southern Africa*. Earthscan, London. pp. 93-114.

MAKHADO, Z. and KEPE, T. 2006. Crafting a livelihood: local-level trade in mats and baskets in Pondoland, South Africa. *Development South Africa* **23**: 497-509.

MARSH, D.M. and TRENHAM, P.C. 2008. Current trends in plant and animal population monitoring. *Conservation Biology* **22**: 647-655.

MCDONALD, R.I. and BOUCHER, T.M. In press. Global development and the future of the protected area strategy. *Biological Conservation*

MCGARRY, D. 2008. The impact of HIV/AIDS on rural children's reliance on natural resources within the Eastern Cape, South Africa. MSc thesis, Rhodes University, Grahamstown.

MCGARRY, D. and SHACKLETON, C.M. 2009. Children navigating rural poverty: Rural children's use of wild resources to counteract food insecurity in the Eastern Cape, South Africa. *Journal of Children and Poverty* **15**: 19-37.

MIDGLEY, J., SEYDACK, A., REYNELL, D. and MCKELLY, D. 1990. Fine-grain pattern in Southern Cape plateau forests. *Journal of Vegetation Science* **1**: 539-546.

MORENO, C.E. and HALFFTER, G. 2000. Assessing the completeness of bat biodiversity inventories using species accumulation curves. *Journal of Applied Ecology* **37**: 149-158.

MOTINYANE, T.R. 2002. The influence of structure, density and direct use benefits on the harvesting of trees in the rural village of Pikoli, Eastern Cape, South Africa. MSc thesis, Rhodes University.

MUCINE, L. and RUTHERFORD, M.C. 2006. *The vegetation of South Africa, Lesotho and Swaziland.* Strelitzai 19, SANBI, Pretoria.

NIKLAS, K.J. 1994. Plant allometry: the scaling of form and process. University of Chicago Press, Chicago, Illinois, USA.

OBIRI, J.A. 1997. Socio-economic and environmental impacts on the utilisation of the umsimbithi tree Millettia grandis in Eastern Cape: A case sudy of Mt Thesiger Forest Reserve Pondoland. Unpublished MSc. Thesis, University of Natal, Pietermaritzburg.

OBIRI, J., LAWES, M. and MUKOLWE, M. 2002. The dynamics and sustainable use of high-value tree species of the coastal Pondoland forests of the Eastern Cape Province, South Africa. *Forest Ecology and Management* **166**: 131-148.

PALGRAVE, K.C. 1977. *Trees of Southern Africa*. (First edition). Struik, South Africa.

PALMER, R. 2003. From title to entitlement: the struggle continues at Dwesa-Cwebe. Conference, working paper No. 46, Fort Hare Institution of Social and Economic Research.

PALMER, R. and FAY, D. 2002. The residents. In: PALMER, R., TIMMERMANS, H. and FAY, D. (eds). *From conflict to negotiation: natural-based development on South Africa's wild Coast*. Human Science Research Council, Pretoria. Chap. 2, pp 15-29.

PEREIRA, T., SHACKLETON, C.M. and SHACKLETON, S. 2006. Trade in reed-based craft products in rural villages in the Eastern Cape, South Africa. *Development Southern Africa* **223**: 477-495.

POORTER, L., BONGERS, L. and BONGERS, F. 2006. Architecture of 54 moist-forest tree species: traits, trade-offs, and functional groups. *Ecology* **87**: 1289-1301.

PRINSLOO, D.W. 2000. The role of fire in the lifecycle of *Leucadendron pondoense*. Unpublished, University of the Free State.

REID, H. and TURNER, S. 2004. The Richtersveld and Makuleke contractual parks in South Africa: win-win for communities and conservation? In: FABRICIUS, C., KOCH, E., MAGOME, H. and TURNER, S. (eds). *Rights, resources, and rural development: community-based natural resource management in southern Africa*. Earthscan, London. pp. 223-234.

RIBOT, J.C., AGRAWAL, A. and LARSON, A.M. 2006. Recentralisating whilst decentralisating: how national government reappropriates forest resources. *World Development* **34**: 1864-1886.

ROE, D. 2008. The origins and evolution of the conservation poverty debate: a review of key literature, events and policy processes. *Oryx* **42**: 491-503.

ROA, P., BARIK, S.K., PANDEY, H.N. and TRIPATHI, R.S. 1990. Community composition and tree population structure in a sub-tropical broad-leaved forest along a disturbance gradient. *Vegetation* **88**: 151-162.

ROSE, E.F. 1972. Senecio species: toxic plants used as food and medicine in the transkei. *South African Medical Journal* **46**: 1039-1043.

SCHEEPERS, K. 2004. Preference for kraalwood species in Machibi Village, Eastern Cape. In: LAWES, M.E., EELEY, H.C., SHACKLETON, C.M. and GEACH, B. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice*. University of KwaZulu-Natal Press, Pietermaritzburg. pp 341-343.

SHACKLETON, C.M. 1989. An ecological survey of a selected area of Pondoland sourveld with emphasis on its response to the management practices of burning and grazing. MSc thesis, University of the Witwaterstrand.

SHACKLETON, C.M. 1992. Area and species selection by wild ungulates in coastal sour grasslands of Mkambati Game Reserve, Transkei, southern Africa. *African journal of Ecology* **30**: 189-202.

SHACKLETON, C.M. 2001. Managing regrowth of an indigenous savanna tree species (*Terminalia sericea*) for fuelwood: the influence of stump dimensions and post-harvest coppice pruning. *Biomass & Bioenergy* **20**: 261-270.

SHACKLETON, C.M., GRANGER, J.E., MCKENZIE, B. and MENTIS, M.T. 1991. Multivariate analysis of coastal grasslands at Mkambati Game Reserve, north-eastern Pondoland, Transkei. *Bothalia* **21**: 91-107.

SHACKLETON, C.M., GRIFFIN, N.J., BANKS, D.I., MAVRANDONIS, J.M. and SHACKLETON, S.E. 1994. Community structure and species composition along a disturbance gradient in a communally managed South African savanna. *Vegetatio* **115**: 157-167.

SHACKLETON, C.M., GUTHRIE, G. and MAIN, R. 2005. Estimating the potential role of commercial over-harvesting in resource viability: a case study of five useful tree species in South Africa. *Land Degradation & Development* **16**: 273-286.

SHACKLETON, C.M., PARKIN, F., CHAUKE, M.I., DOWNSBOROUGH, L., OLSEN, A., WEIDEMAN, C. and BRILL, G. 2009. Conservation, commercialisation and confusion: harvesting of *Ischreyolepis* in a coastal forest, South Africa. *Environment, Development & Sustainability* **11**: 229-240.

SHACKLETON, C.M. and SHACKLETON S.E. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science* **100**: 658-664.

SHACKLETON, C.M., SHACKLETON, S.E., NTSHUDU, M. and NTZEBEZA, J. 2002. The role and value of savanna non-timber forest products to rural households in the Kat River Valley, South Africa. *Journal of Tropical Forest Products* **8**(1): 45-65.

SHACKLETON, C.M., TIMMERMANS, H.G., NONGWE, N., HAMER, N. and PALMER, R.C.G. 2007. Direst-use value of non-timber forest products from two areas on the Transkei Wild Coast. *Agrekon* **46**: 135-155.

SHACKLETON, S.E. 1989. Autecology of *Cymbopogon validus* (Stapf) Stapf ex Burtt Davy in Mkambati Game Reserve, Transkei. MSc thesis, University of the Witwatersrand, Johannesburg.

SHACKLETON, S.E. 1990. Socio-economic importants of Cymbopogon validus in Mkambati Game Reserve, Transkei. *South African Journal of Botany* **56**: 675-682.

SHACKLETON, S.E. and SHACKLETON, C.M. 1994. Habitat factors influencing the distribution of *Cymbopogon validus* in Mkambati Game Reserve, Transkei. *Afr J Range For Sci* **11**:1-6.

SHACKLETON, S.E. and STEENKAMP, C. 2004. The woodcraft industry in the Mpumalanga-Limpopoprovince lowveld. In: LAWES, M.J., EELEY, H.A.C., SHACKLETON, C.M. and GREACH, B.G.S. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice*. University of KwaZulu Natal press, Pietermaritzburg. pp 399-435.

SHUTE, D.A. and WEST, N.E. 1982. Two basic methodological choices in wildland vegetation inventories: their consequences and implications. *Journal of Applied Ecology* **19**: 249-262.

SIST, P., FIMBEL, R., SHEIL, D., NASI, R. and CHEVALLIER, M. 2003. Towards sustainable management of mixed dipterocarp forests of South-east Asia: moving beyond minimum diameter cutting limits. *Environmental Conservation* **30**: 364-374.

SOLARI, S., RODRIGUEZ, J.J., VIVAR, E. and VELAZCO, P.M. 2002. A framework for assessment and monitoring of small mammals in a lowland tropical forest. *Environmental Monitoring and Assessment* **76**: 89-104.

STATISTICS SOUTH AFRICA. 2000. *Measuring poverty in South Africa*. Statistics South Africa, Pretoria.

STEELE, M.Z. 2008. Natural resource harvesting and disturbance in communal lands: assessing the roles of local ecological knowledge, dependency and market access. MSc thesis, Rhodes University, Grahamstown.

STRUHSAKER, T.T. 1998. A biologist's perspective on the role of sustainable harvest in conservation. *Conservation Biology* **12**: 930-932.

SUKUMAR, R., DATTARAJA, H.S., SURESH, H.S., RADHAKRISHNAN, J., VASUDEY, R., NIRMALA, S. and JOSHI, N.V. 1992. Long-term monitoring of vegetation in a tropical deciduous forest in Mudumalai southern India. *Current Science* **62**: 608-616.

TAYLOR, R.H. 1996. Rush cutting in Natal, South Africa. In: PRESCOTT-ALLEN, R. and PRESCOTT-ALLEN, C. (eds). *Assessing the sustainability and uses of wild species: case studies and initial assessment procedure*. Occasional paper No 2. IUCN Species Survival Commission. IUCN, Gland, Switzerland. pp 52-56.

THAPA, S. and CHAPMAN, D.S. 2010. Impact of resource extraction on forest structure and diversity in Bardia National Park, Nepal. *Forest Ecology and Management* **259**: 641-649.

TICKTIN, T. 2004. The ecological consequence of harvesting non-timber forest products. *Journal of Applied Ecology* **41**: 11-21.

TICKTIN, T. and SHACKLETON, C.M. in press. Harvesting non-timber forest products sustainably: opportunities and challenges. In: SHACKLETON, S.E., SHACKLETON, C.M. and SHANLEY, P. (eds). *Non-timber forest products in the global context*. Springer.

TIMMERMANS, H. 2002. Natural resource use at Dwesa-Cwebe. In: PALMER, R., TIMMERMANS, H. and FAY, D. (eds). *From conflict to negotiation: natural-based development on South Africa's wild Coast*. Human Science Research Council, Pretoria. Chap. 8, pp 173-198.

TIMMERMANS, H.G. 2004. Rural livelihoods at Dwesa/Cwebe: poverty, development and natural resource use on the wild Coast, South Africa. MSc thesis, Rhodes University, Grahamstown.

TIMMERMANS, H. and NAICKER, K. 2002. The land. In: PALMER, R., TIMMERMANS, H. and FAY, D. (eds). *From conflict to negotiation: natural-based development on South Africa's wild Coast*. Human Science Research Council, Pretoria. Chap. 1, pp 2-14.

TRAYNOR, C.H. 2008. *Juncus kraussii* harvesting in Umlalazi Nature Reserve, KwaZulu-Natal, South Africa: socio-economic aspects and sustainability. *African Journal of Aquatic Science* **33**: 27-36.

VEDELD, P., ANGELSEN, A., SJAASTAD, E. and KOBUGABEBERG, G. 2004. *Counting on the environment: forest incomes and the rural poor*. World Bank, Washington DC.

VENTER, F. and VENTER, J. 1996. *Making the most of indigenous trees*. (First edition) Briza Publications, Pretoria, South Africa.

VERMAAK, M. and PECKHAM, B. 1996. Towards integrated natural resource management at Dwesa-Cwebe nature reserve & adjacent communal land: A preliminary survey of the legal history of the reserve, current legislation, & the legal rights & obligations of interested parties. Section One - Commentary. Unpublished report. Rhodes University, Grahamstown.

VIISTEENSAARI, J., JOHANSSON, S., KAARAKKA, V. and LUUKKANEN, O. 2000. Is the alien tree species *Maesopsis eminii* Engl. (Rhamnaceae) a threat to tropical forest conservation in the East Usambaras, Tanzania? *Environmental Conservation* **27**: 76-81.

VODOUHÉ, F.G., COULIBALY, O., ADÉGBIDI, A. and SINSIN, B. 2010. Community perception of biodiversity conservation within protected areas in Benin. *Forest Policy & Economics* **12**: 505-512.

VON BREITENBACH, F. 1976. On a visit to the natural forests of Transkei from 2 September to 30 October 1976 and preliminary recommendations. Unpublished report. Department of Forestry, Pretoria.

WEHMEYER, A.S. and ROSE, E.R. 1983. Important indigenous plants used in the Transkei as food supplements. *Bothalia*, **23**(4): 322-331.

WEST, A.G., MIDGLEY, J.J. and BOND, W.J. 2000. Regeneration failure and the potential importance of human disturbance in a subtropical forest. *Applied Vegetation Science* **3**: 223-232.

WHITE, R.M., EELEY, H.C., COCKS, M., HERBERT, D.G. and HAMER, M.L. 2004. Traditional medicine from forest animals. In: LAWES, M.E., SHACKLETON, C.M. and GEACH, B. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice*. University of KwaZulu-Natal Press, Pietermaritzburg. pp 474-477.

WIEGAND, K., WARD, D., THULKE, H. and JELTSCH, F. 2000. From snapshot information to long-term population dynamics of Acacias by a simulation model. *Plant Ecology* **150**: 97-114.

WILHERE, G.F. 2002. Adaptive management in habitat conservation plans. *Conservation Biology* **16**: 20-29.

WILLIS, C.B. 2004. Policy frameworks pertaining to the conservation and sustainable use of forests and woodlands in South Africa. In: LAWES, M.J., EELEY, H.A., SHACKLETON, C.M. and GEACH, B.G. (eds). *Indigenous forests and woodlands in South Africa: policy, people and practice*. University of Kwazulu-Natal press, Pietermaritzburg. pp. 77-108.

YATES, C.J., NORTON, D.A. and HOBBS, R.J. 2001. Grazing effects on plant cover, soil and microclimate in fragmented woodlands in South-West Australia: implications for restoration. *Austral Ecology* **25**: 36-47.

APPENDICES

Appendix 1: Demographic information of participants at Dwesa-Cwebe community workshop

Age (yrs)	Sex	Education level	Occupation	Position in HH	No. of HH members present	Village	Park
Dwesa							
39	F	G12	Part time teacher (ABET)	Mother	9	Hobeni	Dwesa-Cwebe
57	M	G7	Unemployed	Father	10	Hobeni	Dwesa-Cwebe
56	F	G8	Unemployed	Mother	8	Ngoma	Dwesa-Cwebe
31	F	G12	Unemployed	Daughter	8	Ntubeni	Dwesa-Cwebe
53	F	G8	Traditional healer	Mother	10	Nsimbikazi	Dwesa-Cwebe
67	F	no schooling	Traditional healer	Mother	2	Ngoma	Dwesa-Cwebe
48	M	G9	unemployed	Father	9	Ntlangana	Dwesa-Cwebe
54	F	G12	self employed	Father	6	Ntubeni	Dwesa-Cwebe
57	F	G10	Traditional healer	Mother	5	Hobeni	Dwesa-Cwebe
49	F	none	healer;unemployed;cultivates &livestock	head	1	Ntubeni	Dwesa-Cwebe
69	F	G8	healer;unemployed;own livestoc	wife	7	Entlangano	Dwesa-Cwebe
57	M	G8	unemployed;own livestock	head	6	Ehoboni	Dwesa-Cwebe
62	M	G3	unemployed;own livestock	head	7	Medwane	Dwesa-Cwebe
20	F	G12	unemployed	daughter	3	Medwane	Dwesa-Cwebe
45	M	G9	unemployed;own livestock	head	1	Mpume	Dwesa-Cwebe
60	M	G8	unemployed;own livestock	head	8	Medwane	Dwesa-Cwebe
53	M	G5	unemployed;own livestock	head	6	Medwane	Dwesa-Cwebe
26	F	G12	unemployed	daughter	9	Mpume	Dwesa-Cwebe
32	F	Std 9	Unemployed	Daughter	8	Ntubeni	Dwesa-Cwebe
34	F	Std 8	Unemployed	Daughter	8	Mpume	Dwesa-Cwebe
58	F	Std 2	Traditional healer	Mother	6	Ntlangano	Dwesa-Cwebe
66	F	Std 1	Traditional healer	Head	4	Mpume	Dwesa-Cwebe
79	M	Grade R	Unemployed	Head	30	Hobeni	Dwesa-Cwebe
49	F	Std 9	Unemployed	Mother	14	Ntubeni	Dwesa-Cwebe
40	M	Std 1	Traditional healer	Head	1	Lurhwayizo	Dwesa-Cwebe
58	M	Std 6	Unemployed	Head	8	Ntlangano	Dwesa-Cwebe
26	M	G12	Unemployed	Son	3	Lurhwayizo	Dwesa-Cwebe
32	F	G12	Temp - Dept of Sports, Recreation, Arts and Culture	Mother	5	Nkonjane	Dwesa-Cwebe

Appendix 2: Demographic information of participants at Hluleka community workshop

Age (yrs)	Sex	Education level	Occupation	Position in HH	No. of HH members present	Village	Park
Hluleka							
25	M	G9	Unemployed	Son	3	Xhuthudwele	Hluleka
37	M	G3	Unemployed	Son	7	Lucingweni	Hluleka
26	M	G10	Unemployed	Son	8	Xhuthudwele	Hluleka
58	M	G5	Unemployed	Head	9	Xhuthudwele	Hluleka
24	M	G10	Unemployed	Son	8	Xhuthudwele	Hluleka
42	M	G9	Machine operator	Father	7	Xhuthudwele	Hluleka
42	M	G9	Unemployed	Father	3	Lucingweni	Hluleka
41	M	G8	Unemployed	Father	6	Xhuthudwele	Hluleka
37	F	G12	Housewife	Mother	10	Gangeni	Hluleka
78	M	G5	Pensioner	Granfather	22	Lucingweni	Hluleka
82	M	G4	Pensioner	Granfather	6	Xhuthudwele	Hluleka
22	M	G7	Unemployed	Son	8	Xhuthudwele	Hluleka
41	M	G9	Builder	Father	7	Xhuthudwele	Hluleka
35	M	G9	Unemployed	Son	5	Xhuthudwele	Hluleka
34	F	G11	Unemployed	Mother	3	Xhuthudwele	Hluleka
27	M	G12	Unemployed	Son	13	Xhuthudwele	Hluleka
28	M	G9	Unemployed	Son	4	Gangeni	Hluleka
30	F	G12	NPDE Tertiary educ	daughter	15	Xhulu`dwele	Hluleka
34	F	G8	Comm social worker(looks after childen;forster)	daughter	10	Bucula	Hluleka
26	M	G6	lifesaver	son	7	Xhulu`dwele	Hluleka
29	M	G10	lifesaver	son	25	Lucingweni	Hluleka
28	M	G7	Football Coach	son	10	Xhulu`dwele	Hluleka
64	M	none	pensioner	head	20	Lucingweni	Hluleka
45	M	G12	unemployed;comm dev worker	head	5	Bucula	Hluleka
56	M	none	owns a few livestock	head	9	lucingwenihl	Hluleka
70	M	none	pensioner	head	6	lucingweni	Hluleka
59	M	G7	Cultivates fields	head	11	Bucula	Hluleka
63	M	G7	Bricklayer;cultivation	head	10	Xhulu`dwele	Hluleka
39	M	G12	monitors the sea	son	3	Xhulu`dwele	Hluleka
33	F	G12	bee keeping project	daughter	7	Xhulu`dwele	Hluleka
33	F	G12	housewife	wife	6	lucingweni	hluleka
33	M	G12	Councillor	Son	5	Ntsundwane	Hluleka
43	M	G9	Tour guide	Son	7	Hluleka	Hluleka
59	F	Std 6	Unemployed	Daughter	6	Gangeni	Hluleka
38	F	G12	Unemployed	Daughter	14	Bucula	Hluleka
38	F	G12	Unemployed	Daughter	14	Bucula	Hluleka
81	M	Std 6	Pensioner	Head	20	Xhuthidweli	Hluleka

Appendix 3: Demographic information of participants at Mkambati community workshop

Age (yrs)	Sex	Education level	Occupation	Position in HH	No. of HH members present	Village	Park
Mkambati							
65	M	no schooling	unemployed (pensioner)	Head	6	Tahle	Mkambati
67	M	G8	unemployed (not receiving penison!)	Head	8	Umtshayelo	Mkambati
24	F	G6	herbal trader	Head	8	Khanyayo	Mkambati
23	F	G12	Part time student	Daughter	7	Nqusa	Mkambati
43	M	G4	Herbalist (ixwele)	Head	15	Tahle	Mkambati
70	F	G3	Diviner	Mother	18	Cele	Mkambati
56	F	G11	Unemloyed	Mother	8	Cele	Mkambati
30	F	G9	Unemployed	Mother	14	Khanyayo	Mkambati
39	M	G12	Unemployed	Head	7	Tahle	Mkambati
59	F	G10	Ward council;subsistence farmer-goats & cattle	Head	5	Ngquza	Mkambati
59	F	none	medicinal plant collector & sells; garden & livestock	Head	6	Khanyayo	Mkambati
67	F	G8	Trad healer;garden;livestock	Head	15	Ngquza	Mkambati
65	F	G8	member of trust;got chicken+pigs;got	wife	11	Khanyayo	Mkambati
33	M	G12	builder;lvestock;cultivate& garden	son	15	Cele	Mkambati
42	M	G3	unemployed;no;livestock;no garden;rekies on wifes grant	son	17	Ramzi	Mkambati
56	F	none	member of trust;disability grant	wife	12	Ngquza	Mkambati
68	M	G8	Umployed;trust member;field&garden	Head	9	Cele	Mkambati
40	F	G11	Grows veggies/Member of trust	Daughter	6	Mahumuzeni	Mkambati
55	M	G0	Farmer/maize	Head	8	Khanyayo	Mkambati
20	F	BEd	Student	Daughter	11	Mtshayelo	Mkambati
50	F	G9	Farmer/veggies and maize	Housewife	15	Vlei	Mkambati
73	M	G10	Pensioner/Farmer - at least 50 trees at each homestead. Has 4 wives and 5 homesteads	Head	15	Vlei	Mkambati
36	M	G10	Brick layer	Head	1	Khanyayo	Mkambati
43	M	G11	Field Ranger	Head	7	JB	Mkambati
50	F	G5	Qhira - Traditional Healer	Housewife	9	Khanyayo	Mkambati
45	F	G2	Qhira - Traditional Healer	Head and house wife	11	Cele	Mkambati
56	F	G0	Medicine trader - sells impepho	Head	4	Cele	Mkambati
36	F	Diploma NRM	Nature Conservator	Head	1	N/A	Mkambati

Appendix 4: Demographic information of participants at Silaka community workshop

Age (yrs)	Sex	Education level	Occupation	Position in HH	No. of HH members present	Village	Park
Silaka							
19	M	G9	Unemployed	Son	5	Caguba	Silaka
76	F	G6	Diviner (pensioner)	Mother	12	Caguba	Silaka
25	M	G7	not schooling and unemployed	Son	3	Caguba	Silaka
64	M	G10	self employed crafter	Head	8	Mthumbane	Silaka
34	M	G10	Unemployed	Son	6	Sicambene	Silaka
21	M	G12	Unemployed	Son	7	Caguba	Silaka
24	F	G11	Studying at college	Daughter	7	Sicambene	Silaka
46	F	G12	Diviner	Mother	3	Caguba	Silaka
56	F	G8	Unemployed	Mother	9	Sicambene	Silaka
46	F	no schooling	Diviner	Mother	4	Caguba	Silaka
62	M	G4	Unemployed	Head	8	Isilaka	Silaka
69	M	none	makes baskets to sell; cultivates his garden; has no livestock	Head	7	Sicambeni	Silaka
34	F	G4	Trad healer; cultivates plants ;got goats.unemployed	Head	8	Caguba	Silaka
54	F	G9	cultivates garden;makes baskets;grant for children	Head	12	sicambeniSila	Silaka
60	F	none	healer;cultivate	Head	3	Caguba	Silaka
57	F	G6	employed;cultivates garden;no livestock;no grant	Head	4	Caguba	Silaka
19	M	G9	unemployed;;grants;cultivated;livestock;piece jobs	single	1	Caguba	Silaka
21	M	G9	unemployed;father gets	son	6	Caguba	Silaka
35	M	G11	student intern @reserve	son	12	Cwebeni	Silaka
23	M	G9	unemployed;no grants;cultivating;no livestock	son	2	Sicaneni	Silaka
20	M	G11	Organizer of cultural group	son	5	Caguba	Silaka
69	F	G0	Qhira - Traditional Healer	Head	10	Caguba	Silaka
28	F	G11	Unemployed	Daughter	5	Sicambeni	Silaka
50	F	G12	Qhira - Traditional Healer	Head	8	Caguba	Silaka
18	M	G6	Unemployed	Nephew	6	Caguba	Silaka
22	M	G10	Unemployed	Nephew	3	Caguba	Silaka
44	M	G7	Artisan/woodcraft	Head	2	Mthumbane	Silaka
25	M	G12	Unemployed	Son	4	Sicambeni	Silaka
36	M	G5	Grows veggies for sale	Head	2	Sicambeni	Silaka
57	M	G4	Assistant ranger	Head	10	Sicambeni	Silaka
36	F	G10	Trainee Qhira - Traditional Healer	Daughter	8	Caguba	Silaka
30	M	G12	Tourist guide - self employed	Head	6	Mthumbane	Silaka

Appendix 5: Names of plants generated at community workshops at Dwesa-Cwebe Nature Reserve

Xhosa name	Possible botanical name	Collection Frequency	Importance	Use
Amaqunube	*Rubus sp.*	often collected	Very important	fruit
Amatantyisi	*Coix lacryma-jobi*	commonly collected	very important	necklace for medicine &for teething
Amathungululu	*Carissa macrocarpa*	often collected	very important	fruit
Candathambo	*Allophylus decipiens*	occassionally collected	important	medicine
Cawuze		commonly collected	important	medicine
Chitibunga	*Rhoicissus tomentosa*	commonly collected	very important	medicine
Cholachola	*Helichrysum spp.*	commonly collected	important	medicine
Cimamlilo	*Pentanisia prunelloides*			
Dwabe	*Monanthotaxis caffra*	occasionally collected	Very important	Amasiko
Gwava	*Psidium guajava*			
Gwenye wezinja	*Ekebergia capensis*			
Icokwe	*Cussonia sp.*	often collected	Very important	fruit
Icunube	*Rubus sp.*			
Igcukuma	*Carpobrotus sp.*			
Ihlabangubo	*Bidens pilosa*			
Ikhala	*Aloe ferox*			
Ikhalakhulu	*Aloe ferox*			
Ikhulathi		commonly collected	Very important	medicine
Imbikicane	*Chenopodium murale*	commonly collected	very important	Veggies/imifino
Imfingwane	*Stangeria eriopus*			
Imizi	*Cyperus textilis*	often collected	Very important	mats/craft
Impendulo	*Rubia petiolaris*	commonly collected	Very important	medicine
Imphepho	*Helichrysum odoratissimum*	commonly collected	most important	amasiko/medicine
Imphinda	*Adenia gummifera*			
Inceba	*Hermannia sp.*			
Indevuzomlungu	*Galinsoga parviflora*	commonly collected	Very important	Veggies/imifino
Ingcolo	*Dioscorea dregeana*	Commonly collected	Most important	medicine
Ingcongolo	*Phragmites australis*	occasionally collected	important	amasiko/musical instrument
Inongwe	*Hypoxis sp.*			
Inqawa				
Intangazana	*Zehneria scabra*			
Intelezi	*Gasteria, Haworthia species*			
Intlungunyembe	*Acokanthera oblongifolia*			

Intongwana	*Englerophytum natalensis*			
Intsenge	*Cussonia spicata*			
Intsihlo	*Capparis sepiaria var. citrifolia*			
Intsinde	*Coddia rudis*	occasionally collected	important	building(kraals)
Intunzi	*Mimusops caffra*			
Intwane				
Inxopho	*Juncus effusus*	occasionally collected	important	amasiko
Inzinziniba	*Lippia javanica*	commonly collected	very important	Medicine
Iphuzi	*Gunnera perpensa*	commonly collected	Most important	medicine
Irhashu	*Festuca costata*			
Irwabe	*Sonchus oleraceus*			
Isanama	*Achyranthes aspera*	commonly collected	very important	Veggies/imifino
Isaqoni	*Rhoicissus tridentata*	commonly collected	important	medicine
Ishwadi	*Boophone disticha*			
Isibomvu		occasionally collected	important	medicine/building
Isiduli	*Juncus kraussii*	occasionally collected	important	medicine
Isihlungu	*Commiphora*	Commonly collected	Most important	medicine
Isikholokhotho	*Sansevieria hyacinthoides*	often collected	very important	medicine
Isilawu	*Silene undulata*			
Isilevu	*Merxmuellera disticha*	often collected	Very important	broom
Isindiyandiya	*Bersama sp.*			
Isipingo	*Scutia myrtina*	often collected	very important	fruit
Isisefo	*Faurea saligna*	often collected	important	medicine/furniture
Isithobothi	*Cryptocarya woodii*	occasionally collected	important	building/fuelwood
Isivumbampunzi	*Tulbaghia alliacea*	commonly collected	Most important	medicine
Isixeza	*Buxus natalensis*	occasionally collected	important	fuelwood/building
Isiziba	*Cassipourea gummiflua*			
Iskolopathi	*Dioscorea sylvatica*			
Ithembu	*Watsonia sp.*	often collected	important	Thatching rope
Itswele lenyoka	*Tulbaghia sp.*	commonly collected	Very important	medicine
Izicwe	*Helichrysum pedunculare*	occasionally collected	important	Circumcision
Izungu	*Dalbergia sp.*	commonly collected	important	medicine/ fuelwood
Makhiwane	*Ficus sp.*	often collected	very important	fruit
Mathunga	*Haemanthus albiflos*	commonly collected	Most important	medicine
Matshinitshini	*Plumbago auriculata*	commonly collected	very important	medicine
Matungulu	*Carissa macrocarpa*			

Mavumbuka	*Sarcophyte sanguinea*	commonly collected	Most important	medicine
Mayibophe	*Acridocarpus natalitius*	commonly collected	very important	medicine
Mayime	*Clivia sp.*	commonly collected	Very important	medicine
Mayisake	*Vernonia mespilifolia*	commonly collected	very important	medicine
Mbhongisa	*Diospyros dichrophylla*	often collected	very important	fruit
Mbomvane	*Mystroxylon aethiopicum*	often collected	important	medicine
Mfincamfincane	*Leonotis leonurus*	often collected	important	fruit
Mfingwane	*Stangeria eriopus*	commonly collected	Very important	medicine
Mkhwenkwe	*Pittosporum viridiflorum*	Commonly collected	Most important	medicine
Mlungumabele	*Zanthoxylum capensis*	commonly collected	most important	medicine
Mncwane		Commonly collected	Most important	medicine
Mnebelele	*Heywoodia lucens*	occassinally collected	important	medicine/furniture
Mnono	*Strychnos henningsii*	Commonly collected	Most important	Medicine/building
Mntunzi	*Mimusops caffra*	often collected	important	medicine/fruit
Mpinda	*Adenia gummifera*	commonly collected	very important	medicine
Msimbithi	*Millettia grandis*	occasionally collected	Most important	medicine/building/ craft
Mthimkhulu		commonly collected	very important	Veggies/imifino
Mwelela	*Tulbaghia*	commonly collected	Most important	medicine
Mzane	*Vepris lanceolata*	commonly collected	Most important	medicine/fuelwood
Ngwenye	*Harpephyllum caffrum*	often collected	very important	fruit
Nozitholana	*Silene undulata*	Commonly collected	Most important	Medicine
Ntlolokotshane	*Rhus sp.*	often collected	Very important	fruit
Ntomntwana		commonly collected	Very important	medicine
Phantsikhomnga	*Haplocarpha sp.*			
Phenyane		often collected	important	building/uelwood
Rotala	*Ctenomeria capensis*	often collected	Very important	broom/thatch rope
Shwati	*Boophone disticha*	occasionally collected	important	medicine
Sigcimamlilo	*Pentanisia prunelloides*	commonly collected	Most important	medicine
Sixeza	*Buxus natalensis*	occasionally collected	important	medicine
Skolpathi	*Dioscorea sylvatica*	commonly collected	very important	medicine
Sundu	*Phoenix reclinata*	occasionally collected	important	broom/medicine
Thongothi	*Hyperacanthus amoenus*	occasionally collected	important	building/fuelwood
Tolofiya	*Opuntia ficus-indica*	often collected	Very important	fruit

Tshinitshini	*Plumbago auriculata*			
Tyatyambane	*Premna mooiensis*			
Ubazi	*Laportea peduncularis*	Commonly collected	very important	Veggies/imifino
Ubobo	*Caesalpinia decapetala*	commonly collected	important	fuelwood
Ubushwa	*Arctotis arctotoides*	commonly collected	Most important	medicine
Uduli	*Juncus kraussii*	often collected	Very important	mats
Udwabe	*Monanthotaxis caffra*	occasionally collected	very important	amasiko
Ufudo	*Dioscorea sylvatica*			
Ugangashane	*Ranunculus multifidus*			
Ugcokhwe	*Cussonia sp.*			
Ugonothi	*Flagellaria guineensis*			
Uhlwehlwe	*Duvernoia adhatodoides*	occasionally collected	important	building/fuelwood/ fencing
Ulathile	*Hippobromus pauciflorus*	Commonly collected	Most important	medicine
Umathanga	*Cucurbitaceae*			
Umayika				
Umbande	*Garcinia gerradii*	occasionally collected	important	Medicine/building
Umcawuse				
Umchachambane	*Premna mooiensis*	occasionally collected	important	building/fuelwood
Umdubi	*Combretum caffrum*	occasionaly collected	important	medicine
Umemezi	*Cassipourea gummiflua*			
Umgalagala	*Buxus natalensis*	occasionally collected	important	medicine
Umgqeba	*Brachylaena ilicifolia*	occasionally collected	important	building(kraal & home)
Umgwenyezinja	*Ekebergia capensis*	often collected	important	medicine
Umhlabangulo	*Bidens pilosa*	commonly collected	very important	Veggies/imifino
Umhlakuva	*Ricinus communis*			
Umhlangala	*Euclea sp.*			
Umhlinza	*?Rhamnus prinoides*	often collected	Very important	medicine
Umhlontlo	*Euphorbia sp.*	often collected	very important	medicine
Umhlunguthu	*Commiphora sp.*	often collected	important	medicine/musical instrument
Umjelo	*Rauvolfia caffra*	commonly collected	most important	medicine
Umkwenkwe	*Pittosporum viridiflorum*			
Umlovulovu	*Cordia caffra*	occasionally collected	important	Spanning cattle
Umlungumabele	*Zanthoxylum capensis*			
Umnama	*Strychnos decussata*	occasionally collected	Very important	medicine/veggies
Umnga	*Acacia karroo*	commonly collected	most important	fuelwood
Umnonono	*Strychnos henningsii*			

Umnqabaza	*Grewia occidentalis*	commonly collected	Most important	medicine
Umnqayi	*Mystroxylon aethiopicum*	occasionally collected	very important	medicine
Umnquma	*Olea europaea subsp. africana*			
Umnyamazi		often collected	important	medicine
Umqaphuni				
Umqungu	*Cymbopogon validus*	commonly collected	Most important	medicine
Umsenge	*Cussonia spicata*	often collected	Very important	fruit
Umsimbithi	*Millettia grandis*	commonly collected	most important	building/fuelwood/ medicine
Umsingizane		occasionally collected	important	broom
Umsintsi	*Erythrina caffra*		very important	Medicine
Umsobo	*Solanum nigrum*			
Umsuka				
Umtala	*Miscanthus capensis*	occasionally collected	important	Thatching grass
Umthathi	*Ptaeroxylon obliquum*	Commonly collected	Most important	medicine/fuelwood/amasiko/building
Umthimkhulu				
Umthombe	*Ficus sp.*			
Umthongothi	*Hyperacanthus amoenus*			
Umthwazi	*Rhoicissus spp.*	often collected	important	Circumcision house
Umvili		often collected	very important	fruit
Umvuma	*Solanum sodomaeodes*	occassionally collected	important	medicine
Umvumvu	*Celtis africana*			
Umwelela	*Tulbaghia alliacea*			
Unomadyukrumba		commonly collected	important	medicine
Unomdloboyi	*Amaranthus spp.*	commonly collected	very important	Veggies/imifino
Unongotyozana	*Centella spp.*	Commonly collected	very important	Veggies/imifino
Urhwabe	*Sonchus oleraceus*	commonly collected	very important	Veggies/imifino
Usundu	*Phoenix reclinata*			
Uthongothi	*Hyperacanthus amoenus*	occassionally collected	important	medicine
Utyatyambane	*Premna mooiensis*			
Uvelabahleke	*Lotononis corymbosa*	commonly collected	most important	medicine
Uzikhali	*Haplocarpha scaposa*			
Uzintlwa	*Protorhus longifolius*	Commonly collected	Most important	medicine

Appendix 6: Names of plants generated at community workshops at Hluleka Nature Reserve

Xhosa name	Possible botanical name	Collection Frequency	Importance	Use
Amangcukufa				
Amaqunube	*Rubia sp.*	Occasionally collected	Very important	fruit
Amathungulu	*Carissa macrocarpa*	Occasionally collected	important	fruit
Galagala	*Buxus natalensis*			
Gamtriya	*Eucalyptus sp.*			
Gonothi	*Flagellaria guineensis*	commonly collected	most important	craft
Ibetse				
Ibhontshi	*Salacia leptoclada*	Often collected	important	fruit
Iganandela	*Passiflora sp.*	Occasionally collected	Very important	fruit
Igqwalatshu				
Ihlosi	*Schotia brachypetala*	Often collected	important	fruit
Ikhamanga	*Strelitzia nicolai*			
Ikhiwane	*Ficus sp.*			
Imbuya	*Marrubium vulgare*	commonly collected	important	imifino
Imfihlo	*Capparis sepiaria var. citrifolia*	commonly collected	most important	medicinal
Imfingwana	*Stangeria eriopus*			
Imfinyongo		Occasionally collected	most important	medicinal
Imizi	*Cyperus textilis*	Occasionally collected	Very important	Thatch
Imphepho	*Helichrysum odoratissimum*			
Impinda	*Adenia gummifera*	commonly collected	most important	medicinal
Impontshane	*Nemesia melissifolia*	commonly collected	Very important	medicinal
Ingcongolo	*Phragmites australis*	Occasionally collected	Very important	Thatch
Ingwenye	*Harpephyllum caffrum*	Occasionally collected	Very important	fruit/medicinal
Inkwambazele	*?Dioscorea sp.*	Occasionally collected	important	imifino
Intelezi	*Gasteria sp.*			
Intlolokotshane	*Rhus sp.*	Occasionally collected	important	fruit
Intomntwana				
Intongwane	*Englerophytum natalensis*	Occasionally collected	important	fruit
Intozani	*Dais cotinifolia*	commonly collected	most important	fuelwood
Intshebe bhokhwe	*Gunnera perpensa*	Occasionally collected	important	imifino
Intsinde	*Coddia rudis*	commonly collected	Very important	building
Inxopho	*Juncus effusus*			
Ipaki				

Iqunde	*Themeda triandra*	Occasionally collected	Very important	broom
Isaqoni	*Rhoicissus tridentata*	Occasionally collected	important	fruit
Isihawuhawu	*Stachys aethiopica*	commonly collected	most important	medicinal
Isihlungu	*Commiphora sp.*			
Isihlungu sehlathi	*Teucrium sp.*	commonly collected	Very important	medicinal
Isikhungathi	*Rhus sp.*	commonly collected	most important	building
Isisende	*Hyperacanthus amoenus*			
Isithobothi	*Cryptocarya woodii*	commonly collected	most important	building
Isixeza	*Buxus natalensis*	commonly collected	most important	building
Ithwabe		Occasionally collected	important	Veggies/imifino
Ivongo				
Ivuzi				
Mbambosi	*Bambuseae*			
Ubobo	*Caesalpinia decapetala*	commonly collected	most important	fuelwood
Ububazi	*Laportea peduncularis*	commonly collected	important	Veggies/imifino
Ubuchope benja	*Canthium sp.*			
Ubuchopho	*Canthium ciliatum*	Occasionally collected	important	fruit
Ubuhlwehlwe	*Duvernoia adhatodoides*			
Ubuka	*Secamone gerrardii*	commonly collected	most important	craft/building
Ubuqholo		Occasionally collected	important	fruit
Ubuvimba	*Withania somnifera*			
Ugalagala	*Buxus natalensis*	commonly collected	Very important	building/fuelwood
Ugaqamnyama		Occasionally collected	important	fruit
Ugcamche		Occasionally collected	important	imifino
Ugonothi	*Flagellaria guineensis*	Occasionally collected	most important	Thatch
Uhlolo	*Crotalaria capensis*	commonly collected	most important	building
Uhlwehlwe	*Duvernoia adhatodoides*	commonly collected	Very important	fuelwood
Ukrilityane				
Umbambozenja	*Pristimera bojeri*			
Umbantaka		Occasionally collected	Very important	Thatch
Umbiza		commonly collected	Very important	fuelwood
Umbomvane	*Mystroxylon aethiopicum*			
Umgxam	*Schotia latifolia*	commonly collected	most important	medicinal
Umhlabakufeni	*Croton sylvatica*			
Umhlabangubo	*Bidens pilosa*	Occasionally collected	important	Veggies/imifino
Umhlakela		Occasionally	important	fruit

		collected		
Umhlakothi	*Rhus laevigata*			
Umhlontlo	*Euphorbia sp.*			
Umhlonyane	*Artemisia afra*	commonly collected	most important	medicinal
Umhlunguthi	*Commiphora sp.*			
Um-inki	*Cestrum laevigatum*	commonly collected	Very important	building
Umjelo	*Rauvolfia caffra*	commonly collected	most important	medicinal
Umkhuhlu	*Trichilia emetica*	commonly collected	most important	medicinal
Umlungumabele	*Zanthoxylum capensis*	commonly collected	most important	building
Umnebelele	*Heywoodia lucens*			
Umnga	*Acacia karroo*	commonly collected	most important	fuelwood
Umnonono	*Strychnos heningsii*	commonly collected	most important	building/medicinal
Umnqayi	*Mystroxylon aethiopicum*			
Umnqwani	*Erythrina latissima*	commonly collected	Very important	craft
Umntshica	*Leucosidea sericea*	commonly collected	most important	medicinal
Umntunzi	*Mimusops caffra*	Occasionally collected	Very important	craft/fruit
Umgxama	*Schotia latifolia*			
Umnyamanzi	*Acacia caffra*	commonly collected	most important	craft
Umqaqobi	*Schotia afra*	Occasionally collected		fruit
Umqha				
Umqonga		Often collected	Very important	building
Umqungu	*Cymbopogon validus*	Occasionally collected	most important	Thatch/Medicine
Umqunube	*Rubus sp.*	commonly collected	Very important	medicine/fuelwood/building
Umsimbithi	*Millettia grandis*			
Umsingizani		Occasionally collected	most important	Thatch
Umsobo	*Solanum nigrum*	Occasionally collected	important	imifino
Umsuka		Often collected	important	broom
Umthala	*Miscanthus capensis*	Occasionally collected	Very important	Thatch
Umthathi	*Ptaeroxylon obliquum*	commonly collected	Very important	medicine/fuelwood/building
Umthole	*Acacia caffra*	commonly collected	Very important	craft
Umthombe	*Ficus sp.*	commonly collected	Very important	medicine
Umthongothi	*Hyperacanthus amoenus*			
Umthuma	*Solanum sodomaeodes*			
Umthungwa	*Clutia pulchella*	commonly collected	Very important	building
Umthunzi	*Mimusops caffra*	Occasionally collected	most important	building/rope

Umtyatyambani	*Premna mooiensis*	commonly collected	most important	building
Umvilo	*Pachystigma venosum*	Occasionally collected	important	fruit
Umvuthuza	*Ranunculus multifidus*	commonly collected	most important	medicinal
Umwelela	*Tulbaghia alliacea*	commonly collected	Very important	mediicinal
Umxekisa		Occasionally collected	important	fruit
Umzani	*Vepris lanceolata*	commonly collected	Very important	fuelwood/fruit
Unomaletyani		Occasionally collected	important	imifino
Unomdlomboyi	*Amaranthus spp.*	Occasionally collected	most important	imifino
Unongoboza	*Gunnera perpensa*	commonly collected	important	imifino
Unongomanzi				
Uqanqangazane				
Uqhwaqhwatyu		Occasionally collected	important	imifino
Usundu	*Phoenix reclinata*	commonly collected	Very important	craft/broom
Uthongothi	*Hyperacanthus amoenus*	commonly collected	Very important	building
Utyatyambane	*Premna mooiensis*			
Uvuma		commonly collected	most important	medicinal
Uzithambo				
Uzungu		commonly collected	most important	fuelwood/craft
Imizi	*Cyperus textilis*			
Imphepho	*Helichrysum odoratissimum*			
Umsimbithi	*Millettia grandis*			
Umqungu	*Cymbopogon validus*			
Umnebelele	*Heywoodia lucens*			
Mbambozenja	*Pristimera bojeri*			
	(=Hippocratea schlechteri)			
Isichwe	*Helichrysum pedunculare*			
Umthathi	*Ptaeroxylon obliquum*			
Utyatyambani	*Premna mooiensis*			
Umlungamabele	*Zanthoxylum capensis*			

Appendix 7: Names of plants generated at community workshops at Mkambati Nature Reserve

Xhosa name	Possible botanical name	Collection Frequency	Importance	Use
Abangqonqozi	*Podocarpus spp.*			
Amafutha omhlaba		Commonly collected	Very important	
Gqangendlela	*Plantago major*			
Ibheka	*Scabiosa columbaria*			
Ibhulu	*Nicotiana tabacum*	Commonly collected	Very important	
Iboza	*Tetradenia sp.*	Often collected	Important	
Ichola-chola	*Helichrysum nudifolium*	Occasionally collected	Important	
Icimamlilo	*Pentanisia prunelloides*	Often collected	Very important	
Icubadwane	*Ledebouria cooperi*	Often collected	Important	
Igaligi		Commonly collected	Very important	
Ikhala	*Aloe ferox*			
Ilabatheka	*Hypoxis sp*	Commonly collected	Most important	
Ilabatheka	*Hypoxis rigidula*			
Imalala	*Strychnos decussata*			
Imbolisa	*Mentha aquatica*			
Imfingo	*Stangeria eriopus*			
Impepho	*Helichrysum odoratissimum*	Commonly collected	Most important	Medicinal
Imphepho	*Helichrysum odoratissimum*			
Impinda	*Adenia gummifera*	Commonly collected	Very important	
Impindampinda	*Adenia gummifera*			
Impumelelo				Medicinal
Imqungu	*Cymbopogon validus*			
Inceba	*Hermannia sp.*	Commonly collected	Very important	
Ingcelwani	*Aloe arborescens*	Commonly collected	Most important	
Ingcoco	*Hypoxis sp.*			
Ingcolo	*Dioscorea dregeana*	Occasionally collected	Important	
Ingephu				
Ingobo makhosi	*Hypoxis sp.*			
Inkomba		Occasionally collected	Very important	
Inkqubebe		Commonly collected	Very important	
Inkutshu				
Intelezi	*Gasteria sp.*			
Inthuthe	*Protorhus longifolia*	Commonly collected	Most important	Medicinal
Intlaba		Often collected	Important	
Intlobo tshane	*Rhus sp.*	Commonly collected	Most important	

Intlunguntlungu	*Vernonia mespilifolia*			
Intolwane	*Elephantorrhiza elephantina*			
Intsunkumbini				
Intuma	*Solanum sp.*	Commonly collected	Important	
Inyanzangoma				
Iphazle		Commonly collected	Very important	
Iqwathibana				
Iqwili	*Alepidea sp.*			
Isgatsi		Commonly collected	Very important	
Isindiyandiya	*Bersama sp.*			
Isiqiki somkhovu				
Isiwezi				
Isixhonxo/impundu				
Isixhoxho		Commonly collected	Very important	
Isthethemfazi	*Polygala myrtifolia*			
Isundu	*Phoenix reclinata*			
Itolofiya	*Opuntia ficus-indica*			
Itswele lomlambo	*Tulbaghia sp.*			
Ityholo	*Clematis brachiata*	Often collected	Very important	
Ixhonya	*Kniphofia sp.*			
Izibu				
Jinja	*Siphonochilus aethiopicus*	Commonly collected	Very important	
Lwathile	*Hippobromus pauciflorus*			
Mashwilishwili		Occasionally collected	Important	
Matshiqolo		Commonly collected	Most important	
Mgada nkamu		Often collected	Very important	
Mkhanyakude		Occasionally collected	Important	
Mkhondweni		Occasionally collected	Important	
Mnjoni				
Mthunyelelwa	*Pleurostylia capensis*	Commonly collected	Important	
Ndiyaza	*Bersama sp.*	Commonly collected	Very important	
Nyanzangoma		Often collected	Very important	
Rosalina	*Cinnamomum camphora*			
Ubane	*Plumbago auriculata*			
Ubani	*Agapanthus sp.*			
Ubhotshane	*ehretia rigida*	Commonly collected	Very important	
Uchithibunga	*Rhoicissus spp.*			
Udwabe	*Monanthotaxis caffra*			
Ugobho				
Uloslima	*Cinnamomum camphora*	Commonly collected	Very	

			important	
Umababaza	*Obetia tenax*	Commonly collected	Very important	
Umalilisa		Commonly collected	Very important	
Umathithibala	*Haworthia spp.*			
Umatshiqolo	*Osteospermum imbricatum*			
Umayime	*Clivia sp.*	Commonly collected	Very important	
Umayisake	*Cissampelos capensis*			
Umbezo	*Clutia pulchella*	Occasionally collected	Important	
Umbinda	*Garcinia gerrardii*	Commonly collected	Very important	
Umdlebe	*Linociera foveolata*			
Umhawu-hawu	*Stachys aethiopica*	Often collected	Very important	
Umhlonyane	*Artemisia afra*	Often collected	Very important	
Umkhondweni				
Umkhwenkwe	*Pittosporum viridiflorum*	Commonly collected	Important	
Umlahleni	*Curtisia dentata*	Often collected	Important	
Umlungamabele	*Zanthoxylum capensis*			
Ummemezi	*Cassipourea gummiflua*	Often collected	Very important	
Umnama	*Gymnosporia acuminata*	Often collected	Very important	
Umnga	*Acacia karroo*	Commonly collected	Very important	
Umnonono	*Strychnos henningsii*	Occasionally collected	Very important	
Umnxam	*Schotia latifolia*			
Umphafa	*Ptaeroxylon obliquum*	Often collected	Important	
Umpumeleli	*Macaranga capensis*			
Umqonga	*Clerodendrum glabrum*	Commonly collected	Very important	
Umsa	*Gerbera piloselloides*	Commonly collected	Very important	
Umsilinga	*Melia azedarach*			
Umsintsi	*Erythrina caffra*			
Umsombothi	*Spirostachys africana*			
Umsuzwani	*Lippia javanica*	Often collected	Very important	
Umthathi	*Ptaeroxylon obliquum*			
Umthole	*Acacia caffra*	Commonly collected	Very important	
Umtuma	*Solanum sodomaeodes*			
Umvuthuza	*Ranunculus multifidus*	Often collected	Very important	
Umvuthuza	*Ranunculus multifidus*			
Umwelela	*Tulbaghia aliceae*	Commonly collected	Important	
Umzaneno	*Vepris lanceolata*	Commonly collected	Most important	Medicinal
Unozixhekana		Commonly collected	Very important	

Uphuzi lomlambo	*Gunnera perpensa*	Often collected	Very important	
Uvelebahleke	*Lotononis corymbosa*	Commonly collected	Most important	Medicinal
Velangase moyeni		Occasionally collected	Very important	

Appendix 8: Names of plants generated at community workshops at Silaka Nature Reserve

Xhosa name	Possible botanical name	Collection Frequency	Importance	Use
Amafutha omhlaba	*Callilepis laureola*	Commonly collected	Very important	Medicine
Amagcukumfa	*Carpobrotus sp.*	commonly collected	important	Fruit
Amakhiwane, Ikwane	*Ficus sur*	occassionally collected	important	Fruit
Amalango				
Amaqunube	*Rubus sp.*	occassionally collected	very important	Fruit
Amasowasemlabo	*Rauvolfia sp.*			
Amatungulu	*Carissa bispinosa*	occassionally collected	important	Fruit
Amavilo	*Vangueria infausta*	occassionally collected	important	Fruit/Thatching
Amazulu	*Vernonia sp.*	often collected	most important	Medicine
Bekamina ndendwa				
Chithibunga	*Rhoicissus tomentosa*	Commonly collected	most important	
Dagga	*Cannabis sativa*			
Gamtriya	*Eucalyptus sp.*	commonly collected	very important	Fuelwood
Guava	*Psidium guava*			
Ibhelela	*Heywoodia lucens*	commonly collected	very important	Medicine
Idelanina	*Xysmalobium involucratum*			
Idololenkonyana	*Rumex sp.*	commonly collected	very important	Imifino/Medicine
Iganandela	*Passiflora sp.*	occassionally collected	important	Fruit
Igangatshani	*Ranunculus sp.*	often collected	most important	Medicine
Ikrwabe	*Sonchus oleraceus*	commonly collected	important	Imifino
Ilabatheka	*Hypoxis spp.*	often collected	very important	Medicine
Imbotyisa				
Imbuya	*Amaranthus spp.*	occassionally collected	important	Imifino
Imfihlo (Intsihlo)	*Capparis sepiaria var. citrifolia*	Commonly collected	most important	
Imfingwane	*Stangeria eriopus*			
Imithwani	*Cucurbitaceae*	occassionally collected	very important	Imifino
Imizi	*Cyperus textilis*	occassionally collected	most important	Craft
Imphepho	*Helichrysum odoratissimum*	commonly collected	most important	Medicine
Impinda	*Adenia gummifera*	often collected	very important	Medicine

Impumeleli	*Macaranga capensis*	often collected	most important	Building/Medicine
Imthala	*Miscanthus capensis*			
Indlebezekati	*Helichrysum pedunculatum*	occassionally collected	important	Imifino
Ingcebelezane				
Ingcelwane	*Bulbine latifolia, Bulbine natalensis*	often collected	very important	Medicine
Ingcongolo	*Phragmites australis*	occassionally collected	most important	Thatching
Ingwenya	*Harpephyllum caffrum*	occassionally collected	important	Fruit
Ingximba	*Rhoicissus sp.*	commonly collected	very important	Building
Inikisi		often collected	most important	Medicine
Injunja	*?Silene burchellii*	commonly collected	most important	Medicine
Inkumbazembe	*Scolopia sp.*	occassionally collected	important	Medicine
Intazane	*Dais cotinifolia*			
Intekwane	*Nymphaea nouchali*	often collected	most important	
Intenenende	*Diospyros whyteana*			
Intongwane	*Englerophytum natalensis*			
Intsenge	*Cussonia spicata*	commonly collected	important	Fruit
Intshuku	*?Momordica sp.*	occassionally collected	important	Imifino
Inzande				
Iqundu	*Trichocladus ellipticus*			
Iquzu	*Physalis peruviana*	commonly collected	important	Imifino
Isabetha	*Carissa bispinosa*	commonly collected	most important	Fruit/Medicine
Isibharha	*Warburgia salutaris*	occassionally collected	important	Medicine
Isiduli	*Juncus kraussii*	commonly collected	most important	
Isihlungu sehlathi	*?Teucrium sp.*			Fruit/Medicine
Isikhaba	*?Peltophorum*	occassionally collected	important	Thatching
Isilawusehlathi	*Behnia reticulata*			
Isipheka	*Duvernoia adhatodoides*	often collected	most important	Building/Fencing
Isiphephetho	*Siphonochilus aethiopicus*			
Isiqwatshumbe	*Raphanus raphanistrum*	commonly collected	important	Imifino
Isithombothi	*Spirostachys africana*			
Ispeka				
Isundu	*Phoenix reclinata*			
Ithambo	*Nuxia floribunda*	commonly collected	important	Building/Medicine
Ixonya	*Kniphofia sp.*			
Izakwane	*Coddia rudis*			
Mayime	*Clivia sp.*	often collected	most important	
Mpanyane				
Msimbithi	*Millettia grandis*			
Nomdlombiyi	*Amaranthus spp.*	occassionally collected	very important	Imifino

Ntongwane	*Englerophytum natalensis*			
Okoqo		commonly collected	very important	Fruit
Pantsikwesibaya	*Nicotiana tabacum*			
Roselina	*Cinnamomum camphora*	commonly collected	most important	
Ubomvana	*Mystroxylon aethiopicum*			
Ububazi	*Laportea peduncularis*	often collected	important	Imifino
Ubuchope				
Ubuka	*Secamone gerrardii*	commonly collected	most important	Baskets
Ubulawu	*Behnia reticulata*	commonly collected	most important	Medicine
Ubulawu baselwandle	*Asparagus asparagoides*			
Ubuvumba	*Withania somnifera*	often collected	most important	Medicine
Udelanina	*Xysmalobium involucratum*			
Uduli	*Juncus kraussii*			
Udwabe	*Monanthotaxis caffra*	commonly collected	very important	Baskets
Ugcamehe		commonly collected	important	Imifino
Ugonothi	*Flagellaria guineensis*	commonly collected	very important	Baskets
Ugxitshibana		commonly collected	most important	Baskets
Uhlolo	*Crotalaria capensis*	occassionally collected	very important	Fruit/Baskets
Uhlunguhlungu	*Vernonia mespilifolia*	often collected	important	Medicine
Uhlwehlwe	*Duvernoia adhatodoides*			
Ulwathile	*Hippobromus pauciflorus*	commonly collected	most important	Medicine
Umabele eghongosi	*Eulophia spp.*	often collected	very important	Medicine
Umafumbuka	*Sarcophyte sanguinea*	commonly collected	very important	Medicine
Umagageni				
Umagaqane	*Bowiea volubilis*	commonly collected	most important	Medicine
Umahlabekufeni	*Croton sylvatica*			
Umahlalekufeni	*Croton sylvatica*	occassionally collected	important	Medicine
Umakhiwane	*Ficus sur*			
Umapope	*Plumbago auriculata*			
Umayime	*Clivia sp. probably C. miniata*			
Umbande	*?Greyia sutherlandii*	occassionally collected	important	Building
Umbantanka		occassionally collected	important	Thatching
Umbhabha	*Calodendron capensis*	often collected	very important	Craft
Umbhodlalilonga		commonly collected	most important	Fuelwood/Medicine
Umbomvana	*Mystroxylon aethiopicum*	commonly collected	very important	Building/Medicine
Umbotyi waselwandle	*Entada rheedii*			
Umbunwendodendala	*Combretum sp.*	commonly collected	important	Imifino

Umdlambalala	*Strychnos henningsii*	occassionally collected	most important	Building
Umemezi	*Cassipourea gummiflua*			
Umgwava	*Psidium guajava*	commonly collected	important	Building/Fruit
Umgwenya	*Harpephyllum caffrum*	commonly collected	most important	
Umhlaba (Khala)	*Aloe ferox*			
Umhlakelo	*Trichilia dregeana*			
Umhlakoti	*Rhus chirindensis*	commonly collected	very important	Building/Medicine
Umhlolokotshane	*Rhus sp.*	often collected	most important	Fruit
Umhlonyani	*Artemisia afra*	commonly collected	most important	Medicine
Umhlunguthi	*Commiphora sp.*	commonly collected	very important	Carving
Umhlwehlwe	*Duvernoia adhatodoides*			
Um-Inki	*Cestrum laevigatum*	commonly collected	important	Building/Fuelwood
Umkhomakhoma		often collected	very important	Medicine
Umkhuhlu	*Trichilia sp.*	commonly collected	very important	
Umlahleni	*Curtisia dentata*			
Umlomomnandi	*Anthospermum rigidum*			
Umlovulovu	*Cordia caffra*	occassionally collected	very important	Building
Umlungumabele	*Zanthoxylum capensis*	commonly collected	very important	Building/Medicine
Umnebelele	*Heywoodia lucens*	occassionally collected	very important	Building/Medicine
Umnga	*Acacia karroo*	commonly collected	most important	Fuelwood
Umngampunzi	*Acacia sp.*	commonly collected	very important	Fuelwood
Umngcele	*Hyparrhenia hirta*			
Umnonono	*Strychnos henningsii*	commonly collected	very important	Building/Medicine
Umnqawe	*Acacia sp.*	commonly collected	important	Fuelwood/Medicine
Umnqayi	*Mystroxylon aethiopicum*			
Umntunzi	*Mimusops caffra*	occassionally collected	important	Fruit
Umnxamu	*Rauvolfia caffra*			
Umphonyane/ Isixeza	*Buxus natalensis*	commonly collected	very important	Building/Medicine
Umpihlo	*Capparis sepiaria subsp. citrifolia*			
Umpumeleli	*Macaranga capensis*			
Umqaqoba	*Gymnosporia heterophylla*	commonly collected	important	
Umqokolo	*Dovyalis caffra*			
Umqonga	*Clerodendrum glabrum*			Building/Medicine
Umqungu	*Cymbopogon validus*	occassionally collected	most important	Thatching
Umsika		occassionally collected	important	Thatching
Umsilawenkosi		occassionally collected	important	Medicine
Umsilinga	*Melia azedarach*	often collected	most important	Medicine

Umsimbithi	*Millettia grandis*	commonly collected	most important	Building/Medicine
Umsingizane	*Sporobolus africanus*	occassionally collected	important	Thatching
Umsintsi	*Erythrina caffra*	often collected	most important	Medicine
Umsuzwani	*Lippia javanica*	commonly collected	very important	Medicine
Umtenenende	*Cola natalensis*	occassionally collected	most important	Building
Umthala	*Miscanthus capensis*	occassionally collected	very important	Thatching
Umthathi	*Ptaeroxylon obliquum*	commonly collected	most important	building/Fuelwood
Umthongwane	*Cryptocarya woodii*	occassionally collected	very important	Building
Umthwazo	*Rhoicissus digitata*			
Umvuthuza	*Ranunculus multifidus*			
Umwelela	*Tulbaghia alliacea*	commonly collected	most important	Medicine
Umzane	*Vepris lanceolata*	occassionally collected	very important	Building
Unomaletyane		occassionally collected	important	Imifino
Unomaweni	*Aloe arborescens*	commonly collected	very important	Medicine
Unongobozana		often collected	important	Imifino
Uphuncuka	*Talinum caffrum*	commonly collected	most important	Medicine
Uqaleqola		occassionally collected	most important	Building
Uqangazani		commonly collected	most important	Fuelwood/Medicine
Uqhudalele		commonly collected	important	Imifino
Uqibeleweni	*Croton sylvaticus*	commonly collected	most important	Medicine
Uqunube	*Rubus sp.*			
Uqwangu	*Nicandra physalodes*	commonly collected	important	Imifino
Uqwaqwaqwa	*Nicandra physalodes*	often collected	important	Imifino
Usapheka	*Duvernoia adhatodoides*			
Usitshana	*Calodendrum capensis*	occassionally collected	important	Building
Utyatyambane	*Premna mooiensis*			
Uvalamazibuko		commonly collected	most important	Medicine
Uvelabahleke	*Lotononis corymbosa*	commonly collected	most important	Medicine
Uvelemampondweni		commonly collected	important	Imifino
Uxhishibane				
Uzeneke	*Haemanthus albiflos*			
Uzisukazandila-ndela		often collected	very important	Medicine
Uzungu	*Dalbergia sp.*	commonly collected	very important	Fuelwood/Baskets

Appendix 9: List of species used by local communities and their uses as cited in the literature review

Latin Name	Use	Citation	Reserve/Region			
			Mkambati	Dwesa	Silaka	Hluleka
Acacia cafra	Medicinal	Kepe 2002	X			
Acacia karoo	Medicinal, fuelwood	Kepe 2002, Palmer et al. 2002, Kepe 2003	X	X	X	
Acokanthera oblongifolia	Medicinal	Kepe 2002	X			
Agathosma ovata	Medicinal	Kepe 2002	X			
Aloe maculata	Medicinal	Kepe 2002	X			
Amaranthus hybridus	Imifino	Kepe 2002	X			
Amaranthus paniculutus	Imifino	Kepe 2002	X			
Apodytes dimidiata	Handicrafts	Palmer *et al*. 2002		X	X	
Aristida junciformis	Thatch, brooms	Kepe *et al*. 2000, Cousins & Kepe 2002, Kepe 2002, Kepe 2003	X			
Artemisia afra	Medicinal: Treats common colds	Kepe 2002	X			
Asclepias albens	Medicinal	Kepe 2002	X			
Aster bakeranus	Medicinal	Kepe 2002	X			
Becium obovatum	Medicinal	Kepe 2002	X			
Bersma lucens	Medicinal	Kepe 2002	X			
Bidens pilosa	Imifino	Kepe 2002	X			
Boophne disticha	Medicinal	Kepe 2002	X			
Braechaleana uniflora	Medicinal	Kepe 2002	X			
Bulbine natalensis	Medicinal	Kepe 2002	X			
Burchellia bubalina	Medicinal	Kepe 2002	X			
Buxus macowanii	Handicrafts, fuelwood	Palmer *et al*. 2002		X	X	
Buxus natalensis	Fuelwood	Palmer *et al*. 2002		X	X	
Callilepis laureola	Medicinal	Kepe 2002	X			
Canthium spinosa	Medicinal	Kepe 2002	X			
Cassipourea gerrardii	Medicinal	Kepe 2002	X			
Centella asiatica	Medicinal	Kepe 2002	X			
Centella sp.	Imifino	Kepe 2002	X			
Cercopithecus aethiops	Bushmeat	Shackleton *et al*. 2007		X		
Chenopodium album	Imifino	Kepe 2002	X			
Clerodendrum glabrum	Handicrafts	Palmer *et al*. 2002		X	X	
Clivia miniata	Medicinal	Kepe 2002	X			
Coccinea sp.	Imifino	Kepe 2002	X			
Combretum erythrophyllum	Medicinal	Kepe 2002	X			
Combretum krausii	Handicrafts	Palmer *et al*. 2002		X	X	
Conyza floribunda	Imifino	Kepe 2002	X			
Conyza scabrida	Medicinal	Kepe 2002	X			
Crotalaria globifera	Medicinal	Kepe 2002	X			
Croton sylvatica	Medicinal	Kepe 2002	X			
Cusonia spicata	Medicinal	Kepe 2002	X			

Cyanotis speciosa	Medicinal	Kepe 2002	X			
Cymbopogon excavatus	Thatch, rope	Fay 1999, Palmer *et al*. 2002		X		
Cymbopogon validus	Thatch, rope	Shackleton 1989, Fay 1999, Palmer *et al*. 2002	X	X		
Cyperus latifolius	Thatch	Kepe 2002	X			
Cyperus pulcher	Rituals	Fay 1999		X		
Cyperus textilis	Weaving, sitting mats, food mats and collecting baskets	Fay 1999, Palmer et al. 2002, Kepe 2002, Kepe 2003	X	X		
Dietes butcheriana	Medicinal	Kepe 2002	X			
Digitaria eriantha	Thatch, rope, bangles and floor mats	Kepe *et al*. 2000, Cousins & Kepe 2002, Kepe 2002, Kepe 2003	X			
Diospyros villosa	Medicinal	Kepe 2002	X			
Dracaena arletirformis	Medicinal	Kepe 2002	X			
Eriosema dregei	Medicinal	Kepe 2002	X			
Eriosema kraussianum	Medicinal	Kepe 2002	X			
Eriosemopsis subanisophylla	Medicinal	Kepe 2002	X			
Erythrina caffra	Medicinal	Kepe 2002	X		X	
Eucalptus spp.	Fuelwood, poles	Palmer *et al*. 2002		X		
Euclea natalensis	Medicinal	Kepe 2002	X			
Eucomis autumnalis	Medicinal	Kepe 2002	X			
Ficus ingens	Medicinal	Kepe 2002	X			
Ficus sur	Medicinal	Kepe 2002	X		X	
Flagellaria guineensis	Weaving	Cawe & Ntloko 1997			X	
Gerbera piloselloides	Medicinal	Kepe 2002	X			
Gnidia krassiana	Medicinal	Kepe 2002	X			
Gunnera perpensa	Medicinal: Used in childbirth and treatment of wounds	Kepe 2002	X			
Harpephyllum caffrum	Medicinal, edible wild plant	Kepe 2002, Shackleton et al. 2007	X	X	X	
Helichrysum natalium	Medicinal	Kepe 2002	X			
Helichrysum odoratissimum	Medicinal	Kepe 2002	X			
Helinus intearifolius	Medicinal	Kepe 2002	X			
Heywoodia lucens	Handicrafts	Palmer *et al*. 2002		X	X	
Hippobromus pauciflora	Medicinal	Kepe 2002	X			
Hyperacanthus amoenus	Medicinal	Kepe 2002	X			
Hyperrinia hirta	Thatch	Kepe *et al*. 2000, Cousins & Kepe 2002, Kepe 2002	X			
Hypoxis colchicifolia	Medicinal	Kepe 2002	X			
Hypoxis rigidula	Medicinal	Kepe 2002	X			
Juncus krausii	Weaving	Fay 1999, Palmer *et al*. 2002		X		
Kniphofia spp.	Medicinal	Kepe 2002	X			

Knowltonia vesicatora	Medicinal: Treats common colds and toothache	Kepe 2002	X			
Lobelia erinus	Medicinal	Kepe 2002	X			
Loxostylis alata	Medicinal	Kepe 2002	X			
Maesa lanceolata	Medicinal	Kepe 2002	X			
Millettia grandis	Handicrafts	Palmer *et al*. 2002		X	X	
Mimosops obovata	Medicinal	Kepe 2002	X			
Mimusops caffra	Handicrafts	Palmer *et al*. 2002		X		
Miscanthus capensis	Thatch	Fay 1999, Kepe *et al*. 2000, Cousins & Kepe 2002, Kepe 2002, Palmer et al. 2002	X	X		
Miscanthus junceus	Thatch	Kepe 2002	X			
Morella pilulifera	Medicinal	Kepe 2002	X			
Ochna natalitia	Handicrafts	Palmer *et al*. 2002		X		
Peddiea africana	Imifino	Kepe 2002	X			
Pentanisia prunelloides	Medicinal	Kepe 2002	X			
Petopentia natalensis	Medicinal	Kepe 2002	X			
Phragmites mauritianus	Thatch	Kepe 2002	X			
Potamochoerus pocus	Bushmeat	Shackleton *et al*. 2007		X		
Ptaeroxylon obliquum	Medicinal, poles	Kepe 2002, Palmer et al. 2002	X	X	X	
Pycnostachys reticulata	Medicinal	Kepe 2002	X			
Ranuncuslus multifidus	Medicinal	Kepe 2002	X			
Rapanea melanophloeos	Medicinal	Kepe 2002	X			
Raphionacme hirsutum	Medicinal	Kepe 2002	X			
Rhispalis baccifera	Medicinal	Kepe 2002	X			
Rhoicussus tomentoso	Medicinal	Kepe 2002	X		X	
Rhothmania globosa	Medicinal	Kepe 2002	X			
Rhus guenzii	Medicinal	Kepe 2002	X		X	
Rhus rehmanniana	Medicinal	Kepe 2002	X			
Rubus immixtus	Medicinal	Kepe 2002	X			
Rubus rigidus	Edible wild plant	Shackleton *et al*. 2007		X		
Rumex dregeanus	Medicinal	Kepe 2002	X			
Scabiosa columbaria	Medicinal	Kepe 2002	X			
Schotia afra	Medicinal	Kepe 2002	X			
Scilla nervosa	Medicinal	Kepe 2002	X			
Scuria sp.	Imifino	Kepe 2002	X			
Scutia myrtina	Edible wild plant	Shackleton *et al*. 2007		X	X	
Senecio madagascariensis	Imifino	Kepe 2002	X			
Senecio rhyncholaenus	Medicinal	Kepe 2002	X			
Sida rhombifolia	Imifino	Kepe 2002	X			
Solanum nigrum	Imifino	Kepe 2002	X			
Solanum retroflexum	Imifino	Kepe 2002	X			
Solanum supinum	Medicinal	Kepe 2002	X			
Sporobolus fimbriatus	Thatch, rope	Fay 1999, Palmer *et al*. 2002		X		

Sporobulus africanus	Thatch, rope	Fay 1999, Kepe 2002	X	X		
Stachys nigricans	Medicinal	Kepe 2002	X			
Strangeria eriopus	Medicinal	Kepe 2002	X			
Strychnos decussate	Handicrafts	Palmer *et al*. 2002		X		
Strychnotis henningsii	Medicinal	Kepe 2002	X			
Sylvicapra grimmia	Bushmeat	Shackleton *et al*. 2007		X		
Syzygium cordatum	Medicinal	Kepe 2002	X			
Thesium acutissium	Medicinal	Kepe 2002	X			
Tragelaphus scriptus	Bushmeat	Shackleton *et al*. 2007		X		
Tragia meyeriana	Medicinal	Kepe 2002	X			
Typha capensis	pillows	Kepe 2002, Kepe 2003	X			
Typhae latifolia	Rope	Fay 1999		X		
Urtica urens	Imifino	Kepe 2002	X			
Vepris lanceolata	Medicinal, handicraft	Kepe 2002, Palmer et al. 2002	X	X	X	
Watsonia pillansii	Medicinal	Kepe 2002	X			
Xymalos monospora	Poles	Palmer *et al*. 2002		X	X	
Zantedeschra aethiopia	Medicinal	Kepe 2002	X			
Zanthoxylum capensis	Handicrafts	Palmer *et al*. 2002		X	X	
Zanthoxylum davyii	Handicrafts	Palmer *et al*. 2002		X	X	
Ziziphus mucronata	Medicinal	Kepe 2002	X		X	