CHAPTER 8

SYNTHESIS AND MANAGEMENT RECOMMENDATIONS

Abstract

The study on sustainability of some of the indigenous medicinal plant species traded in Venda region, Limpopo province of South Africa came about as a way of assessing bark harvesting impact on indigenous medicinal plants in Venda. Approx 31% of all woody species in the Venda region have been reported to have medicinal properties in their bark and many of these are traded in the muthi markets. Vulnerability scoring also revealed that there are a number of factors that renders a species vulnerable or resilient and was used to identify those species which are most threatened.

Studies on the impact of bark harvesting for medicinal purposes on *Elaeodendron transvaalense* and *Brackenridgea zanguebarica* revealed a high degree of overexploitation. Although their populations looked healthy it was clear to note that there are size classes that need to be protected in order for the populations to remain viable into the future.

Conservation efforts from all levels are highly welcomed since they are contributing in their own ways towards conservation of indigenous medicinal plants. It is therefore clear that an integrated approach of taking best conservation practices from western as well as indigenous systems can be the way to go. Formation of a Participatory Natural Resource Management Associations in areas where natural resources are being threatened by unsustainable harvesting practice can help in bringing together interested stakeholders into the mainstream of protecting such resources. Such associations should be governed by natural resource harvesting policy with clear objectives around documentation, monitoring and evaluation of harvesting. The policy should cover ecological, social, as well as economical concerns.

Key words: Harvesting impact, integrated management, sustainable harvesting

8.1 Introduction

The concepts of sustainability and sustainable development have come to the forefront of many ecological as well as political debates over the last few decades (Goodland 1995). Sustainable development has become a widely accepted concept, although it used to be regarded as a poorly defined one (Dernbach 2001; Kennedy 2001). Yet, achieving sustainability still remains a problem. Sustainable utilization of resources should be seen as a cornerstone of conservation instead of being seen merely as a way of alleviating pressure on our natural resources. For conventional conservation to be efficient, reserve networks including large ecological reserves work best. However, establishing protected areas is associated with many conflicting issues because of the incompatibility of land uses as a result of the high human population growth rate (Nantel *et al.* 1998, West and Brockington 2006, Gaugris and Van Rooyen 2010). It is therefore obvious that much, if not the majority of conservation efforts, have to be devoted to non-conserved areas (Smith *et al.* 2006). Regarding the latter it is especially important to retain landscape heterogeneity and to preserve a variety of natural habitats under anthropogenic disturbance regimes, but also to improve resource use and control resource extraction (Lindenmayer *et al.* 2006; Naughton-Treves *et al.* 2007).

The exploitation of *Elaeodendron transvaalense* and *Brackenridgea zanguebarica* for medicinal purposes is currently very high in the Venda region. Despite the reasonable number of seedlings that are established in both species, the destruction rate of large trees is a point of concern. For both species bark harvesting for medicinal purpose is the major contributor to the loss of mature individuals. In the case of *E. transvaalense*

it is also used for firewood but this only occurs when it is dry. In the case of *B. zanguebarica* it is not used for anything else due to taboos associated with it (Netshia pers. comm.[12]). However, the taboos associated with it encourage men to use poles of the species for fencing so that women could not attempt to use the fence as firewood.

8.2 Discussion

8.2.1 Sustainable harvesting and conservation

The idea that conservation and sustainable use are linked together is now widely accepted as is the belief of the inextricable link that exists between our survival and that of other species around us (Salafsky *et al.* 2002, Heywood and Iriondo 2003). The World Conservation Strategy defines conservation as the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and the aspirations of the future generation (IUCN/UNEP/WWF 1980). It is also acknowledged that human harvesting of natural resources is not the sole cause of extinctions. There are other major unintended and irreversible ecological consequences of human activities that may lead to species extinction, through biodiversity loss such as by habitat loss or as a result of global climate change (Fisher and Krutilla 1974, Johannes 2002, Brooks *et al.* 2002, Antoci *et al.* 2005).

The large amount of bark harvesting for medicinal purposes in Venda region as revealed in Chapter 4 is cause for concern. Of the 498 woody plant species listed for

[12] NETSHIA, L. 1998. Traditional healer. Thohoyandou, Limpopo province.

the Venda region 30.7% (n = 158 plant species) have been reported to have medicinal properties in their bark. However, only 11.7% (n = 58) of these species are actively traded for their bark in muthi shops around Venda. From the 58 species used for their bark only five species appeared on the list of species most commonly traded in Venda region (Tshisikhawe 2002).

The first step in determining the potential of sustainable bark harvesting of the species of Venda was therefore to assess each species by means of a vulnerability score so that measures can be taken to improve the protection and monitoring of the most vulnerable species by trying to reduce human induced biodiversity threats (Gauthier *et al.* 2010). What is consoling is to realize that 81% of the 58 medicinal plants harvested for their bark were not threatened since they showed high resilience score of above 15. However, 19% of the 58 medicinal plant species harvested for their bark were considered to be species at risk and it is this group of species that requires urgent inclusion into management protection plans.

Some of the problems of bark harvesting for medicinal purposes can be addressed by simply following the correct procedures of harvesting as well as by adhering to the myths associated with medicinal bark collection wherein traditional healers believe that killing the plant may result in patients not getting healed (Netshia pers. comm[13]. and Ramaliba pers. comm[14].). Promoting adherence to these myths amongst those who believe in them can go a long way in protecting biodiversity. Adherence to myths and taboos is also important to consider when proposing harvesting strategies because the use of bark for medicinal purposes is embedded in the mindsets of rural traditional

[13] NETSHIA, L. 1998. Traditional healer. Thohoyandou, Limpopo province.
[14]RAMALIBA, T.Z. 2007. Traditional healer.Thohoyandou, Limpopo province.

healers and they may not use leaves which are harvested in a less destructive way even when proved to have the same compounds when compared to barks (Zschocke *et al.* 2000a and b, Drewes *et al*. 2001, Geldenhuys 2004a).

Analyzing the population size class distribution of *Elaeodendron transvaalense* and *Brackenridgea zanguebarica* gave an insight on their status. In spite of the problems of inferring population dynamics from once off surveys (Condit *et al*. 1998, Boudreau *et al.* 2005)these surveys revealed size classes that needed careful attention and which are important in maintaining healthy populations (Chapters 5 and 6). This method of analyzing the population structure by a size class analysis if repeated after some years, as was the case with *Brackenridgea zanguebarica,* can help in understanding the dynamics of the population and checking whether significant differences between the size class regression curves could be detected through an analysis of covariance (Chapter 6).

The size class distribution analysis revealed some important features of the population structure of the species. It is important to have accurate counts of small individuals when the size class distribution of a species is investigated, because these individuals need to ensure the survival of the species. Both species investigated in the current study showed the ability to resprout from a lignotuber. In the current study resprouts were generally classified as seedlings since it could only be established that they were resprouts after digging up the lignotuber. The classification of resprouts as seedlings could give a false impression of the success of regeneration by seeds. It is however also important to consider small individuals whenever estimates on plant biodiversity are carried out. It has been found that such biodiversity estimates can seriously be

jeopardized whenever surveys tend to neglect very small individuals such as the case in surveys of forested communities (Niklas *et al*. 2003).

There are some mechanisms whereby species can show a degree of resilience towards bark harvesting. The ability to coppice or resprout is regarded as one method to afford some resilience against bark harvesting (Botha *et al.* 2004, Geldenhuys 2004a). Another mechanism of resilience towards bark harvesting is the ability of the species to regrow its bark (Cunningham and Mbenkum 1993, Cunningham 1993, Delvaux *et al.* 2009). This ability has been shown to be species-specific (Fasola and Egunyomi 2005, Vermeulen 2006, Geldenhuys *et al.* 2007, Delvaux *et al.* 2009). Both *Elaeodendron transvaalense* and *Brackenridgea zanguebarica* show the ability to regrow their bark after being harvested. Bark regeneration is therefore very important for the survival of matured individuals within the population. There are a number of factors affecting the degree of bark regeneration. The intensity of the harvest seems to have a negative impact on the bark's regrowth potential. A relationship has also been demonstrated between tree size and bark regrowth, with larger trees more resilient to bark harvesting (Vermeulen and Geldenhuys 2004). Furthermore, the degree of bark regrowth depends on the harvesting technique (Delvaux *et al.* 2009). Removing a narrow strip of bark may improve the chances of healing the wound.

In spite of these mechanisms to improve the resilience of the species to bark harvesting, they do not guarantee sustainability of harvesting. As soon as the harvesting intensity exceeds the resilience capacity of the species it will be vulnerable to overharvesting. This has been demonstrated for *Prunus africana,* which has the ability to regrow its bark; however populations are declining due to commercial

harvesting of this species in Cameroon (Cunningham and Mbenkum 1993, Stewart 2009).

The size class distribution analysis was complemented by a matrix analysis in the case of *Elaeodendron transvaalense.* Using matrix modelling as conducted with *E. transvaalense* population can help in making projections into the future, but even more important the elasticity analysis could indicate the most vulnerable stage in the life cycle. However, more sophisticated matrix modeling, such as incorporating density-dependence, generally needs vast amounts of data and many years of repeated data sampling (Pfab and Scholes 2004). In this project the matrix was derived from data collected in two years and with the assumption that all the plants will reach flowering stage since there was no information on mortality. Although matrix analysis is a rigorous method it may be too time consuming if employed in the evaluation of all species subjected to bark harvesting in Venda, since it requires a lot of data and more time. However, matrix modelling should in future be used in evaluating those species that were found to be most at risk after evaluating their vulnerability (Chapter 4).

For a species such as *Brackenridgea zanguebarica* with a restricted distribution and specific habitat requirements, it is important to protect it *in situ* since its distribution is influenced by the surrounding environmental conditions. To ensure the species' survival it is essential to protect a viable population. The Burgman method (Burgman *et al.* 2001, Gaugris and Van Rooyen, 2010) used in the evaluation of *B. zanguebarica* and its reserve requirement proved to be a good method although it depends largely on the expert's knowledge when making the assessment (Chapter 7). However, after

evaluating the population with the Burgman *et al.* (2001) method and establishing the reserve adequacy of the Brackenridgea Nature Reserve it will still require protection efforts that are inclusive of all stakeholders. Including all the stakeholders in the management of this species is imperative, because some of the recommendations to protect *B. zanguebarica* will require community members to reduce some of their activities. The Burgman method (Burgman *et al.* 2001) is a valuable tool to set the size of target plant conservation areas only if the expert making the assessment has a good knowledge of the species and its requirements. However, because the method is time consuming it can only be used for evaluating special cases.

For sustainability to be achieved local resources should be controlled by local people. As is the case in Mafungabusi State Forest of Zimbabwe, involving local residents in management and control of protected areas has proved successful (Vermeulen 1996). The approach of co-management with tribal authorities of the woodland vegetation in which *Brackenridgea zanguebarica* is found is promoted as was suggested by officials from Water Affairs and Forestry Department (Saidi and Tshipala-Ramatshimbila 2006). This approach is appealing and extremely relevant since natural ecosystems are often closely associated with the history of human societies. The role of human communities should therefore be recognized because the future of ecosystems and human activities are closely intertwined (Thompson *et al.* 2011).

8.2.2 Indigenous conservation techniques

Indigenous conservation techniques are informed by indigenous knowledge, which is defined as accumulated knowledge, skill and technology of local people. It is derived

from their direct interaction with the environment (Verlinden and Dayot 2005). Indigenous medicinal plants have always been harvested for medicinal purposes by traditional healers with reverence. The respect shown by these traditional healers through indigenous techniques has made it possible for many plant species to survive all these years of exploitation. Taboos, myths, beliefs and rituals are generally used in the protection of indigenous medicinal plants in the Venda region. This is generally practiced during the collection of all medicinal plant material by the traditional healers (Tshisikhawe 2005). As an example it should be noted that if traditional healers believe that a plant from which medicinal material is harvested should not be killed as a result of harvesting impact, since it may cause the medicinal material to be ineffective, then it means that they will always exercise extreme caution when harvesting such material. Whether the myth is true or not, adhering to it will always promote protection of the species concerned.

It is generally regarded as a taboo by traditional healers to ring-bark a medicinal plant, during collection of medicinal material. This taboo also applies to *Elaeodendron transvaalense* and *Brackenridgea zanguebarica*. This is due to the fact that if such a plant dies it is believed that the medicine may also become ineffective and even kill the patient instead of healing (Mabogo 1990). According to tradition, medicinal material from the stem may only be collected from opposite sides. Collection from the north facing side is accompanied by collection from the opposite southern side of the stem. If collection is done on the eastern side the same removal is done on the western side. Such a type of collection technique is further promoted by the belief held by traditional healers that winds which blow from different directions carry healing powers (Mabogo 1990). During collection of roots only lateral roots may be

removed and the place from which they are removed should be covered again for the plant to be able to recover (Mabogo 1990, Tshisikhawe 2002).

Collection of medicinal material from *Brackenridgea zanguebarica* has always been accompanied by the performance of rituals (Netshiungani and Van Wyk 1980, Mabogo 1990, Netshia 1998 pers. comm.[15]). There is a dedicated person from the Vhatavhatsindi clan who is responsible for the collection of medicinal material from the plant since there is a belief amongst the Vhatavhatsindi people that the plant is a gift to them by their ancestors. Before collection they talk to the plant so that it knows that they have visited it and the fact that they would like to collect medicinal material from it in order to help the nation. If they need roots they also ask it to make their job easy by not hiding the roots from them (Ramaliba 2007 pers. comm.[16]).

It is also believed that if an unauthorized person collects medicinal material from the plant, such a person may become sterile if he or she was still sexually active (Netshia 1998 pers. comm.[17], Ramaliba 2007 pers. comm.[18]). Sometimes such a person may become insane. The nature of these indigenous techniques has scared people from coming into contact with *Brackenridgea zanguebarica* over the years.

[15] NETSHIA, L. 1998. Traditional healer. Thohoyandou, Limpopo province.
[16]RAMALIBA, T.Z. 2007. Traditional healer.Thohoyandou, Limpopo province.
[17] NETSHIA, L. 1998. Traditional healer. Thohoyandou, Limpopo province.
[18]RAMALIBA, T.Z. 2007. Traditional healer.Thohoyandou, Limpopo province.

Figure 8.1: A traditional healer (Dr TZ Ramaliba - standing) being assisted by a dedicated Mutavhatsindi person (locating the roots) who is responsible for the digging of medicinal material of *B. zanguebarica.*

Traditional woodland management is still seen as a good way of resource management in the area where the *Brackenridgea zanguebarica* population occurs (Saidi and Tshipala-Ramatshimbila 2006). The Department of Water Affairs and Forestry (currently the Department of Agriculture, Forestry and Fisheries) believe that co-management of the woodland with the tribal authorities can be the best way of protecting it. Community based approaches that build on local medicinal knowledge system of the species must be encouraged with supportive policies and legislative measures at provincial, national and global levels (Shukla and Gardner 2006). Co-management of natural resources is discussed in more detail under integrated management in section 8.2.4.

8.2.3 Conventional conservation techniques

Orthodox conservation techniques can also play a major role in conserving endangered species through law enforcement. Reserves have always played a pivotal role in conservation of biodiversity especially in areas where resources can still be obtained outside them. It is however becoming a challenge in situations where resources may be exhausted outside the reserve area.

The Vhembe district Municipality in which the two study sites, namely Tshirolwe and Thengwe, lie has been declared by UNESCO as a Biosphere region (UNESCO 2009). This programme of protecting biodiversity will also go a long way in promoting sustainable utilization of resources since all the inhabitants of the region will be guided by biosphere principles in their daily lives.

In the case of *Brackenridgea zanguebarica* the individuals outside the reserve have been depleted, even amidst law enforcement by the tribal authority. The tribal authority monitored the collection of medicinal materials from those *B. zanguebarica* individuals that were left outside the Brackenridgea Nature Reserve. They did that by accompanying collectors of medicinal material to the field and making sure that they collected enough, but in a sustainable way. They also monitored the development of the population by prohibiting collection to allow the population to recover. However, illegal collection of medicinal material has since occurred and depleted the population outside the reserve. Illegal collection of medicinal material, which is usually done during odd hours, has also extended into the reserve area and is now threatening the population of *B. zanguebarica* within the reserve.

An alternative conventional conservation technique would be *ex situ* conservation in botanical gardens or in medicinal plant gardens (Wiersum *et al.* 2006, Schippmann *et al.* 2006). In a botanical garden medicinal plant species that are being threatened with overharvesting can be propagated and taken good care off. The propagation programme within the botanical garden can extend its service to the community of users by providing them with seedlings to plant in their homestead. It is important to note that although traditional healers do not prefer to obtain medicinal materials from gardens they are willing and prepared to propagate medicinal plants in their own yards (Tshisikhawe 2002).

Some progress has been made towards improving the harvesting techniques applied to specific species. Depending on the extent and the rate of wound closure a strategy could be developed for those species that qualify for strip harvesting (Vermeulen 2006, Delvaux *et al.*2009). Key aspects of the harvest strategy would include strip width and length, harvest rotation, minimum diameter of harvested trees, percentage of the trees in the population to be exposed to bark harvesting and the number and rotation of strips on selected trees (Vermeulen 2006).

Even although it has been shown that leaves could contain the same compounds as bark (Zschocke *et al.* 2000a and b, Drewes *et al*. 2001, Geldenhuys 2004a) using the leaves for traditional medicine is not acceptable to the Venda traditional healer community. Traditional healers believe that if a plant is initially utilized for its medicinal bark such can hardly be substituted with leaves since they may not have the same strength.

A number of indigenous medicinal plant species have been successfully propagated after investigating a number of horticultural techniques on those species that may be difficult to propagate. To enhance the germination of woody plant species, a seed coat cracking pretreatment, as a way of breaking dormancy of hard-seeded species, improved germination by 62% (Netshiluvhi 1999). Tissue culture techniques have also successfully been used to propagate indigenous medicinal plants for commercial purposes (Rout *et al.* 2000). Micropropagation of indigenous medicinal plants is also seen as a way of protecting wild populations from overexploitation (Moyo *et al* 2011). Cultivation of medicinal plants may therefore in the long-term remove pressure from the forests and divert it to the production sites outside forest sites (Tshisikhawe 2002, Geldenhuys 2004b). While looking forward to this medium to long-term solution, efforts should focus on integrated management of the remaining populations of species that are threatened with harvesting as part of the short-term solution. The intergrated management should involve the use of western approach as well as the indigenous approach which is led by the tribal authority.

8.2.4 The integrated management of *Elaeodendron transvaalense* and *Brackenridgea zanguebarica*

The protection of *Elaeodendron transvaalense* and *Brackenridgea zanguebarica,* which are species in demand due to their medicinal value, will require an integrated management approach. The approach should draw best practices in conservation from western as well as indigenous conservation techniques. The system must also enjoy a buy in from the communities that are utilizing the plant resources. It therefore calls for ecological solidarity in the fight against their demise. The concept of

ecological solidarity is based on the notion that individuals become united around a common goal and that they are conscious of their common interests and shared responsibility (Thompson *et al.* 2011). Ecological solidarity in this case will require the community to use the best of western as well as indigenous approach of conservation for the achievement of sustainable utilization of the resources that they need. Whether it is towards the use of natural resources, which may include the use of traditional medicine, to the protection of a threatened species, human societies can contribute to the preservation of biodiversity where no monetary value can be identified. Human communities must be reminded of them being part of nature and that the future of nature lies in their capable hands. Integrated conservation and development, which must involve all relevant stakeholders from the start, should therefore have multiple targets related to both conserving biodiversity and improving human welfare (Salafsky *et al*. 2002, Geldenhuys 2004b). Intergrated concept should allow for sustainable utilization of resources by community members.

This integrated conservation concept becomes relevant in the Vhembe District Municipality where the study of this research was based because of the area being accepted by UNESCO as a Vhembe Biosphere Reserve. It is acknowledged that UNESCO's Man and the Biosphere (MAB) strategy of implementing biosphere reserves might constitute an appropriate planning tool in as far as conservation is concerned. Zonations in biosphere reserves allow for traditional forest use areas, traditional agriculture and settlements, and recreational zones (Bucking 2003, Zafra-Calvo *et al.* 2010). In fact biosphere reserves are another model of integrating different types of forest protection and use together (Bucking 2003).

The biosphere concept therefore offers the communities and the whole fraternity of stakeholders within Vhembe District Municipality the opportunity to engage with one another in a holistic approach to conservation. The ecological solidarity concept within the biosphere can work very well with systematic conservation planning, since it will attempt to represent and maintain all the biodiversity within the Vhembe Biosphere region. Complementary systematic conservation planning will provide numerous benefits over the *ad hoc* planning approaches (Lombard *et al.* 2003, Sarkar *et al.* 2006, Zafra-Calvo *et al.* 2010). Conservation plans should ideally use approaches that combine land classification data with that of the species. Conservation planning should therefore not only concern the location and design of reserves that represent the biodiversity of a region, but it should at the same time enable the persistence of that diversity by sustaining key ecological and evolutionary processes (Desmet *et al*. 2002, Cowling *et al*. 2003). However, successful implementation will be possible only if the planning incorporates socio-economic considerations (Berliner 2005) and identification of a general need to develop conservation landscapes that allow the maintenance of biodiversity whilst minimising impacts on the livelihoods of local people (Driver *et al.* 2003).

The ecological solidarity concept will go well with community based natural resource management (CBNRM), which clearly affirms management system of resources that existed amongst indigenous communities. Because of their reliance on natural resources, indigenous communities adhered to management of resources approaches that were meted out by traditional institutions such as chiefs, headmen and healers (Fabricius 2004). Community participation form the core of CBNRM and it should enable them to regain control over natural resources while at the same time

strengthening their decision making skills (Wainwright and Wehrmeyer 1998). The Thengwe tribal authority institutions will set boundaries that controlled natural resource utilization. Revival and adherence to these tribal institutions and their practices can play an important ecological role in promotion and sustenance of biodiversity. Carrying out rural development initiatives within a legal framework and effective institutional structures is one of the four components that need to be integrated in order to achieve sustainability of natural resource use. Other components to be integrated concern ecological, social, and economical aspects (Geldenhuys 2004a).

The integrated approach will therefore only prosper when commitment is provided by all sectors of the community. Failing to provide support by all the sectors concerned may lead to the downfall of the integrated management approach. Its strength is that everybody becomes the custodian of the natural resources in this people centered approach to resource management. Communication between different stakeholders is essential for the participatory management approach and the continued sustainability of natural resources (Geldenhuys 2004b). Any information generated on studies of natural resources should be shared amongst different stakeholders.

8.3 Conclusions and recommendations

It is clear that indigenous conservation techniques (ICT) and orthodox conservation play major roles in the conservation of indigenous medicinal plants. It is therefore important to acknowledge the two approaches in the conservation model that should be put into place by the Provincial Department of Environment and the tribal

authority institutions of Thengwe and Tshirolwe where the study areas of *Brackenridgea zanguebarica* and *Elaeodendron transvaalense* were respectively located. Instead of focusing only on law enforcement initiatives, efforts should be made that will also focus on the mentality of the communities. People around Thengwe and Tshirolwe should be made to understand the real meaning of having a species that is considered to be rare growing in their area. The Provincial Department of Environment and the tribal authority institution should make the immediate communities feel the sense of ownership in reality.

The feeling of ownership within the Vhatavhatsindi clan in the case of *B. zanguebarica* must cascade down to every member of the community around the area where the species is growing. The information that the species is only found in the Thengwe area of Limpopo province in the whole of South Africa must be communicated to all members of surrounding communities in order for them to understand its place in global, national, provincial as well as local environmental management plans. It is also clear that expansion of Brackenrigea nature reserve by 256 ha is feasible and can go a long way in conserving the species. The research has demonstrated that there is enough potential habitat for the species to expand its distribution.

In the case of *E. transvaalense* the community around Tshirolwe must understand its importance in the healthcare system so that they can look after it with care since the species is used in most of the traditional remedies. Its many uses in traditional medicines offer it the opportunity of breaking into the pharmaceutical markets.

However, for it to get into pharmaceutical markets it will require large scale propagation in order not to deplete its population in the wild.

Propagation intervention is therefore necessary to reduce the stress experienced by both *E. transvaalense* and *B. zanguebarica* through harvesting of medicinal materials. Optimal conditions for propagation need to be established in order to produce enough seedlings that can be distributed to traditional healers who may be prepared to start their own medicinal plant gardens. The approach towards promotion of propagation of medicinal plants is encouraged by the fact that some of the traditional healers have already started introducing medicinal plants of interest to them amongst their crops in their home gardens (Tshisikhawe 2002). It is therefore important to inform people that our own welfare, the survival of other species and the resilience of global life support systems are all intertwined and at risk of extinction threats (Aronson *et al.* 2006). More than ever before it means that people are part of nature and must practice ecological conservation and restoration since it matters in our lives.

The development of an action plan is paramount in as far as the success of the protection and management of natural resources is concerned. In the case of *Brackenridgea zanguebarica*, the action plan should be developed as follows:

- Formation of an association – An association that will look at the conservation of species under threat must be formed. The terms of reference should involve the drafting of a constitution that will drive the process of participatory management of natural resources with specific focus on bark harvesting for medicinal purposes. The constitution for the association should have a clear mission and vision statement as well as a policy for sustainable integrated

resource use. The policy should outline the do's and don'ts around harvesting of barks for medicinal purposes.

- Identification of stakeholders – Stakeholders with interest in the protection of natural resources should be identified and recruited to form part of the association. Relevant stakeholders that should be involved in the association include the Department of Water Affairs and Forestry, tribal authority, district and local municipalities, Brakenridgea Nature Reserve, academic and research institutions, traditional healers associations, art and craft associations, and other relevant NGOs operating around such resources. Stakeholders that will be drawn from different sectors of the community are expected to provide knowledge and skill in the management of natural resources.
- Mobilization of stakeholders –The formation of an association should be discussed with individual stakeholder groups for them to understand the need and endorse the process. Once all the stakeholders have bought into the idea the association can start convening and engage as a group.
- Investigation of mechanisms for local groups to co-operate – Local groups must have representation within the identified stakeholders. Their roles should also be accommodated within the harvesting policy for sustainable integrated resource use.
- Framework for planning and documentation of the project – the action plan on the protection of natural resources must be treated as a project that needs careful planning, documentation, monitoring and evaluation. The planning document should emphasized sustainable harvesting of natural resources which should be monitored continuously. Evaluation of the project will help in assessing the success of the sustainable resource use action plan.

- Sustainable harvesting – The emphasis is that resources should be utilized in a sustainable manner. In the case of medicinal plants such as *Elaeodendron transvaalense* and *Brackenridgea zanguebarica* it will be important to understand the ecology of such species for sustainable management of harvesting.
  - Scientific ecological studies that include quantification of the available resources, assessment of the growth rate of the species, as well as production rate will assist in strengthening the harvesting policy. Modelling will also help in projecting into the future in terms of assessing the future impacts of harvesting practice on the population.
  - The socio-economic survey will also help in understanding the demand of the resource for improvement of livelihood. Data from the socio-eonomic survey should flag out the demand of the species and it should help in determining the harvesting quota that should leave behind a viable population.
  - The demand and supply should be supplemented by best harvesting practice. Research on best harvesting practice of the species should inform the harvesting policy.
  - Alternative resources for medicinal materials such as botanical gardens, nurseries, and home gardens should be identified and developed.
  - Access into the forest should be regulated. The harvesting policy should outline the access policy which should include permit to use forest products obtainable from the association.
- Monitoring and evaluation – Harvesting impacts of medicinal materials should be monitored. Evaluation of the impacts should be based on the assessment of

harvesting techniques. Evaluation of the techniques should inform the continuation of such techniques or modification thereof. Simple and easy to apply techniques of assessing harvesting impacts should be developed. The technique should be able to collect and analyze enough data within a short period in a cost-effective manner.

- Funding proposals should be developed for submission to national and international funding institutions that champion biological diversity conservation initiatives.

In general, embracing the association of participatory management of natural resources by all the stakeholders can make such a plan of action a success. The model of action plan developed around the protection of *B. zanguebarica* can therefore be replicated in all the areas that require integrated approach of natural resource management.

References

ANTOCI, A., BORGHESI, S. AND RUSSU, P. 2005. Biodiversity and economic growth: Trade-offs between stabilization of the ecological system and preservation of natural dynamics. *Ecological Modelling* **189: 333-346.**

ARONSON, J., MILTON, S.J., BLIGNAUT, J.N. AND CLEWELL, A.F. 2006. Nature Conservation as if people mattered. *Journal for Nature Conservation* **14: 260-263.**

BERLINER, D. 2005, Systematic conservation planning for the forest biome of South Africa. Approach, methods and results of the selection of priority forests for conservation action, Water and Forestry Support Programme, Department of Water Affairs and Forestry, Pretoria.

BOTHA, J., WITKOWSKI, E.T.F. AND SHACKLETON, C.M. 2004. 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.**

BROOKS, T.M., MITTELMEIER, R.A., MITTELMEIER, C.G., DA FONSECA, G.A.B., RYLANDS, A.B., CONSTANT, W.R., FLICK, P., PILGRIM, J., OLDFIELD, S., MAGIN, G. AND HILTON-TAYLOR, C. 2002. Habitat loss and extinction in hotspots of biodiversity. *Conservation Biology* **16: 909-923.**

BUCKING, W. 2003. Are there threshold numbers for protected forests? *Journal of Environmental Management* **67: 37-45.**

BURGMAN, M.A., POSSINGHAM, H.P., LYNCH, J.J., KEITH, D.A., McCARTHY, M.A., HOPPER, S.D., DRURY, W.L., PASIOURA, J.A. AND DEVRIES, R.J. 2001. A method for setting the size of plant conservation target areas. *Conservation Biology* **15: 603-616.**

CONDIT, R., SUKUMAR, R., HUBBEL, S. AND FOSTER, R. 1998. Predicting population trends from size distributions: a direct test in a tropical tree community. *American Naturalist* **152: 495-509.**

COWLING, R.M., PRESSEY, R.L., ROUGET, M. AND LOMBARD, A.T. 2003.A conservation plan for a global biodiversity hotspot – the Cape Floristic Region, South Africa. *Biological Conservation* **112: 191−216.**

CUNNINGHAM, A.B. 1993. African medicinal plants: Setting priorities at the interface between conservation and primary healthcare. UNESCO, Paris.

CUNNINGHAM, A.B. AND MBENKUM, F.T. 1993. Sustainability of harvesting *Prunus africana* bark in Cameroon: a medicinal plant in international trade. UNESCO, Paris.

DELVAUX, C., SINSIN, B., DARCHAMBEAU, F. AND VAN DAMME, P. 2009. Recovery from bark harvesting of 12 medicinal tree species in Benin, West Africa. *Journal of Applied Ecology* **46:703-712.**

DERNBACH, J. 2001. From Rio to Johannesburg, Implementing Sustainable Development at the Global and Local Scale. Pp. 46-50 in Recommendations for Achieving Sustainable Communities, Science and Solutions. Report from the second National Conference on Science, Policy and Environment. National Council for Science and the Environment. Smithsonian National Museum of Natural History, Washington, DC.

DESMET, P.G., COWLING, R.M., ELLIS, A.G. AND PRESSEY, R.L. 2002. Integrating biosystematics data into conservation planning: Perspectives from Southern Africa's Succulent Karoo. *Systematic Biology* **51:317–330.**

DREWES, S.E., CROUCH, N.R., MASHIMBYE, M.J., DE LEEUW, B.M. AND HORN, M.M. 2001. A phytochemical basis for the potential use of *Warburgia salutaris* (pepper-bark tree) leaves in the place of bark. *South African Journal of Science* **97: 383–386.**

DRIVER, A., COWLING, R.M. AND MAZE, K.E. 2003.Planning for living landscapes: Perspectives and lessons from South Africa. Botanical Society of South Africa, Cape Town.

FABRICIUS, C. 2004. The fundamentals of community-base natural resource management. In Rights, Resources and Rural Development Community-based Natural Resource Management in Southern Africa. Eds. FABRICIUS, C., KOCH, E., MAGOME, H. AND TURNER, S. Earthscan Publishers, USA.

FASOLA, T.R. AND EGUNYOMI, A. 2005. Nigerian usage of bark in phytomedecine. *Ethnobotany Research and Applications* **3:73–77.**

FISHER, A.C. AND KRUTILLA, J.V. 1974. Valuing long run ecological consequences and irreversibilities. *Journal of Environmental Economics and Management* **1: 96-108.**

GAUGRIS, J.Y. AND VAN ROOYEN, M.W. 2010. Evaluating the adequacy of reserves in the Tembe–Tshanini Complex: a case study in Maputaland, South Africa. *Oryx* **44: 399–410.**

GAUTHIER, P., DEBUSSCHE, M. AND THOMPSON, M.D. 2010. Regional priority setting for rare species based on a method combining three criteria. *Biological Conservation* **143: 1501-1509.**

GELDENHUYS, C.J. 2004a. Meeting the demand for *Ocotea bullata* bark: implications for the conservation of high value and medicinal tree species. In: Indigenous forests and woodlands in South Africa – Policy, People and Practice. Eds. LAWES, M.J., EELEY, H.A.C., SHACKLETON, C.M. AND GEACH. B.G.S. University of Kwazulu-Natal Press, Durban, South Africa: **517-550.**

GELDENHUYS, C.J. 2004b. Bark harvesting for traditional medicine: from illegal resource degradation to participatory management. *Scandinavian Journal of Forest Research* **19: 103-115.**

GELDENHUYS, C.J., SYAMPUNGANI, S., MEKE, G.S. AND VERMEULEN, W.J. 2007. Response of different species to bark harvesting for traditional medicine in Southern Africa. In J.J. Bester, A.H.W. Seydack, T. Vorster, I.J. Van der Merwe AND S. Dzivhani (eds). Multiple Use Management of Natural Forests and Woodlands: Policy Refinement and Scientific Progress. pp. 55–62. Department of Water Affairs and Forestry, Pretoria, South Africa.

GOODLAND, R. 1995. The concept of environmental sustainability. *Annual Review of Ecology and Systematics* **26:1-24.**

HEYWOOD, V.H. AND IRIONDO, J.M. 2003. Plant conservation: old problems, new perspectives. *Biological Conservation* **113: 321-335.**

IUCN/UNEP/WWF. 1980. World Conservation Strategy: Living resource conservation for sustainable development. International Union for the Conservation of Nature, Gland.

JOHANNES, R.E. 2002. Did indigenous conservation ethics exist? *SPC Traditional Marine Resource Management and Knowledge Information Bulletin* **14: 3-7.**

KENNEDY, D. 2001. Sustainability: Problems, science and solutions. Pp. 35-39 in Recommendations for Achieving Sustainable Communities, Science and Solutions. Report from the second National Conference on Science, Policy and Environment. National Council for Science and the Environment. Smithsonian National Museum of Natural History, Washington, DC.

LINDENMAYER, D.B., FRANKLIN, J.F. AND FISCHER, J. 2006. General management principles and a checklist of strategies to guide forest biodiversity conservation. *Biological Conservation* **131: 433–441.**

LOMBARD, A.T., COWLING, R.M., PRESSEY, R.L. AND REBELO, A.G. 2003. Effectiveness of land classes as surrogates for species in conservation planning for the Cape Floristic Region. *Biological Conservation* **112: 45-62.**

MABOGO, D.E.N. 1990. The ethnobotany of the Vhavenda. Master of science thesis. University of Pretoria, Pretoria, South Africa.

MOYO, M., BAIRU, M.W., AMOO, S.O. AND VAN STADEN, J.2011.Plant biotechnology in South Africa: Micropropagation research endeavours, prospects and challenges. *South African Journal of Botany* **77: 996-1011.**

NANTEL, P., BOUCHARD, A., BROUILLET, L. AND HAY, S. 1998. Selection of areas for protecting rare plants with integration of land use conflicts: A case study for the west coast of Newfoundland, Canada. *Biological Conservation* **84: 223-234.**

NAUGHTON-TREVES, L., KAMMEN, D.M. AND CHAPMAN, C. 2007. Burning biodiversity: woody biomass use by commercial and subsistence groups in western Uganda's forests. *Biological Conservation* **134: 232-241.**

NETSHILUVHI, T.R. 1999. Demand, propagation and seedling establishment of selected medicinal trees. *South African Journal of Botany* **65: 331-338.**

NETSHIUNGANI, E.N. AND VAN WYK, A.E. 1980. Mutavhatsindi – mysterious plant from Venda. *Veld and Flora* **66: 87-89.**

NIKLAS, K.J., MIDGLEY, J.J. AND RAND, R.H. 2003. Size-dependent species richness: trends within plant communities and across latitude. *Ecology Letters* **6: 631-636.**

PFAB, M.F. AND SCHOLES, M.A. 2004. Is the collection of *Aloe peglerae* from the wild sustainable? An evaluation using stochastic population modelling. *Biological Conservation* **118: 695-701.**

ROUT, G.R., SAMANTARAY, S. AND DAS, P. 2000. *In vitro* manipulation and propagation of medicinal plants. *Biotechnology Advances* **18: 91-120.**

SAIDI, T.A. AND TSHIPALA-RAMATSHIMBILA, T.V. 2006. Ecology and management of remnant *Brachystegia spiciformis* (Miombo) woodland in north-eastern Soutpansberg, Limpopo Province. *South African Geographical Journal* **88: 205-212.**

SALAFSKY, N., MARGOLUIS, R., REDFORD, K.H. AND ROBINSON, J.G. 2002. Improving the practice of conservation: a conceptual framework and research agenda for conservation science. *Conservation Biology* **16: 1469-1479.**

SARKAR, S., PRESSEY, R.L., FAITH, D.P., MARGULES, C.R., FULLER, T., STOMS, D.M., MOFFET, A., WILSON, K.A., WILLIAMS, K.J., WILLIAMS, P.H. AND ANDELMAN, S. 2006. Biodiversity conservation planning tools: present status and challenges for the future. *Annual Reviews of Environment and Resources* **31: 123-159.**

SCHIPPMANN, U., LEAMAN, D. AND CUNNINGHAM, A.B. 2006. A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. In: BOGERS, R.J., CRAKER, L.E., LANGE, D. (eds).

Medicinal and aromatic plants, agricultural, commercial, ecological, legal, pharmacological and social aspects, pp. 75-95.Springer, Dordrecht, the Netherlands (Wageningen UR Frontis Series 17).

SHUKLA, S. AND GARDNER, J. 2006. Local knowledge in community based approaches to medicinal plant conservation: lessons from India. *Journal of Ethnobiology and Ethnomedicine* **2: 20-24.**

SMITH, R.J., GOODMAN, P.S. AND MATTHEWS, W. 2006. Systematic conservation planning: a review of perceived limitations and an illustration of the benefits, using a case study from Maputaland, South Africa. *Oryx* **40: 400–410.**

STEWART, K. 2009. Effects of bark harvest and other human activities on populations of the African cherry (Prunus africana) on Mount Oku, Cameroon. *Forest Ecology and Management* **258:1121-1128.**

THOMPSON, J.D., MATHEVET, R., DELANOE, O., GIL-FOURIE, C., BONNIN, M. AND CHEYLAN, M. 2011. Ecological solidarity as a conceptual tool for rethinking ecological and social interdependence in conservation policy for protected areas and their surrounding landscape. *Comptes Rendus Biologiques* **334: 412-419.**

TSHISIKHAWE, MP. 2002. Trade of indigenous medicinal plants in the Northern Province, Venda region: their ethnobotanical importance and sustainable use. M.Sc dissertation, University of Venda for Science and Technology, Thohoyandou, South Africa.

TSHISIKHAWE, M.P. 2005. Synthesis on medicinal plants of the Soutpansberg region.http://www.soutpansberg.com/workshop/synthesis/medicinalplants.htm

UNESCO. 2009. 22 new biosphere reserves selected by UNESCO. http://www.unesco.org

VERLINDEN, A. AND DAYOT, B. 2005. A comparison between indigenous environmental knowledge and a conventional vegetation analysis in north central Namibia. *Journal of Arid Environments* **62: 143-175.**

VERMEULEN, S.J. 1996. Cutting trees by local residents in a communal area and an adjacent state forest in Zimbabwe. *Forest Ecology and Management* **81: 101-111.**

VERMEULEN, W.J. 2006. Sustainable harvesting for medicinal use: matching species to prescriptions. In: J.J. BESTER, A.H.W. SEYDACK, T. VOSTER, I.J. VAN DER MERWE AND S. DZIVHANI (Eds) Multiple use management of natural forests and woodlands: policy refinements and scientific progress: Symposium on Natural forests and Savanna Woodlands, Symposium IV. http://www2.dwaf.gov.za/webapp/resourcecentre/Documents/ Reports/4259_Day1_session3_item4.pdf

VERMEULEN, W.J. AND GELDENHUYS, C.J. 2004. Experimental protocols and lessons learnt from strip harvesting of bark for medicinal use in the southern Cape forests. DIFID, UK.

WAINWRIGHT, W. AND WEHRMEYER, W. 1998.Success in integrating conservation and development? A study from Zambia. *World Development* **26: 933-944.**

WEST, P. AND BROCKINGTON, D. 2006. An anthropological perspective on some unexpected consequences of protected areas. *Conservation Biology* **20: 609–616.**

WIERSUM, K.F., DOLD, A.P., HUSSELMAN, M. AND COCKS, M. 2006.

Cultivation of medicinal plants as a tool for biodiversity conservation and poverty alleviation in the Amatola region, South Africa. In: BOGERS, R.J., CRAKER, L.E., LANGE, D. (eds). Medicinal and aromatic plants, agricultural, commercial, ecological, legal, pharmacological and social aspects, pp. 43-57.Springer, Dordrecht, the Netherlands (Wageningen UR Frontis Series 17).

ZAFRA-CALVO, N., CERRO, R., FULLER, T., LOBO, J.M., RODRIGUEZ, M.A. AND SARKAR, S. 2010. Prioritizing areas for conservation and vegetation restoration in post-agricultural landscapes: A biosphere reserve plan for Bioko, Equatorial Guinea. *Biological Conservation* **143: 787-794.**

ZSCHOCKE, S., DREWES, S.E., PAULUS, K., BAUER, R. AND VAN STADEN, J. 2000a. Analytical and pharmacological investigation of *Ocotea bullata* (black stinkwood) bark and leaves. *Journal of Ethnopharmacology* **71: 219–230.**

ZSCHOCKE, S., RABE, T., TAYLOR, J.L.S., JÄGER, A.K. AND VAN STADEN, J. 2000b.Plant part substitution – a way to conserve endangered medicinal plants? *Journal of Ethnopharmacology* **71: 281–292.**