An evaluation of the *Phragmites australis* reed use by communities neighbouring the Tembe Elephant Park, Maputaland, KwaZulu-Natal, South Africa

by

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ABSTRACT

The commercial harvesting of *Phragmites australis* reeds in the Tembe Elephant Park, Maputaland, KwaZulu-Natal was investigated to determine the impact of reed use on the Muzi Swamp. The reed quality in the harvesting areas within the Tembe Elephant Park has deteriorated over time, with the reeds in the harvested areas being by and large shorter and thinner than the reeds in the other areas of the reserve where harvesting is not allowed. The impact of continuous harvesting in combination with the accidental burning of certain areas in the Muzi Swamp was also found to be detrimental to reed production when compared to other treatments. Poor rural communities neighbouring the Tembe Elephant Park are largely dependent on the reed resource for both income supplementation and for use in the construction of dwellings. Reeds offer a cheaper alternative to the more western building materials, which is of utmost importance in an area where the mean yearly income is around

ZAR 6000 per annum. The manufacture of prefabricated reed and forest timber huts by the local reed harvesters in the summer months would facilitate a winter only harvest, which is more beneficial and is integral to the improvement of the long-term reed quality in the Muzi Swamp. In addition, the cost of these proposed prefabricated reed and forest timber huts is approximately one third of the cost of a similar sized hut that is constructed from bricks and cement. Management recommendations for the controlled harvesting area in Muzi Swamp of the Tembe Elephant Park, as well as the section of the Muzi Swamp that is not afforded protection by Ezemvelo KwaZulu-Natal Wildlife, are also presented.

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CHAPTER 1

INTRODUCTION

The common reed *Phragmites australis* (Cav.) Trin. ex Steud. is a cosmopolitan plant species that flourishes in wetlands and will easily dominate other plant species, forming a monospecific reed bed (Den Hartog *et al*. 1989). It employs aggressive and persistent survival strategies, like most other grasses, making it one of the earliest and most successful colonisers of disturbed or newly reclaimed wetlands (Van der Werff 1991; Havens *et al*. 1997; Massacci *et al*. 2001). It reproduces most effectively by vegetative means through rhizomes and regenerative shoots that emerge from the nodes of damaged stems.

Phragmites australis is a plant species with a high annual productivity (Granéli 1984; Massacci *et al*. 2001). The biomass is produced seasonally above ground, but it also accumulates perennially in the below ground parts. The rhizome's perennating nature is based on the nutrient and carbohydrate translocation and cycling which is characteristic of all clonal plants (Hara *et al*. 1993). Nutrient and carbohydrate circulation between the rhizomes and the aerial parts occur annually, with the rhizomes supplying reserves for bud formation and growth early in the season, and the aerial parts relocating the products of photosynthesis to the rhizomes before they die off.

Two types of rhizome, horizontal and vertical, persist perennially and are responsible for the spread of the root system and the production of aerial stems respectively (Haslam 1970). Below ground expansion occurs when the horizontal rhizomes elongate and divide. The vertical rhizomes are branches of the horizontal ones, and they develop buds on the nodes that remain dormant just below the soil surface

(Hara *et al*. 1993). Below ground buds are produced year-round and can remain underground until the winter dormancy is broken. Once the growing conditions are optimal again, usually at the onset of wetter and warmer conditions, the internodes of the buds elongate and the aerial shoots emerge from beneath the soil surface. The emerging aerial shoots obtain nutrients from the rhizomes until they reach a height at which they receive enough light for photosynthesis to take place through the existing reed canopy. At this height the leaves of the reed no longer sheath the stem but differentiate and grow to gather light energy. A characteristic of the emergent shoots is that their eventual height is directly proportional to their initial bud width. The greater the diameter of the bud, the taller the reed can potentially grow. The reed can only reach its potential height if it is not damaged in any way. Damage to the shoot normally leads to the production of a regenerative shoot. Regenerative shoots may be numerous and are always shorter and thinner than the parent shoot. Regenerative shoots should not be considered as replacement shoots because they do not have the same morphometric qualities as the parent shoot, being shorter, thinner and therefore less suitable for use as construction material by rural communities.

Mature reeds produce panicles in the autumn, after the completion of the growing season. The well-developed large reeds can remain standing, even though they are dead, for up to three years. Panicles produce thousands of small seeds, most of which are not viable (Marks *et al*. 1994). The seeds are not anemochorous, being dispersed mainly by birds, animals and man. Seed germination and seedling establishment require specific substrate conditions and young seedlings are susceptible to changes in environmental conditions. The common reed grows in almost any type of soil as long as the ground is wet enough, but seems to perform best in rich mineral soils with a high clay content. This is unlike the Muzi Swamp peatlands of the study area where the soils are fine and have a high organic compound content. Van der Toorn (1972 In: Van der Werff 1991) distinguished between two different ecotypes of *Phragmites australis*. The first was the peat ecotype, which has short shoots and a high shoot density, and the other the riverine ecotype that has longer shoots and fewer reeds per unit area. Phenotypic variation in *Phragmites australis* is vast and is prominent in areas with variable environmental conditions such as water depth (Vretare *et al*. 1999). This large degree of phenotypic variation makes *Phragmites australis* an excellent candidate for re-establishment, especially if reeds with specific characteristics are required. Newly established reeds are genetically identical to the transplanted mother plant.

Many aspects of the biology and ecology of *Phragmites australis* have been investigated since the 1960's (Ostendorp 1989; Sukopp & Markstein 1989). The reason for these investigations has been either to control the spread of *Phragmites australis*, or to combat its decline. *Phragmites australis* is seen by many as a threat to biodiversity in naturally occurring wetlands, dominating other wetland plants by out-competing them for space, nutrients and light (Chambers *et al*. 1999; Mathis & Middleton 2001). Although *Phragmites australis* reed beds appear to be a monoculture, the reed does co-exist with other plant species and the reed beds provide a habitat for numerous animals. *Phragmites australis* reed beds seem to benefit only the generalist bird species, reducing the avifaunal biodiversity when compared with a wetland with more diverse micro-habitats. Micro-habitats within a single wetland such as those found in Ndumo Game Reserve can include, amongst others, open water, vegetated islands, mudflats and hygrophilous grassland. It is because of these micro-habitats that wetland systems such as those found in the Ndumo Game Reserve, which is close to the Tembe Elephant Park, have one of the most diverse avifaunal species compositions in the world. Insect species diversity, however, seems to increase in *Phragmites australis* dominated wetlands when compared with other wetlands (Chambers *et al*. 1999).

Phragmites australis is an important component in the ecology and maintenance of wetland integrity. It has many valuable attributes, such as an extensive root system that consolidates and maintains substrates, minimising the effects of water erosion. It also has the ability to withstand high levels of environmental contamination and it can assimilate heavy metals, nitrogen and phosphorous. In addition it tolerates varying degrees of salinity and acidity (Massacci *et al*. 2001). The establishment and continued existence of *Phragmites australis* reed beds in disturbed wetlands with these attributes facilitate hydrological succession, initiating the restoration of the wetland so as to render it a productive entity (Van der Werff 1991).

The global extent of wetlands has decreased substantially in the last century due to, amongst other reasons, their uncontrolled conversion to agricultural land. This has had serious effects on the environment and has also had severe social and economic impacts on natural resource users (Adger & Luttrell 2000; Hodge & McNally 2000). This is particularly important to primary natural resource users such as poor rural communities who are reliant upon such resources for their daily survival. Land use trends in the Maputaland region, where a single, locally relevant authority controls tribal land and subsistence agriculture is practised, are consistent with other economically underdeveloped regions in the rest of the world. Although this type of subsistence agriculture was practised in many African cultures over the millennia it does not necessarily mean that it did not alter the ecological conditions and environment, even dating as far back as 150 years ago (Campbell & Child 1971). These changes occurred when it was customary for people to create temporary small-scale environmental disturbances, and then to return once the area had recovered. Fabricius (2004) discussed examples of such practices, including 'pulse hunting' where animals were harvested heavily at certain times of the year and then completely left alone the rest of the time so that the population could recover. Patch burning is another type of small-scale disturbance that was used to promote fodder production for wildlife and livestock. Although this type of patch disturbance using fire as a management tool still takes place in many rural areas around South Africa, it is more prominent now because there are more and more people with herds of cattle and they burn the rangeland for grazing production. The overall result is an accumulation of a patchwork of burned areas and is generally followed by overgrazing because of a lack of immediately available fodder for livestock.

The increasingly sedentary nature of rural populations, and the resulting persistent natural resource use in a single area are in many ways contradictory to practices employed in the past. This is evident when one considers the changes to water bodies and wetlands, not only in conventionally “unprotected” tribal areas, but also in areas that are under the protection of conservation authorities. Uncontrolled harvesting of renewable natural resources such as sedges and reeds, fish and invertebrates not only affects the areas in communal land because the systemic nature of wetlands transfers the effect to protected areas too. All the naturally occurring fauna and flora in the pans, rivers and marshes in the northern sub-region of KwaZulu-Natal are under survival pressure because of an increasing intensity of human use. Diminishing fish stocks in the Kosi Bay system as well as the Pongola River are evidence of this. There also is increased pressure on nature reserve managers in the subregion to allow access to higher volumes of harvestable plant material such as Incema *Juncus kraussii*, the common reed and forest timber.

Natural resources such as these were always utilised by local rural communities, but previously this was done on a subsistence basis. The increase in human population size and a seemingly ad hoc development of rural economies in these communities has placed increased pressure on the available resources. The rural poor tend to use the resources that are freely available to them. An increasing human population leads to the amplification in the demand for the resources. Burgeoning rural economies are also responsible for an increase in the utilisation pressure, specifically if there is a demand for the resource in extralimital markets such as in large towns and cities.

The Sibonisweni community of northern Maputaland finds itself in this situation. The flourishing reed market in this area has resulted in few reeds occurring in the part of the Muzi Swamp that is situated in the communal land itself. Reeds are therefore now being harvested in the neighbouring Tembe Elephant Park, where the protection and controlled use of this resource has resulted in it being an almost pristine reed bed. Most of the Muzi Swamp in South Africa, where the reeds are abundant, is situated in the Tembe Elephant Park. The Tembe Elephant Park management grants reed harvesting permits to three neighbouring communities. Sibonisweni is the largest of these communities and as such has a far larger reed quota than other neighbouring communities. The focus of this study was therefore on the reed use within the Sibonisweni community and the harvesting area that was allocated to them in the Tembe Elephant Park. It is conceivable, however, that the results and conclusions of this study could also be applicable to the other neighbouring communities. Ezemvelo KwaZulu-Natal Wildlife recognised a need for a study on the effects of reed harvesting within this area, as it is the most heavily utilised harvesting site.

Some of the main aims of the study in the Tembe Elephant Park would undoubtedly be to promote the maintenance of the Muzi Swamp as a productive natural resource provider of these reeds, and to improve the quality of the existing resource base. To do so, the following aspects were studied:

- The biology of *Phragmites australis*
- Treatments to stimulate the growth of *Phragmites australis*, specifically fire and harvesting treatments

- Estimation of the current condition and quality of the reeds in the Muzi Swamp, Tembe Elephant Park
- Socio-economic aspects and trends of the use of *Phragmites australis* in the Sibonisweni community
- Investigation of the possible introduction of secondary industries pertaining to reed and forest timber use to the communities neighbouring the Tembe Elephant Park
- Formulation of a reed management plan and harvesting regime that does not negatively influence reed growth in the Muzi Swamp.

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CHAPTER 2

STUDY AREA

The Tembe Elephant Park is situated in Maputaland, northern KwaZulu-Natal, South Africa. Its northern boundary is the border between South Africa and Mozambique, while the southernmost boundary is the tar road that leads from Ingwavuma to the rural town of KwaNgwanase, approximately 40 km east of the Tembe Elephant Park. The Tembe Elephant Park comprises some 30 013 ha of Sub-humid Lowveld Bushveld (Low & Rebelo 1996). Moll and White (1978 in: Matthews *et al.* 2001) divided the vegetation into more discrete units, namely, the Pallid Sand Bushveld, Sand Forest, Palmveld, Grassland and the Muzi Swamp. A more detailed description of the vegetation of the Tembe Elephant Park can be found in Matthews *et al*. (2001).

The Muzi Swamp

The Muzi Swamp is one of the larger emergent, palustrine, flat wetlands in southern Africa, stretching northwards from just south of the Tembe Elephant Park all the way into the southern part of Maputo Bay in Mozambique where it flows as the *Rio Futi* into the Indian Ocean. According to the classification system of Dini and Cowan (2000), the Muzi Swamp is a palustrine system by virtue of the fact that it has a greater than 30 percent cover of trees, shrubs, emergent macrophytes, mosses or lichens. It is further classified into a flat subsystem on the basis that it exists on comparatively level land with little or no relief.

The Muzi Swamp is situated in the eastern portion of Tembe Elephant Park. It forms a polygon between the following coordinates: 26º 53’ 08’’ S and 32º 34’ 58’’ E, 26º 53’ 04’’ S and 32º 34’ 59’’ E, 27º 01’ 25’’ S and 32º 29’ 54’’ E and 27º 01’ 24’’ S and 32º 29’ 44’’ E. The Muzi Swamp extends northwards from the KwaMsomi Gate in the south to the Muzi Gate in the north, from where it continues into Mozambique. Most of the South African portion of the Muzi Swamp is situated in the Tembe Elephant Park (Grundling 1999). A small portion of the Muzi Swamp is situated in the Sibonisweni community's land adjacent to the Tembe Elephant Park to the southeast. The section of the Muzi Swamp that lies within Tembe Elephant Park is approximately 560 ha in size (Grundling 1999). It is estimated that the Muzi Swamp in the Tembe Elephant Park is from 200 to 500 m wide and approximately 17 km long. It lies on Holocene peat deposits that were formed as a result of the topography of the underlying Pleistocene KwaBonambi coastal dunes (Grundling 1996). The Muzi Swamp is an elongated north-south running interdune valley that is orientated parallel to the present coastline (Matthews *et al*. 2001). Peat deposits of up to 5 m thick have accumulated in the interdune valley of the permanent Muzi Swamp. This interdune peatland and isolated wetland are fed by groundwater from perched aquifers within the sand dunes (Grundling 1999).

Soils

The movement of ground water towards the Muzi Swamp has lead to the formation of clay-rich, slightly saline or calcareous duplex soils in the low-lying areas of the Muzi Swamp (Matthews *et al.* 2001). Narrow bands of soil with a relatively low soluble salt content and a high exchangeable sodium content around the Muzi Swamp are fairly common (Matthews *et al*. 2001). The Muzi system is characterised by soils that have experienced prolonged saturation with water and have thus undergone intense reduction. These organic-rich histosols (Champagne form) (Matthews *et al.* 2001) contain large amounts of slowly decaying plant material due to the lack of oxygen in the soil. Histosols are essentially repositories for atmospheric carbon that has been fixed by plants during photosynthesis, and as such will tend to expand and accumulate over time. The peat accumulation in the Muzi Swamp occurs at a rate of 1.2 mm per year (Grundling 1999) and it is a result of the partial disintegration and decomposition of plant material under conditions of inundation (Soil Classification Working Group 1991). Grundling's (1999) study, however, showed that the peat profiles of the southern sections of the Muzi Swamp were substantially more arid than those in the northern parts of the swamp. The peat profile, and more specifically the rate of accumulation of the peat layers, illustrate that the southern sections of the Muzi Swamp are also historically drier than the northern sections.

Climate

According to Schultze (1982 in: Matthews *et al*. 2001) the climate of Tembe Elephant Park can be described as warm to hot, humid and subtropical with the winters being drier than the summers. Rainfall can, however, occur throughout the year. Climatological data were collected form the Sihangwana weather station (27º 02' 35'' S and 32º 25' 25'' E) close to the study area and accurately reflects the prevailing climatological conditions. The mean annual rainfall is 721.5 mm. This is high relative to the annual precipitation over most of the rest of South Africa, leading to large amounts of perennial water. The minimum recorded annual rainfall is 245.0 mm, while the maximum is 2105.0 mm. The temperature in Tembe Elephant Park ranges from a minimum of 4.0º C to a maximum of 45.0º C. The proximity of Tembe Elephant Park to the coast along with its low-lying topography result in a high atmospheric humidity (KwaZulu-Natal Nature Conservation Service, Unpublished Report). Graphical climate data are first illustrated in Chapter 4 of this dissertation.

The Sibonisweni community

The Sibonisweni community comprises some 170 households and is one of the most populous communities neighbouring the Tembe Elephant Park, with over 1000 people residing there. The boundaries of the communal land begin on the southeast corner of the Tembe Elephant Park and continue southwards to the tar road that leads to KwaNgwanase. The people of the Sibonisweni Community reside on communal land under the governance of the Tembe Tribal Authority (URL: http://www.up.ac.za/academic/centre-environmental-studies/Asard/A-SARD-UP). People in this and other communities like it in the area practise a subsistence agriculture, and produce arts and crafts for sale to tourists. They also have jobs that are related to tourism in the neighbouring Tembe Elephant Park. The Tembe Elephant Park also provides occasional job opportunities when casual labour is needed for tasks such as routine fence and road maintenance and invasive plant control. Many families in the Sibonisweni community are also reliant on the allocation of harvesting permits for the gathering of reeds in the Tembe Elephant Park. Families that are allocated these permits benefit financially from the commercial sale of the harvested reeds.

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CHAPTER 3

GENERAL METHODS

Introduction

Some chapters in this dissertation are written in journal article format. Those that are written in this manner follow the style of the publication for which they were intended. The overall style of the dissertation follows the format of the *South African Journal of Wildlife Research*. The pages in the dissertation are numbered sequentially, but figures and tables are numbered as they appear in the prepared articles. The figures illustrating the climate data and location of the study area are repeated in some of the chapters. It was necessary to include them each time for the prepared journal articles. The specific methods used are explained in the journal articles as well as generally in this chapter. The references cited at the end of the dissertation are prepared according to the style of the *South Africa Journal of Wildlife Research*.

The response of *Phragmites australis* to harvesting pressure in the Muzi Swamp of the Tembe Elephant Park, South Africa

The reed beds in the southern section of the Tembe Elephant Park were sampled in a south to north direction 300 m from the gate at KwaMsomi Scout Camp for approximately 1 800 m, ending near the Umjangazi area. Harvesting sites were set out 30 m away from perceived edge of the reed bed to prevent any ecotonal effect that might arise from competition between reeds and the hygrophilous grassland community. Thirteen harvesting sites were selected and referenced using a Global Positioning System (GPS). Six quadrates at each harvesting site were destructively harvested using a square 1 m^2 frame.

The quadrates were set out in a rectangular pattern about 5 m from each other. Throwing the square behind the harvester ensured the random placement of quadrates. All the reeds within the frame were harvested at water level, or at ground level in the absence of water, using secateurs. The mass (kg) of the reeds that were harvested in each quadrate was determined using an empty grain sack and a spring balance. The spring balance was calibrated to zero with the grain sack attached to get an accurate reading. The stem diameter (mm) and reed height (m) were measured for each individual reed. The stem diameter was measured at the base of the cut reed using callipers. The reed height was measured by using a tape measure, measuring from the cut stem base to the outstretched apical leaf blade. The water level at each harvesting site was added to the mean reed height. The number of reeds harvested per harvesting site was counted to determine the reed density per m^2.

Evidence of harvesting by reed cutters was estimated in two-monthly intervals. Environmental factors such as degree of trampling by man and animals as well as the water depth were noted. The water depth at each quadrate was calculated using a metal dropper attached to a thin aluminium plate (approximately 0.10 m^2). The aluminium plate prevented the metal dropper from penetrating the soft peat, which would exaggerate the water depth. The mean height (m), diameter (mm), density per m^2 and yield (kg per m^2) of reeds produced were calculated for each quadrate. The mean mass per reed (g) was calculated by dividing the biomass of the reeds by the number of reeds per m^2 of each quadrate.

The various means were plotted against distance to check for a possible degradation gradient in a south to north direction. The frequency distribution of reeds encountered in various height and diameter classes were plotted against distance away from the starting point. The reed characteristics at the various harvesting sites were compared using an Analysis of Variance (ANOVA), Bonferroni test of the Statistica 6 computer package (Statsoft Inc., Tulsa, Oklahoma, U.S.A).

The long term effects of burning and utilisation on *Phragmites australis* reeds in the Muzi Swamp, of the Tembe Elephant Park, South Africa

Harvesting sites that had been sampled in 2000 were revisited in 2002. The areas that had been sampled in 2000 were part of a project conducted by the Botany Department of the University of Pretoria (Tosh 2000) to determine the effects of human harvesting and burning on *Phragmites australis* stands. These areas, prior to 2000, had undergone four different treatments, these treatments were: (i) utilised and burnt, (ii) utilised and unburnt, (iii) unutilised and burnt, and (iv) unutilised and unburnt. Six 1 m^2 quadrates were harvested at each of the four various harvesting sites in 2002. Burnt and unburnt sites with a specific utilisation regime were selected as close as possible to each other to avoid any differences that might occur through environmental variation.

All the reeds within a square 1 m^2 frame were destructively harvested using secateurs. Reeds were cut at water level, or at ground level in the absence of water. The mean water depth was added to the mean reed height at each harvesting site to get a more accurate indication of actual mean reed height. The mean water depth was determined by using a metal dropper attached to a thin aluminium plate. The basal stem diameter (mm) and the reed height (m) was measured for each reed harvested.

Results were analysed using a multifactor analysis of variance (ANOVA) with the General Linear Model of the Statistical Analysis Systems (Statistics Version 6. SAS Institute Inc. Cary, NC., USA.) computer package at $\alpha = 0.05$. Fischer's protected least significant difference (LSD) test was used to determine significant differences between means.

Towards the development of a sustainable use management strategy for the Muzi Swamp, Tembe Elephant Park: an examination of trends in *Phragmites australis* reed use in the Sibonisweni Community

A trained interviewer conducted discussions with a representative from each of the 170 households within the Sibonisweni Community, with the questionnaires being completed by one member of each household. The interviewer was a Zulu-speaking member of the local community and as such the members of the community were quite willing and responsive during the survey process. The use of a local interviewer was found to be less intrusive than using an outsider. The questions were based on information obtained during the interview stage of the study. It is important that the researcher first gains an insight into what aspects of the study are important to the respondents before posing quantitative questions to them (Pratt & Loizos 1992). Although such questionnaire data are not statistically significant because of the non-random character of the sample (Pelto & Pelto 1978) the aim of the present study was not to do a statistical analysis, but merely to quantify the qualitative data obtained during the study. The data from the questionnaires were analysed by using the SPSS (Statistics Package for the Social Sciences) for Windows® (Standard Version 11.5.0. SPSS Inc. South Africa) computer package.

With the help of a local assistant to act as a translator the researcher was able to conduct interviews with members of the Sibonisweni Reed Cutters Association. Interviews were semi-structured, having predetermined questions as well as interactive conversation. Several of these qualitative data were used to structure the questions in the household survey. Some questions had to be structured in such a way as to confirm interviewee answers. These questions were basic, with the interviewer already knowing the scientifically correct answer. This was to make certain that answers were honest and not what the interviewees perceived the researcher wanted to hear. The local community members do not favourably accept research into the reeds in the Muzi Swamp as they believe that any findings will have a negative influence on their harvesting quotas. It was made clear that the research was done on behalf of an independent organisation without a vested interest in the outcome of the study.

The development of secondary industries through the sustainable utilisation of reeds and forest timber in the Tembe Elephant Park, Maputaland, South Africa

Baseline data pertaining to the extent of use of forest timber by local rural communities was obtained during a previous study (Gaugris 2004). The number of harvestable units, or poles, in the size classes preferred by local communities was determined for the Sand Forest plant community within the Tembe Elephant Park. This data was obtained by subtracting the total area of Sand forest in the Tembe Elephant Park available by the minimum area to be set aside for conservation as well as the areas that are less than 200 ha in extent. The number of harvestable poles available in the benchmark Sand Forest vegetation was halved for the Tembe Elephant Park because of the unknown utilisation impact of large herbivores.

Quantitative data with regard to the number of reeds needed to construct a house of a certain dimension (2 x 4 x 2 m) was obtained from questionnaire surveys. These data were then used to extrapolate the required building materials needed to construct a reed hut made from prefabricated reed and forest timber panels. The panels would be 2 x 2 m in dimension and would be three layers of reeds thick. The panels' frameworks were to be constructed out of the harvested forest timber and some additional sundries explained in Chapter 7.

The building methods in this chapter are based on qualitative information obtained during the research phase of both studies. Although the explanations are hypothetical in that the authors have not yet constructed the prefabricated panels *per* *se*, we feel that they are sound because local rural community members are currently implementing similar building methods (Gaugris 2004).

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CHAPTER 4

The response of *Phragmites australis* to harvesting pressure in the Muzi Swamp of the Tembe Elephant Park, South Africa

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Short title: Response of *Phragmites australis* to harvesting pressure in the Muzi Swamp

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ABSTRACT

Phragmites australis (Cav.) Trin. ex Steud. has been harvested in the Muzi Swamp in Maputaland, South Africa for generations. Over the last 10 years, however, a flourishing trade in this reed has developed. Concern has now been expressed that at the current levels of utilisation the ecological integrity of the Muzi Swamp is being compromised, and that the current harvesting rates are not sustainable in the long term. The hypothesis was put forward that a degradation gradient exists with the most severe degradation occurring the closest to where community members enter the park, and the least degradation the furthest from this point. The results of this study, however, show no distinct degradation gradient. Yet the overall condition of the reeds in the harvesting area is poorer than in the non-utilised area. Expansion of the current harvesting area, coupled with adaptive harvesting systems and yearly monitoring will improve the quality of the reeds within the harvesting area without affecting the harvesting quotas.

KEY WORDS: Conservation, degradation gradient, Muzi Swamp, *Phragmites australis*, resource utilisation, sustainable utilisation

INTRODUCTION

Natural resource utilisation within South Africa's protected areas has become a sensitive issue. Increasing demand by communal rural communities for access to the renewable natural resources in protected areas has come about through a total degradation of these resources outside the protected areas, and an increasing demand for a specific resource within such an area. The occurrence of these natural resources within protected areas is often a result of total protection, or of the correct and prudent management of the resources.

When the Tembe Elephant Park was proclaimed in 1983, it was agreed that controlled harvesting of the natural resources within the park by the neighbouring communal rural communities would be allowed. The common reed (*Phragmites australis* (Cav.) Trin. ex Steud.) is currently being harvested in the Muzi Swamp within the Tembe Elephant Park under this agreement, because it is no longer readily available outside the park.

The harvested reeds are used in hut-wall construction, craftwork, and for thatching material (Cunningham, 1985; Begg, 1988; Browning, 2000; Tosh, 2000). The reed beds generate a substantial income for the neighbouring Sibonisweni community members, because most of the harvested reeds are sold elsewhere for use as building material. These reeds are often the only source of income for many of the community members, a development that was not originally planned for. The reed bundles that are not sold, are used by the Sibonisweni community themselves as building material, and in socio-cultural activities such as burial ceremonies (Browning, 2000).

Ezemvelo KwaZulu-Natal Wildlife is responsible for managing the Tembe Elephant Park and has raised the concern that the *Phragmites australis* dominated Muzi Swamp is being overutilised because the reeds are now also being harvested for commercial sale, and not just for subsistence use as was originally intended (Kyle, 2001 *pers.comm.*[1]). The Sibonisweni community members are in turn concerned that the quality of reeds that are being harvested within the area allocated to them, is deteriorating. Since the proclamation of Tembe Elephant Park in 1983 up to and including 1995, no harvesting quotas existed. In 1996, a harvesting quota was implemented to reduce the volume of reeds harvested from approximately 16 000 bundles per year, to the current quota of some 8 000 bundles per year (Kyle, 2000).

The most heavily utilised reed beds within the Muzi Swamp are those harvested by the Sibonisweni community. The proximity of this community to the tar road has lead to a flourishing trade in this reed resource. Members of the Sibonisweni Reed Cutting Association enter the park at KwaMsomi Gate in the south, and harvest the reeds northwards from there for approximately 1.7 km. Reeds of the desired quality are selected and are harvested by using a machete. Each harvester is allowed to cut a single bundle of reeds per day, sometimes weighing up to 64 kg, which must be carried out of the park. The reed bundles are then sorted into smaller, more manageable bundles at KwaMsomi Gate, before being taken to the tar road for sale.

Many factors have been regarded as being detrimental to reed growth, but it has been difficult to quantify this negative effect (Granéli, 1989; Ostendorp, 1989). One of the

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most obvious factors affecting reed growth is that of harvesting. Both the intensity and temporal range of harvesting have an effect on the degree of regeneration and rehabilitation of the reeds (McKean, 2001). Persistent nutrient loss from the above-ground parts because of harvesting during the growing season, causes a decline in the amount of nutrients returned to the rhizomes (Mook and Van der Toorn, 1982). Removal of aerial parts during the growing season prevents full recovery and regrowth in the spring (Čižková *et al*., 2001).

The hypothesis that is tested here is that the utilisation pressure on the reeds of the Muzi Swamp in the Tembe Elephant Park will show a gradient of use, starting with the highest utilisation pressure close to the entrance gate, followed by a gradual reduction in utilisation pressure the further away from that point. If such a utilisation gradient were present, it should be reflected in changes in the measurable properties of reed quality, such as reed height, diameter, density and biomass per unit surface area. These aspects are examined here to test the above hypothesis.

STUDY AREA

The study area is situated in the eastern portion of Tembe Elephant Park in KwaZulu-Natal, Maputaland, South Africa (Figure 1). It forms a polygon between the following coordinates: 26º 53' 08'' S and 32º 34' 58'' E, 26º 53' 04'' S and 32º 34' 59'' E, 27º 01' 25'' S and 32º 29' 54'' E and 27º 01' 24'' S and 32º 29' 44'' E. The Muzi Swamp extends northwards from KwaMsomi Gate in the south to Muzi Gate in the north, from where it continues into Mozambique (Figure 1).

The section of the Muzi Swamp that lies within Tembe Elephant Park is approximately 560 ha in size. It lies on Holocene peat deposits that are controlled by the topography of the underlying Pleistocene KwaBonambi coastal dunes (Grundling, 1996). The Muzi Swamp is an elongated interdune valley that is orientated parallel to the present coastline. This interdune peatland and isolated wetland are fed by groundwater from perched aquifers within the sand dunes (Grundling, 1999). The entire Muzi Swamp is dominated by *Phragmites australis* that is sparsely interspersed with open water, higher lying islands and hygrophilous grasses (Matthews *et al*., 2001).

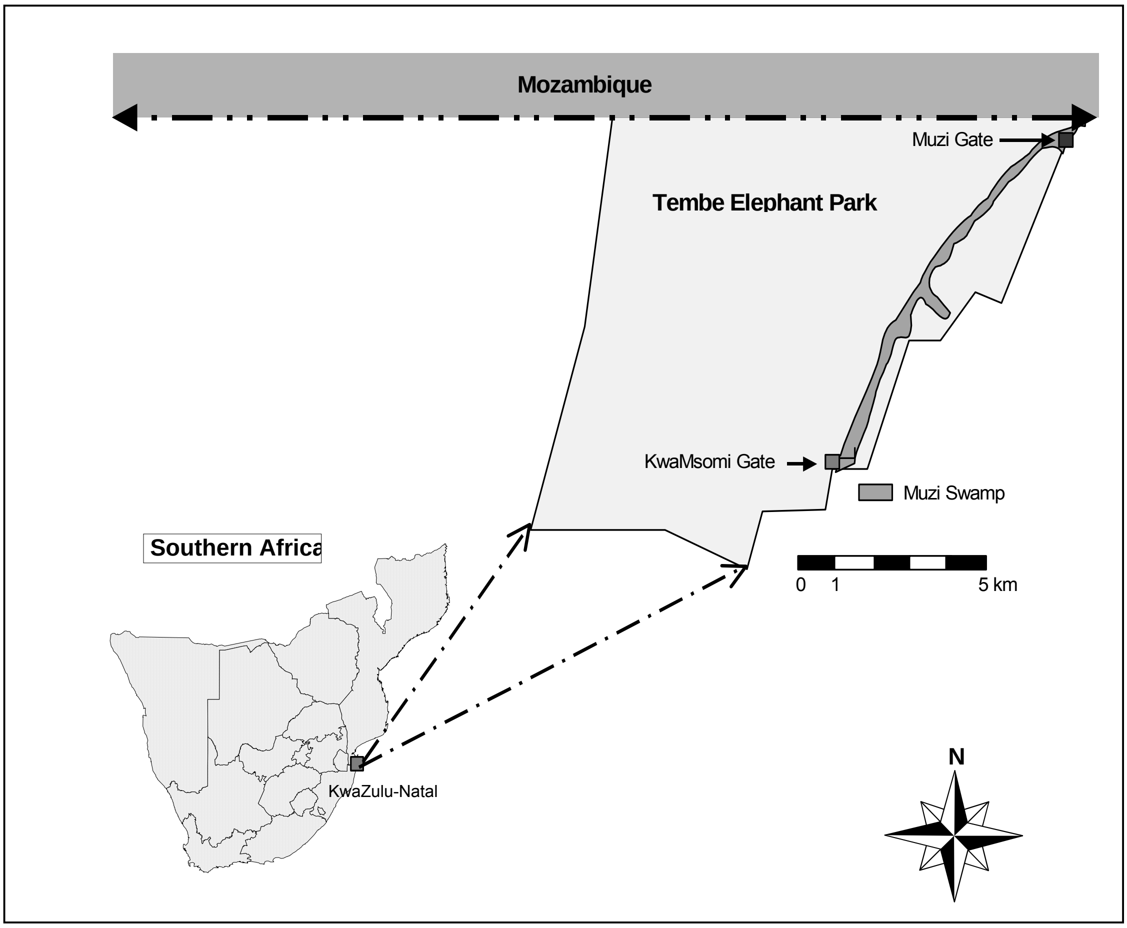


Figure 1: The location of the Muzi Swamp in the Tembe Elephant Park, South Africa.

The mean annual rainfall is 721.5 mm. The minimum recorded annual rainfall is 245.0 mm, while the recorded maximum is 2 105.0 mm. The temperature in Tembe Elephant Park ranges from an extreme minimum of 4ºC to an extreme maximum of 45ºC (Figure 2). The proximity of Tembe Elephant Park to the coast and its low-lying topography result in a high relative humidity of the air (KwaZulu-Natal Nature Conservation Service, 1997).

METHODS

The reed beds in the southern section of the Muzi Swamp were sampled from south to north. Experimental sites were set out approximately every 100 m, starting 300 m from the fence near KwaMsomi Gate (Table 1). Thirteen sites were selected and were referenced by using a Global Positioning System (GPS). Site 13 was considered to be representative of natural areas within the Muzi Swamp where no harvesting is allowed. To ensure uniform sampling of the *Phragmites australis* community, experimental sites were set out approximately 30 m away from the ecotone of the *Phragmites australis* community and the hygrophilous grassland community (Matthews *et al*., 2001).

At each experimental site six replicate quadrates were harvested by using a 1 m^2 frame. All the reeds within the square frame were cut with secateurs at water level, or at ground level in the absence of water. The stem diameter (mm) and reed height (m) were measured for each cut reed within the quadrate. The basal stem diameter was measured by using callipers. The reed height was measured with a tape measure from the stem base to the outstretched apical-leaf blade. To correct for water depth, the water level at each site was added to the mean reed height to obtain total reed height. The number of reeds harvested per sample quadrate was counted to determine the reed density per m^2. The total mass of all the reeds harvested within each sample quadrate was measured in kilogrammes by using a spring balance.

The environmental variables recorded at each site were (Table 1): the distance from the gate; the time since the last harvest by the reed cutters; the degree of trampling; and the water depth. The time since the last harvest by the reed cutters was estimated in two-monthly intervals, with the most recent harvests occurring <2 months before the experimental harvesting trial, and the least recent harvest occurring >10 months before the experimental

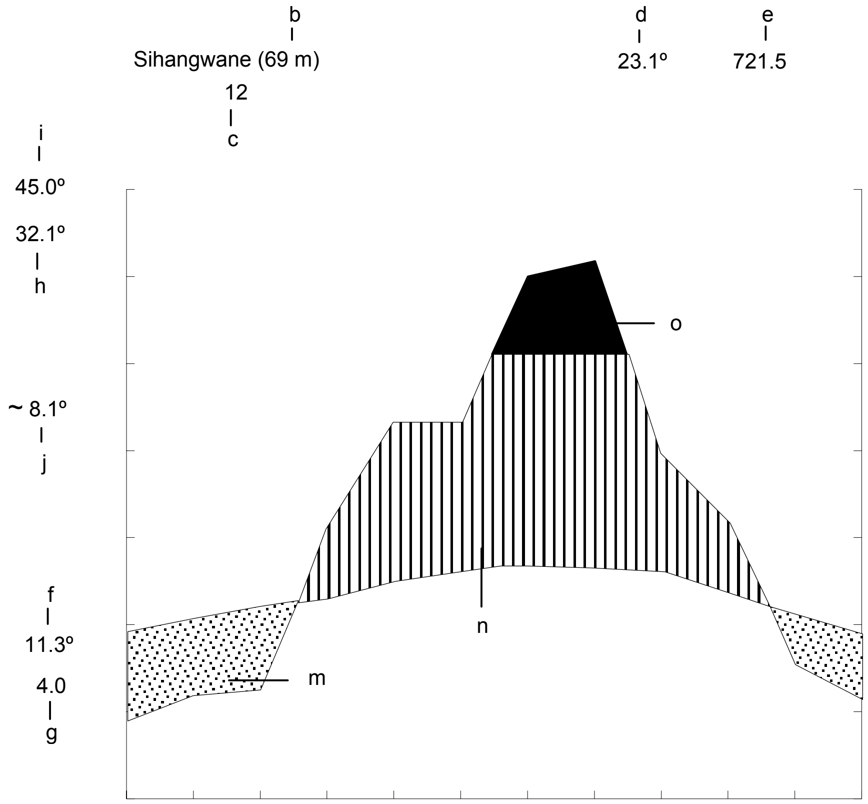


Figure 2: Climatogram of Sihangwane Weather Station, Tembe Elephant Park, following Walter and Moore, 1994). b = height above sea-level in m; c = duration of observations in years; d = mean annual temperature in ºC; e = mean annual precipitation in mm; f = mean daily minimum of the coldest month; g = lowest temperature recorded; h = mean daily maximum of the warmest month; i = highest temperature recorded; j = mean daily temperature variation; m = relative period of drought; n = relative humid season; o = mean monthly rainfall > 100 mm.

Table 1. *Environmental factors at sites in the reed bed in the Muzi Swamp of Tembe Elephant Park, South Africa. Distance from fence indicates distance away from the boundary fence at the KwaMsomi Gate, the degree of trampling by humans and animals is indicated on a 5-point sclae, time since last utilisation in months, and water depth in metres.*

Plot	Distance from fence (m)	Trampling	Utilisation	Water depth (m)
1	300	3	> 6-8	0.00
2	400	3	> 8-10	0.00
3	500	4	< 2	0.00
4	600	3	> 2-4	0.02
5	700	3	> 6-8	0.31
6	800	2	> 10	0.36
7	900	3	> 2-4	0.21
8	1 000	3	> 4-6	0.22
9	1 100	2	> 8-10	0.10
10	1 500	2	> 10	0.18
11	1 600	1	> 8-10	0.16
12	1 700	2	> 6-8	0.05
13	1 800	1	-	0.37

Trampling: high = 5, low = 1

harvesting trial. The degree of trampling at the sites was recorded on a scale of 0 to 5, with 0 being the lowest degree of trampling and 5 being the highest degree of trampling. The creation of channels and paths most often used by reed cutters, the elephant *Loxodonta africana*, buffalo *Syncerus caffer* and black rhinoceros *Diceros bicornis* had longer lasting and more visible impacts, compared with the more subtle degrees of trampling by smaller animals such as the warthog *Phacochoerus africana* and reedbuck *Redunca arundinum*. The water level was measured by using a metal dropper attached to a thin aluminium plate to prevent the penetration of the rod into the peat layer.

The mean height (m), diameter (mm), density per m^2, yield (kg per m^2) and mean mass per reed (g) were calculated for each sample quadrate. These values were used as replicates to calculate the mean values for each site. The site means were used in linear regression models to test for correlations between reed characteristics and environmental variables. An Analysis of Variance (ANOVA), and *post hoc* Bonferroni tests of the Statistica 6 computer package (StatSoft Inc., Tulsa, Oklahoma, U.S.A) were used to determine statistically significant differences between the reed characteristics at the various sites. The frequency distribution of reeds encountered in various height and diameter classes was plotted against the distance away from the starting point.

RESULTS AND DISCUSSION

Reed height

Reed height was not significantly correlated with the gradient of increasing distance away from the boundary fence at KwaMsomi Gate towards the northern parts of the utilisation area or with trampling (Table 2). Reed height was, however, strongly positively correlated with the time since the last harvest by the reed cutters and weakly positively correlated with water depth (Table 2). The results of the *post hoc* test are indicated in Figure 3a. Site 3 that had been harvested by the reed cutters less than 2 months before the experimental trial, had the shortest reeds (mean ± se: 0.32 ± 0.05 m), while site 13 had the tallest reeds (mean ± se: 2.04 ± 0.10 m). There was a significant difference in reed height ($p<0.01$) between site 13 and the rest of the sites. The disparity between site 13 and the rest of the sites can be attributed to its location in the non-utilised area where reeds have never been harvested, implying that

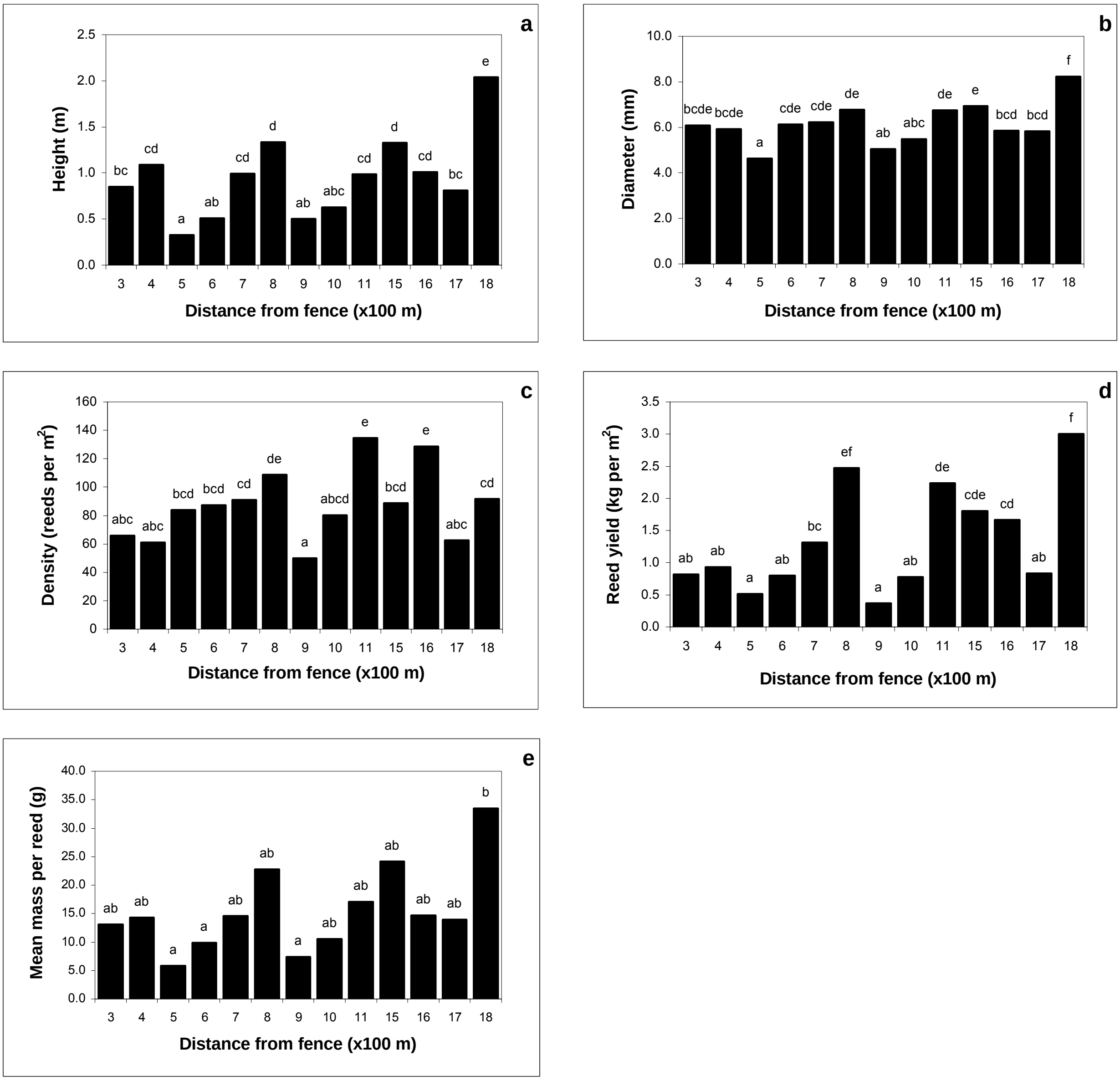


Figure 3: Reed characteristics at sites along a transect from the southern border of the Tembe Elephant Park from site 1 northwards to site 13. (a) Mean reed height; (b) mean reed diameter; (c) mean reed density; (d) mean reed biomass; (e) mean mass per reed. Bars with the same superscripts do not differ significantly (p>0.05).

Table 2. *Simple linear regression between various measures of reed quality and environmental variables. r^2 values and p-values are shown. An asterisk denotes a statistically significant relationship at α = 0.05.*

	Distance from fence		Degree of trampling		Time since last utilisation		Water depth	
	r^2	p	r^2	p	r^2	p	r^2	p
Reed height	0.269	0.069	0.020	0.640	0.885	0.000*	0.368	0.028*
Reed diameter	0.219	0.107	0.011	0.735	0.739	0.000*	0.274	0.066
Reed density	0.092	0.314	0.032	0.556	0.156	0.181	0.079	0.353
Reed yield	0.266	0.071	0.089	0.321	0.74	0.000*	0.405	0.079
Mean mass per reed	0.257	0.076	0.050	0.461	0.821	0.000*	0.379	0.025*
Degree of trampling	0.058	0.429	-	-	0.038	0.523	0.115	0.188
Time since last utilisation	0.266	0.071	0.038	0.523	-	-	0.254	0.079
Water depth	0.171	0.159	0.115	0.188	0.254	0.079	-	-

reed harvesting has a negative effect on reed height.

Sites 3, 4, and 7 that had been harvested by the reed cutters within 4 months before the experimental trial (Table 1) did not have a high percentage of tall reeds. These recently harvested sites had a significantly ($p<0.01$) higher frequency of short reeds in the >0.0–0.5 m height class, than sites 6 and 10 that had been harvested more than 10 months before the experimental trial (Figure 4a). New shoots sprouting from the cut stem of harvested reeds accounted for the high frequency of short reeds in the recently harvested sites. As the height classes increase, the frequency of occurrence of reeds in these classes in the recently harvested sites decreases. Site 13 had a significantly ($p<0.01$) higher frequency (mean ± se: 31.5 ± 5.0%) of reeds in the >2.5 m height class than any of the other sites (Figure 4f).

Reed diameter

Reed diameter was not significantly correlated with the distance gradient away from the boundary fence at KwaMsomi Gate, degree of trampling or water depth (Table 2). Reed diameter was, however, significantly positively correlated with the time since the last harvest by the reed cutters (Table 2). Site 3 had the smallest mean reed diameter (mean ± se: 4.64 ± 0.33 mm)(Figure 3b), while site 13 had the largest one (mean ± se: 8.22 ± 0.23 mm). Site 13 had significantly thicker reeds ($p<0.03$) than the utilised sites, implying that utilisation has had a negative influence on the mean reed diameter of the sites.

Site 13 is 1.8 km away from the boundary fence at KwaMsomi Gate and it has a significantly ($p<0.01$) higher frequency (mean ± se: 23.6 ± 2.4%) of reeds in the >10.0 mm diameter class compared with that of any of the sites that were utilised by the reed cutters less than 10 months before the harvesting trial (Figure 5f).

Phragmites australis is a rhizomatous, perennial plant, producing annual aerial shoots. The basal diameter of the emergent shoot is determined by the size of the bud on the rhizome. The rhizomatous growth habit of *Phragmites australis* also determines the reaction to damage caused by harvesting. Early damage to the emergent shoot's apical meristem results in the complete replacement of the shoot from subterranean buds. Damage to the apical meristem of the shoot late in the growing season leads to replacement by several thinner shoots from the above-ground nodes (Van der Toorn and Mook, 1982).

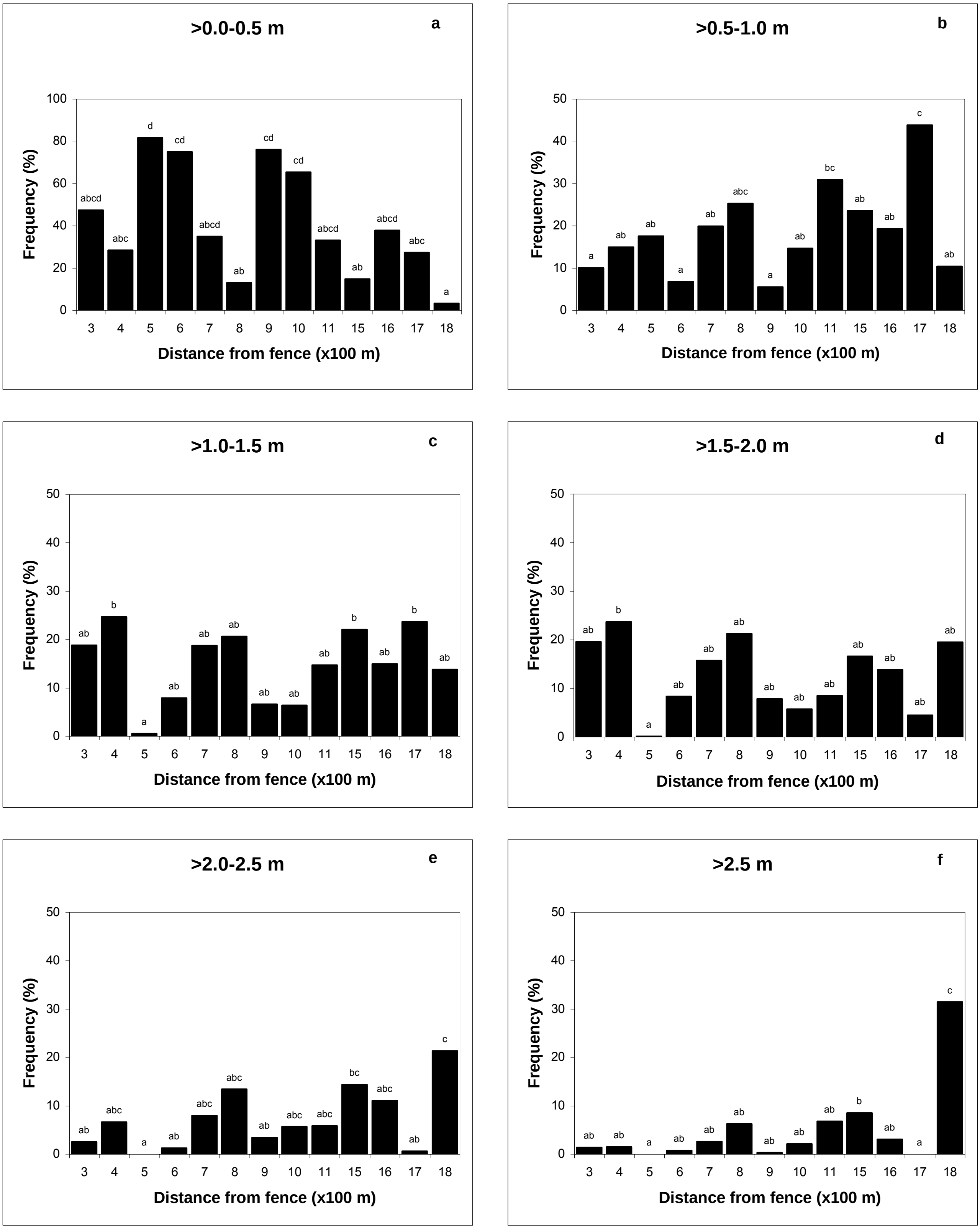


Figure 4: Frequency of height classes of reeds in sites along a transect from 300 m north of the fence at KwaMsomi Gate to 1 800 m north of the fence at KwaMsomi Gate. (a). >0.0-0.5 m height class; (b). > 0.5-1.0 m height class; (c). > 1.0-1.5 m height class; (d). > 1.5-2.0 m height class; (e). > 2.0-2.5 m height class; (f). >2.5 m height class. Bars with the same superscripts do not differ significantly (p>0.05).

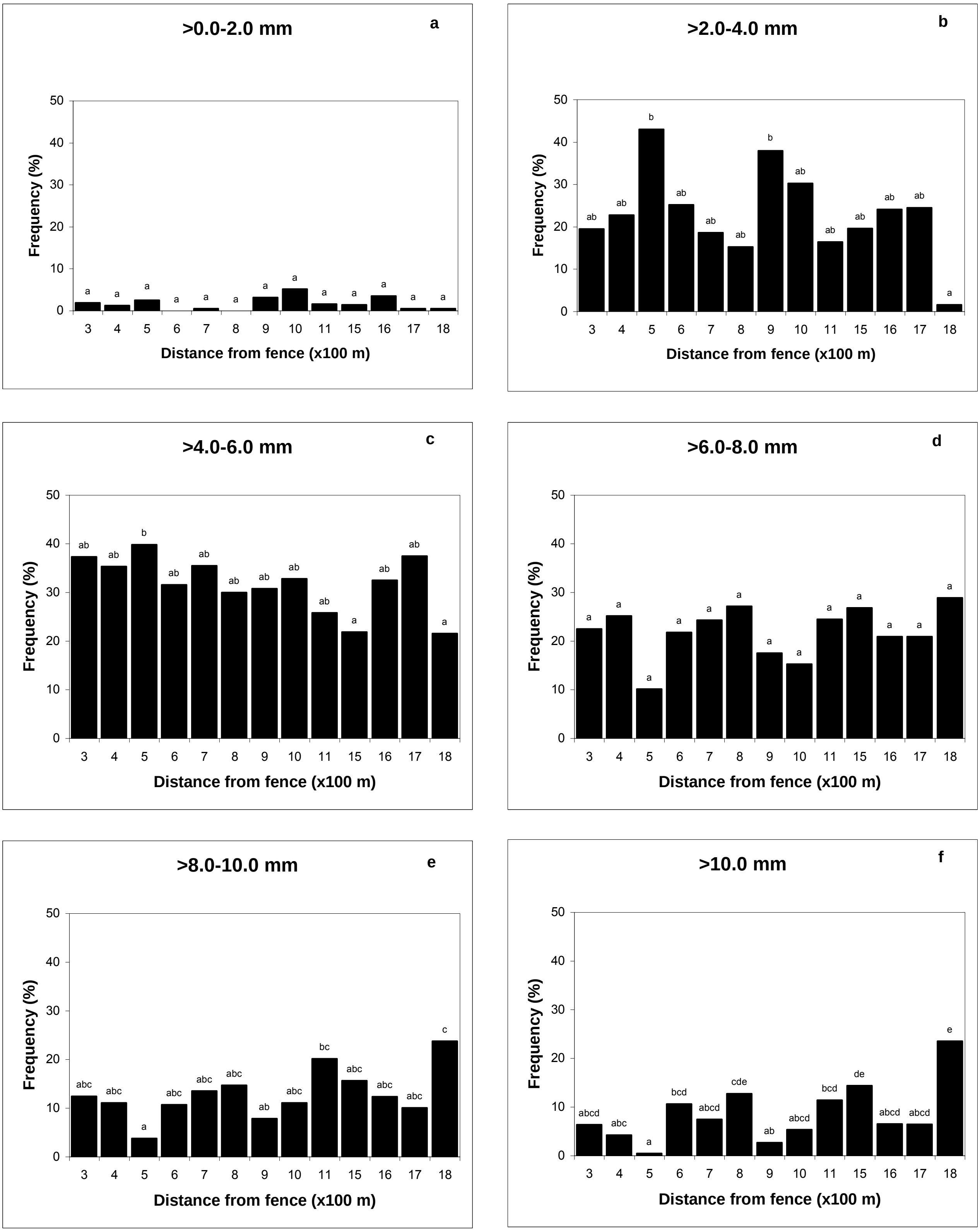


Figure 5: Frequency of diameter classes of reeds in sites along a transect from 300 m north of the fence at KwaMsomi Gate to 1 800 m north of the fence at KwaMsomi Gate. (a) >0.0-2.0 mm diameter class; (b) >2.0-4.0 mm diameter class; (c) >4.0-6.0 mm diameter class; (d) >6.0-8.0 mm diameter class; (e) >8.0-10.0 mm diameter class; (f) >10.0 mm diameter class. Bars with the same superscripts do not differ significantly (p>0.05).

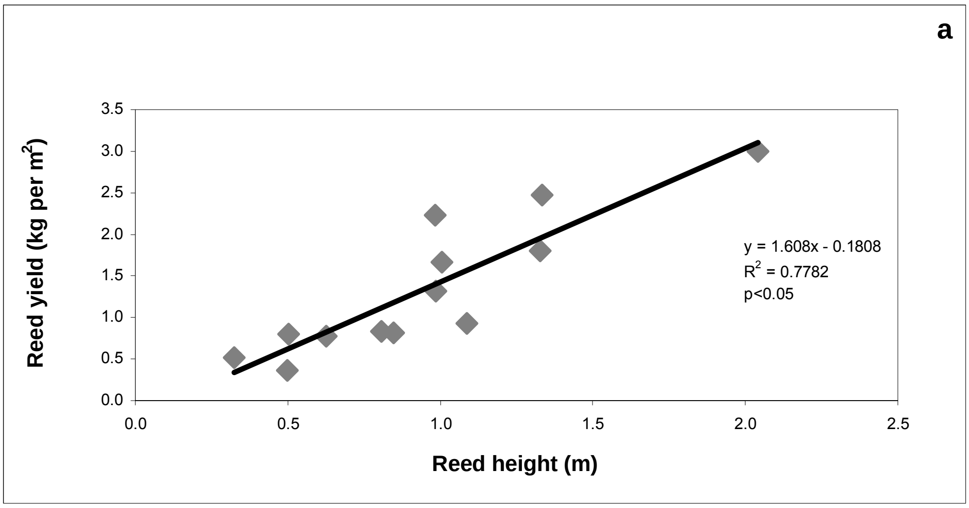
The similarity in the mean diameter of reeds at the various sites can be partly ascribed to the vegetative growth pattern of *Phragmites australis*. Shoots emerging from the rhizome have a basal stem diameter that remains stable throughout the year. An emergent shoot can therefore have a large basal diameter at the beginning of the growing season and not necessarily have grown into a tall reed yet. Nevertheless, Mook and Van der Toorn (1982) found a positive linear correlation between basal diameter and eventual reed height, and reeds with a large basal diameter tend to be proportionately taller than reeds with a small basal diameter. The results of the present study do not reflect this correlation as all the shoots were harvested for the purpose of the study and not only the mature reeds.

Reed density

None of the linear regressions revealed a significant relationship between reed density and the environmental variables that were recorded (Table 2). Reed density did not show a distinct gradient with distance away from the boundary fence at KwaMsomi Gate to the northern sections of the utilisation area (Figure 3c). Site 7 had the lowest mean reed density (mean ± se: 50.00 ± 5.16 reeds per m^2), while site 9 had the highest one (mean ± se: 134.33 ± 11.43 reeds per m^2). Site 13 differs significantly from sites 7 ($p<0.01$), 9 ($p<0.01$) and 11 ($p<0.02$) in terms of reed density, but it did not differ significantly ($p>0.05$) from any of the other sites in this parameter. No predictable effect of reed utilisation on the mean reed density of the reed beds in the Muzi Swamp could be established (Table 2).

Reed yield

As was the case for reed diameter, reed yield per m^2 was not significantly correlated with the distance from KwaMsomi Gate, degree of trampling or water depth (Table 2). Reed yield was, however, significantly positively correlated with the time since the last harvest by the reed cutters (Table 2). Site 7 had the lowest mean reed yield (mean ± se: 0.37 ± 0.15 kg) while site 13 had the highest one (mean ± se: 3.00 ± 0.04 kg) (Figure 3d). There is a significant difference ($p<0.05$) in mean reed yield between site 13 and all of the other sites except for site 6 ($p>0.20$). There is a direct linear relationship between mean reed height and reed yield (Figure 6a).



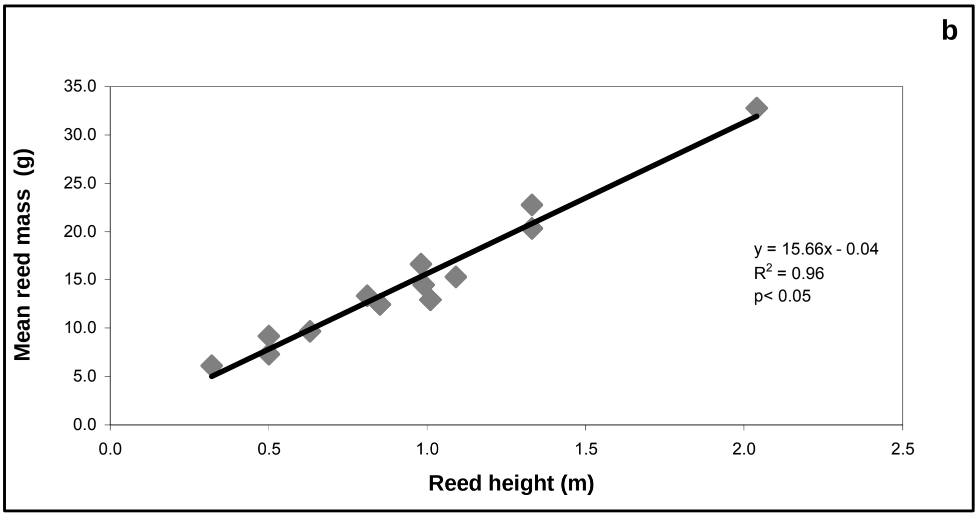


Figure 6: Positive linear relationship between reed height and (a) reed yield and (b) mean reed mass, determined along a transect from 300 m north of the fence at KwaMsomi Gate to approximately 1 800 m north of the KwaMsomi Gate.

Mean reed mass

No significant relationship between mean mass per reed and distance from KwaMsomi Gate or degree of trampling could be demonstrated (Table 2). However, mean mass per reed was strongly positively correlated with the time since the last utilisation and weakly positively with water depth (Table 2). Site 3 had the lowest mean reed mass (mean ± se: 5.77 ± 0.65 g), while site 13 had the highest one (mean ± se: 33.44 ± 2.27 g) (Figure 3e). The mean reed mass in site 13 was significantly higher only from that of sites 3 ($p<0.01$), 4 ($p<0.02$) and 7 ($p<0.01$). Mean reed mass is linearly proportional to reed height (Figure 6b), and differences in the mean reed mass are consistent with the differences in mean reed height for the same sites.

CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

At the current harvesting intensity the structure and size of the reeds fluctuate within the utilisable area in the Muzi Swamp. These fluctuations produce some clear and significant changes in reed quality, but there is no observed gradient in reduced utilisation pressure associated with the distance away from the boundary fence at KwaMsomi Gate in a northwards direction. The lack of such a gradient indicates that the more accessible reeds close to KwaMsomi gate are not under a higher utilisation pressure than those further away. Reed harvesting within the Muzi Swamp is not concentrated entirely to the southern sections of the Muzi Swamp near the KwaMsomi gate, as was expected, due to the limitations placed on the reed cutters' movements. The Sibonisweni reed cutters appear to be harvesting the reeds systematically by selecting areas within the reed bed where reeds of a desirable quality are found. It does also appear that the reed cutters allow a regeneration period before returning to a previously harvested area. However, reed size and structure are not reaching their full potential in the utilisable areas. Reeds outside the harvesting area display an improved quality as is evident from the data obtained in site 13, which is representative of areas where utilisation does not occur.

Areas that were harvested 10 months before the experimental trial showed significantly taller and thicker reeds with a higher reed yield when compared to reed beds outside the utilisation area. The same did not show significant differences in reed density and mean reed mass when compared with reed beds outside the allotted harvesting area. Sites that had been utilised 6 months before the start of the experimental harvesting trial, showed a significantly decreased frequency of reeds in the height class >2.0 – 2.5 m when compared with that of the unutilised site 13. The frequency of reeds occurring in the >2.5 m height class was significantly higher in site 13 than in any of the sites. The results of the frequency of reeds in the various height classes are not reflected in the frequency of occurrence of the reed diameter classes.

The basal diameter of a new reed shoot can be as thick as that of the basal diameter of a fully-grown reed. All reeds were harvested in the quadrates, irrespective of their maturity. This is reflected in the significantly similar diameter frequencies of the sites found in the individual diameter classes. The mean reed diameter at the unutilised site 13 is, however, significantly different from that of all the sites. This might indicate a larger rootstock, and thus improved shoot production, due to greater amounts of nutrient reserves accumulated over time. This is only possible in a reed bed that is allowed adequate recovery time before being re-harvested.

The production potential of the reeds over the entire harvesting area appears to be uniform, but it does not reach the production potential of the areas outside the harvesting area. Reed quality in the harvesting area consistently differs from that of the reed beds outside the harvesting area.

Reed harvesters do appear to be allowing for the regeneration of reeds after harvesting, but the current period of rest between the harvests is not long enough. This can be attributed to the small area within the Muzi Swamp in which the reed cutters are allowed to harvest at present. By increasing the size of the current harvesting area while maintaining similar quotas will allow for the implementation of a rotational resting system. Such a system will allow for a longer recovery period between successive harvests. The extension of the recovery period will result in a healthier rootstock in the long term, and should produce reeds that are comparable in quality to those found outside the utilisation areas.

The expansion of the harvesting area by 30%, or 540 m in a northerly direction, and division of the entire area into three equal sectors for a tri-annual harvest is suggested to allow sufficient time for the recovery of the reed beds to their full potential. Harvesting of these three sectors should only occur in the winter, once the growing season and the nutrient transfer to the rootstock has been completed. The first year's harvest should take place for the larger part in the previously unharvested area, between 1 600 m and 2 400 m north of the fence at KwaMsomi Gate. The second year's harvest should occur in the sector between 800 m and 1 600 m north of the fence at KwaMsomi Gate. The third year's harvest should occur in the sector between the fence to 800 m north of the fence at KwaMsomi Gate. Easily distinguishable posts or markers dividing these sectors should be put in place to avoid any confusion as to the location of the areas. Harvesting quotas should be maintained at their current level, with the focus being to harvest the yearly quota within the winter months, and not to spread the harvest over the entire year as was previously done. Yearly monitoring of the size, number and structure (basal diameter, height and reed density) of the reed bundles being harvested is essential. Non-destructive monitoring of the reed bed structure in the sectors to be harvested in the following years should also be implemented. As an alternative to overutilisation, other sources of building material may also have to be developed. Rehabilitating the degraded reed beds outside Tembe Elephant Park, and developing these for sustainable commercial utilisation will also reduce the harvesting pressure on the reed beds occurring within the park.

The results have shown that the hypothesis put forward at the beginning of the study is incorrect. Reed quality in the Muzi Swamp shows no degradation gradient in a south to north direction in the harvesting area north of KwaMsomi Gate. The study has proved, however, that there is a general reduction in reed quality in the harvested areas.

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The long-term effects of burning and utilisation on *Phragmites australis* reeds in the Muzi Swamp of the Tembe Elephant Park, South Africa

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Abstract

The long-term effect of burning and utilisation of the common reed *Phragmites australis* was investigated in the Muzi Swamp, Tembe Elephant Park over a 2-year period from 2000 to 2002. The effects of four different treatments on the density and size structure of the reed beds were compared. The aim of the study was to determine what consequences utilisation and/or burning have on the reeds within the Muzi Swamp. Continual harvesting combined with burning markedly reduces reed production in terms of reed density. Uncontrolled utilisation results in the overall decrease of reed quality in terms of reed height and diameter. The implications of the results are integral to the further management of the reed beds in terms of providing good quality reeds for neighbouring communities, and to secure the ecological integrity of the ecosystem for conservation.

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Introduction

Phragmites australis (Cav.) Trin. ex Steudel is a common species in both temperate and sub-tropical regions. It tends to dominate the landscape by forming monospecific stands (Granéli, 1989; Den Hartog, Květ, & Sukkop, 1989; Van der Werff, 1991). It occurs in the Muzi Swamp in the form of extensive reed beds interspersed with higher-lying islands and hygrophilous grasses (Matthews *et al*., 2001). The reason for the dominance of *Phragmites australis* in the Muzi Swamp is its competitive advantage over other terrestrial plants that co-occur in the flooded conditions in the swamp. *Phragmites australis'* emergent shoots are not known to succumb to competition from species such as Bulrush *Typha capensis* and Sedge *Cyperus sphaerospermus* (Haslam, 1969b; Matthews *et al*., 2001). The major natural cause for the loss of the reed beds is the terrestrialisation of waterlogged areas (Granéli, 1989). The high production potential of the aerial parts of the reeds and the length of time that it takes for these annual parts, more especially the culms, to decompose, contributes substantially to the rate of terrestrialisation and subsequent loss of their competitive advantage. The dead but not yet decomposed moribund material accumulates which in turn collects silt. This results in drier conditions where other terrestrial plants are able to colonise and survive (Granéli, 1989; Chambers, Meyerson & Saltonstall, 1999). Other natural causes of reduced reed quality include stochastic events such as burning and frost (Van der Toorn & Mook, 1982). However, little is known about the reed beds and the way they maintain their dominance of the habitat that they create over time.

The utilisation of *Phragmites australis* in the Muzi Swamp has resulted in the need for careful study and monitoring of the reed beds in recent times. The commercialisation of the harvesting of reeds by neighbouring local community members has increased the demand for reeds in the area. Reed utilisation by members of the Sibonisweni Reed Cutters Association has reached a peak as far as maintaining the inherent quality of the reeds in the Muzi Swamp is concerned. There is some evidence that reed quality is declining in the utilisable areas in the southern Muzi Swamp because of overutilisation (Tarr, Van Rooyen & Bothma, 2004). In the case of the Tembe Elephant Park, local communities have harvested reeds in the Muzi Swamp for use in hut building, craftwork and thatching material for many generations (Cunningham, 1985; Begg, 1988; Browning, 2000; Tosh, 2000). Reeds have also been used in other parts of the world for paper pulp, heating, forage and litter material (Allirand & Gosse, 1995). In the past the harvesting of reeds was done purely for subsistence use but currently a flourishing market has emerged from the sale of reeds. Increasing demand for reeds and a mounting utilisation pressure on the harvesting area has already influenced the quality of the reeds negatively in the harvesting areas within the Muzi Swamp (Tarr *et al*., 2004).

The severity of the influence of harvesting on the quality of the reeds within the Muzi Swamp partly depends on the time at which reeds are harvested. Although the Tembe Elephant Park's management staff encourages harvesting in the winter in the Muzi Swamp, harvesting still occurs in the summer. Quotas are reduced in the summer compared with the winter. Evidence suggests that like most other pastures, harvesting during the growing season has a detrimental effect on the next replacement crop. Harvesting during the reed emergence period in early spring (August to early September) has little effect on the reed quality and produces a replacement crop similar to an unharvested population. However, harvesting in the summer (late September to April) reduces growth for up to half the growing season. This effectively depresses the production potential of *Phragmites australis*. Continual harvesting of reeds in the early summer or the latter half of the growing season will result in a persistent reed population but it will also greatly reduce the condition and quality of the reeds produced (Haslam, 1969b).

Especially in Africa, fires are a determining factor in the dynamics of terrestrial ecosystems (Van Wilgen & Scholes, 1997). Fire as a management tool has been used successfully in many areas in South Africa. The use of fire to remove moribund and unacceptable plant material, stimulate rotational grazing, prevent bush encroachment, and to reduce the numbers of parasites such as ticks are all examples of this type of management (Trollope, 1990; Van Rooyen, 2002). The practice of burning by local farmers and individuals involved in palm wine tapping (traditional alcoholic drink made from the sap of the lala palm *Hyphaene coriacea*), has had an unknown effect on the ecology of the area. These practices have been recorded since the 1500's when the Portuguese sailed past Maputaland and named it *Terra dos Fumos*, from the endless grass fires lit by the local tribes people (Bruton, Smith & Taylor, 1980). Fires started outside Tembe Elephant Park frequently enter the reserve and occasionally even penetrate the waterlogged areas of the reed beds. Although

Phagmites australis beds are known to burn every two to five years according to Van Wilgen and Scholes (1997), the effect of the sporadic fire events in the Muzi Swamp is yet to be determined. The impact of fire and harvesting on the density, basal diameter and reed length of individual reeds in the Muzi Swamp was first investigated in 2000 (Tosh, 2000).

The former expansive reed beds outside Tembe Elephant Park have all but vanished because of its uncontrolled harvesting. Controlled harvesting within the Tembe Elephant Park has ensured that the resource base remains intact. The objective of the study was to determine what the effects of burning and utilisation have on the reed quality within the reedbeds. The study was deemed necessary to determine what type of management systems need to be implemented to maintain reed quality in the unharvested areas and improve reed quality in the harvested areas within the Muzi Swamp. It is important that the work undertaken in this study be applicable and pliable to both the Tembe Elephant Park's management staff as well as the Sibonisweni community members that utilise the resource. It was hoped that a detailed study of the Muzi Swamp would result in a greater understanding of the workings of the reed as a resource and thereby promote conflict resolution for the parties involved.

Study area

The study area is situated in the eastern portion of Tembe Elephant Park in KwaZulu-Natal, Maputaland, South Africa (Fig. 1). It forms a polygon between the following WGS 84 coördinates: 26º 53' 08'' S and 32º 34' 58'' E; 26º 53' 04'' S and 32º 34' 59'' E; 27º 01' 25'' S and 32º 29' 54'' E; and 27º 01' 24'' S and 32º 29' 44'' E. The Muzi Swamp extends northwards from south of the KwaMsomi Gate to the Muzi Gate in the north, where it continues into Mozambique and becomes the *Rio Futi*.

The portion of the Muzi Swamp that lies within Tembe Elephant Park is approximately 560 ha in size. It lies on Holocene peat deposits that are controlled by the topography of the underlying Pleistocene KwaBonambi coastal dunes (Grundling, 1996). The Muzi Swamp is an elongated interdune valley that is orientated parallel to the present coastline because of the dune topography. This interdune peatland and isolated wetland are fed by groundwater from perched aquifers within the sand dunes (Grundling, 1999).

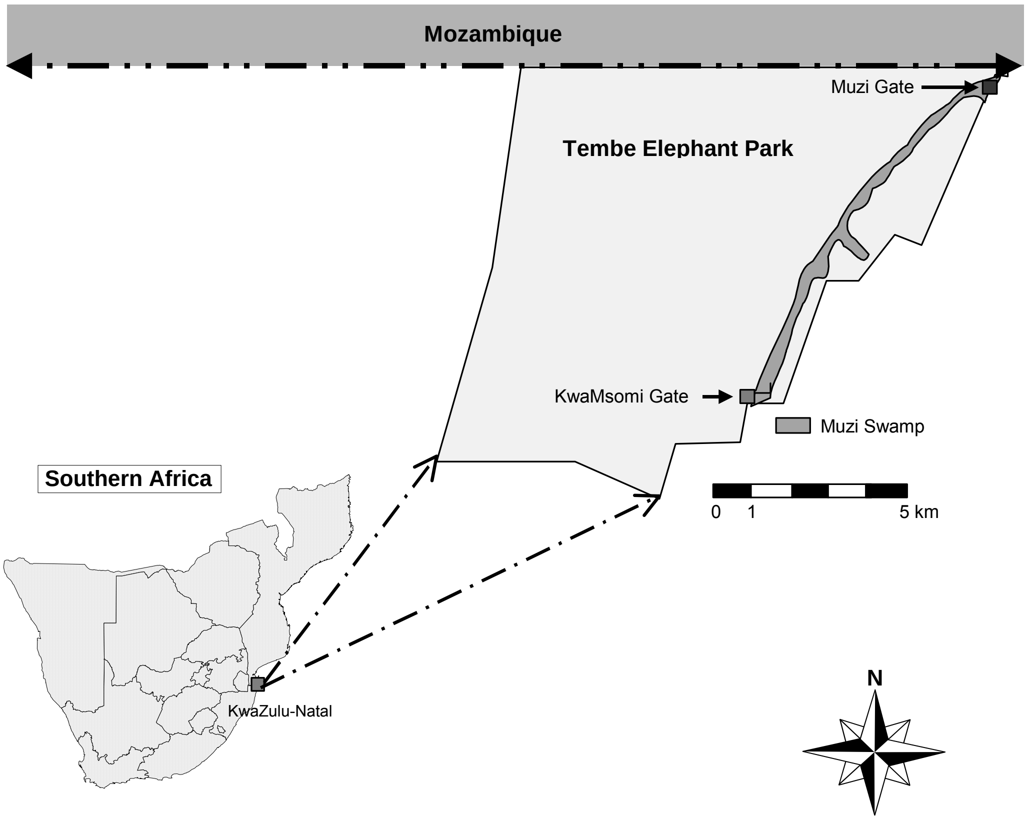


Fig. 1 The location of the Muzi Swamp in Tembe Elephant Park, South Africa.

The mean annual rainfall is 721.5 mm. Most of the rainfall occurs in the summer, but it is not limited to the summer and some precipitation occurs throughout the year. The minimum recorded annual rainfall is 245.0 mm, while the maximum is 2 105.0 mm. The ambient temperature in Tembe Elephant Park ranges from a minimum of 4.0ºC to a maximum of 45ºC. The climatological data for the study area appear in Figure 2. The proximity of Tembe Elephant Park to the coast and its low-lying topography results in a high relative humidity of the air (KwaZulu-Natal Nature Conservation Service, unpublished data).

Materials and methods

This study was part of an MSc (Wildlife Management) by the senior author. Harvesting plots that had been sampled in 2000 were revisited in 2002. These included areas that had undergone four different treatments before the initial harvesting trial in 2000. These treatments were: (i) utilised and burnt, (ii) utilised and unburnt, (iii) unutilised and burnt, and (iv) unutilised and unburnt. Six 1 m^2 quadrates (sample plots) were destructively harvested at each of the harvesting plots. Burnt and unburnt sites within a specific utilisation zone were close to each other to minimise possible effects of other environmental factors. All the reeds within a 1 m^2 square frame were harvested at water level, or at ground level in the absence of water.

The stem diameter (mm) and reed height (m) were measured for each reed. The basal stem diameter was measured by using callipers. The reed height was measured by using a tape measure from the stem base to the tip of the outstretched apical-leaf blade. Total reed height was obtained by correcting for water depth. This was consistent with the methods of Tosh (2000). The number of reeds harvested per sample plot was counted to determine the reed density per m^2.

Results were analysed using a multifactor analysis of variance (ANOVA) with the General Linear Model of the Statistical Analysis Systems (1994) computer package at $\alpha = 0.05$. Fischer's protected least significant difference (LSD) test was used to determine significant differences between means.

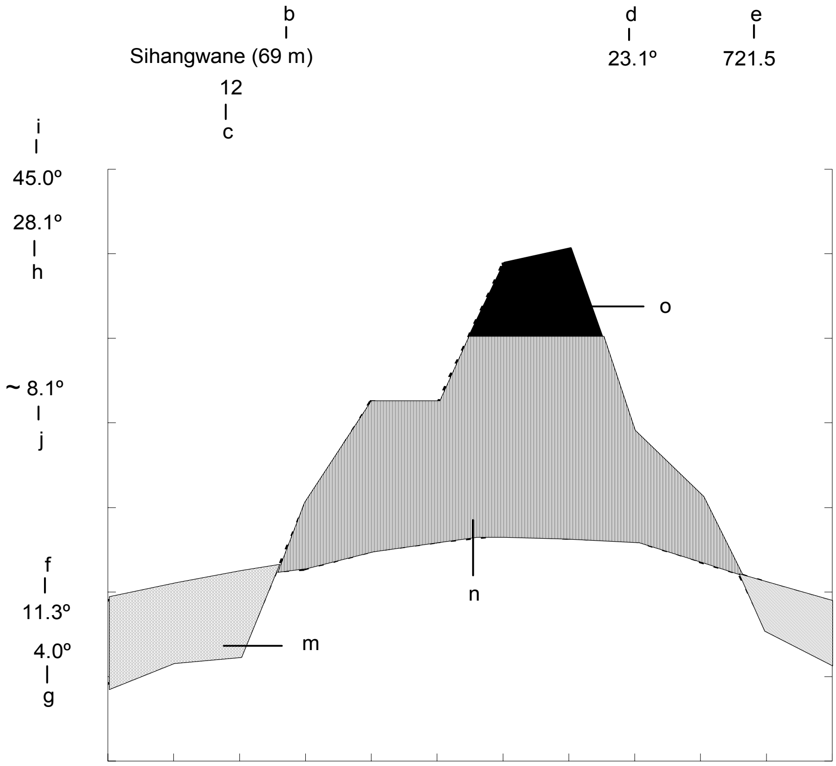


Fig. 2 Climatogram of Sihangwane Weather Station, Tembe Elephant Park, following Walter (Cox and Moore, 1994). b = height above sea-level in m; c = duration of observations in years; d = mean annual temperature in ºC; e = mean annual precipitation in mm; f = mean daily minimum of the coldest month; g = lowest temperature recorded; h = mean daily maximum of the warmest month; i = highest temperature recorded; j = mean daily temperature variation; m = relative period of drought; n = relative humid season; o = mean monthly rainfall > 100 mm.

Results and discussion

The results of the statistical analysis are summarised in Table 1 and show the following:

Reed height

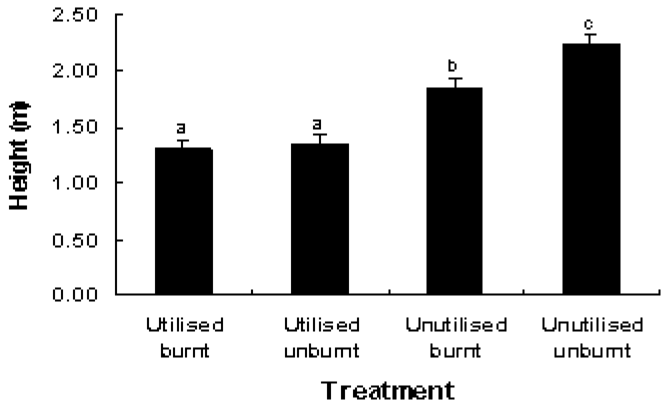
The mean reed height of areas within the Muzi Swamp that had undergone various treatments differed significantly between the utilised and the unutilised reed beds (Fig. 3A). Utilised reed beds had shorter reeds than the mean height for unutilised ones. In the unutilised areas the unburnt reeds were also significantly (P = 0.0015) taller than the burnt reeds. Constant utilisation of the reedbeds has therefore lead to a significant reduction in reed height in the utilised reedbeds. The potential reed height cannot be reached if the environment is permanently unfavourable (Haslam, 1969a) or in this case constantly utilised.

There is also a significant difference between the mean reed height over the entire sample area between 2000 and 2002 (Fig. 3B). The mean reed height in 2000 was significantly lower than that in the same areas in 2002. The unusually high rainfall that was experienced in 1999/2000 might explain this phenomenon. The summer season prior to the 2000 harvest was an exceptionally wet season with 1 541.3 mm of rain falling from August 1999 to June 2000. Extraordinarily high water levels in the Muzi Swamp, due to flooding in southern Mozambique and northern KwaZulu-Natal at this time, could also have resulted in a lower than expected biomass and subsequent replacement crop because of damage to reeds during that growing season. It is known that elevated water levels for extended periods can prevent shoot emergence in *Phragmites australis* (Armstrong *et al*., 1999).

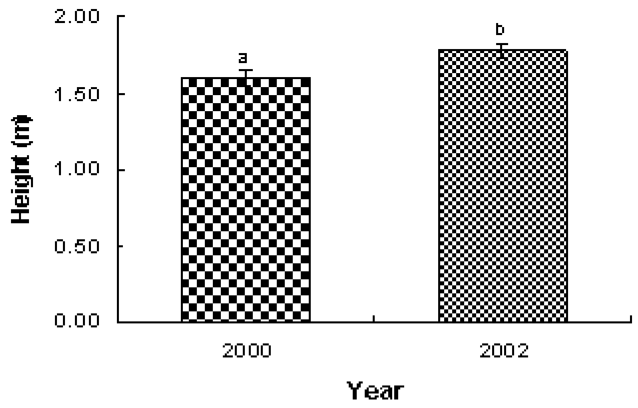
The combined effect of year and treatment also supported a significant difference between the reed height in the utilised and unutilised areas with the unutilised reeds being taller than the utilised ones (Fig. 3C). Within the utilised zone, year of examination and burning did not significantly affect reed height. However, in the unutilised zone the unburnt reeds were significantly taller than all the other treatments in 2002. The unutilised unburnt areas in 2002 had apparently recovered from the damage sustained in the flooding in 1999/2000, and were producing taller reeds than at the previous burnt site.

Table 1: *Analysis of variance results for a comparison of Phragmites australis reed height, diameter and density by comparing utilised burnt, utilised unburnt, unutilised burnt and unutilised unburnt treatments from 2000 to 2002 in the Muzi Swamp, Tembe Elephant Park.*

	Height (r^2 = 0.70)				Diameter (r^2 = 0.74)				Density (r^2 = 0.40)			
Source of variation	df	Sum of squares	F	Pr>F	df	Sum of squares	F	Pr>F	df	Sum of squares	F	Pr>F
Time	1	0.45	5.16	0.0276	1	23.23	33.01	< 0.0001	1	4210.01	5.10	0.033
Treatment	3	8.24	31.26	< 0.0001	3	42.26	20.02	< 0.0001	3	21509.35	8.69	< 0.0001
Time X Treatment	3	1.66	6.29	0.0011	3	35.19	16.67	< 0.0001	3	4969.07	2.01	0.126
Total	7	10.35	-	-	7	100.68	-	-	7	30688.43	-	-



(B)



(C)

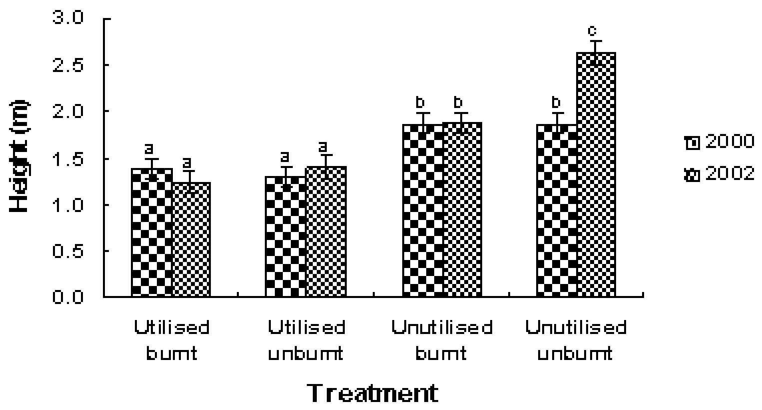


Fig. 3 Mean reed height under different utilisation and burning regimes in two years in the Muzi Swamp, Tembe Elephant Park. (A) Marginal means for different treatment as main effect. (B) Marginal means for year as main effect. (C) Cell means for all combinations of treatment and year. Bars with the same superscripts do not differ significantly by Fisher's least significance test at $\alpha = 0.05$.

Reed diameter

There was a significant difference in mean reed diameter between the utilised and unutilised reedbeds within the study area when the effects of time were removed from the data (Table 1) (Fig. 4A). This implies that if the effects of time are removed, then the unutilised reedbeds will produce thicker reeds. The mean diameter of the unutilised burnt reedbeds was also significantly smaller than that of the unutilised unburnt ones.

If the effects of the various treatments were removed from the data (Fig. 4B) then the mean diameter of the reeds collected in 2002 was significantly larger than in 2000. This reduction could be ascribed to the damage from the flooding in 2000. Reedbeds that experience a stochastic event such as a flood or fire later in the growing season do not recover fully during that season. Nutrient return to the rhizomes is reduced after such an event because of a lack of aerial parts that are required in the photosynthetic process. This inhibition of nutrient return will also cause a lack of nutrient reserves in the rhizomes, which in turn will cause a limited production of thick reeds during the next growing season (Haslam, 1969b; Thompson & Shay, 1985; Granéli, 1989). Reed buds require a substantial amount of nutrients from the rhizomes until they reach a critical height. Thereafter photosynthesis allows the reed to meet its own energy requirements (Allirand & Gosse, 1995).

There were no clear trends in terms of the variations in reed diameter when the combined effects of time and treatment are examined (Fig. 4C). There is, however, a significant difference between the unutilised unburnt reedbeds of 2002 and all of the other reedbeds.

Reed density

Both main effects, namely year and treatment, significantly affected reed density (Table 1). When the effects of time were removed from the data the two types of burnt reedbeds had similar reed densities, as did the two unburnt ones (Fig. 5A). The differences in reed density between the burnt and unburnt reedbeds were not significant. However, there was a significant reduction in reed density between the utilised burnt reedbeds and the utilised unburnt one. This emphasises the damage that an untimely burn, followed by continual harvesting can inflict on a reedbed.

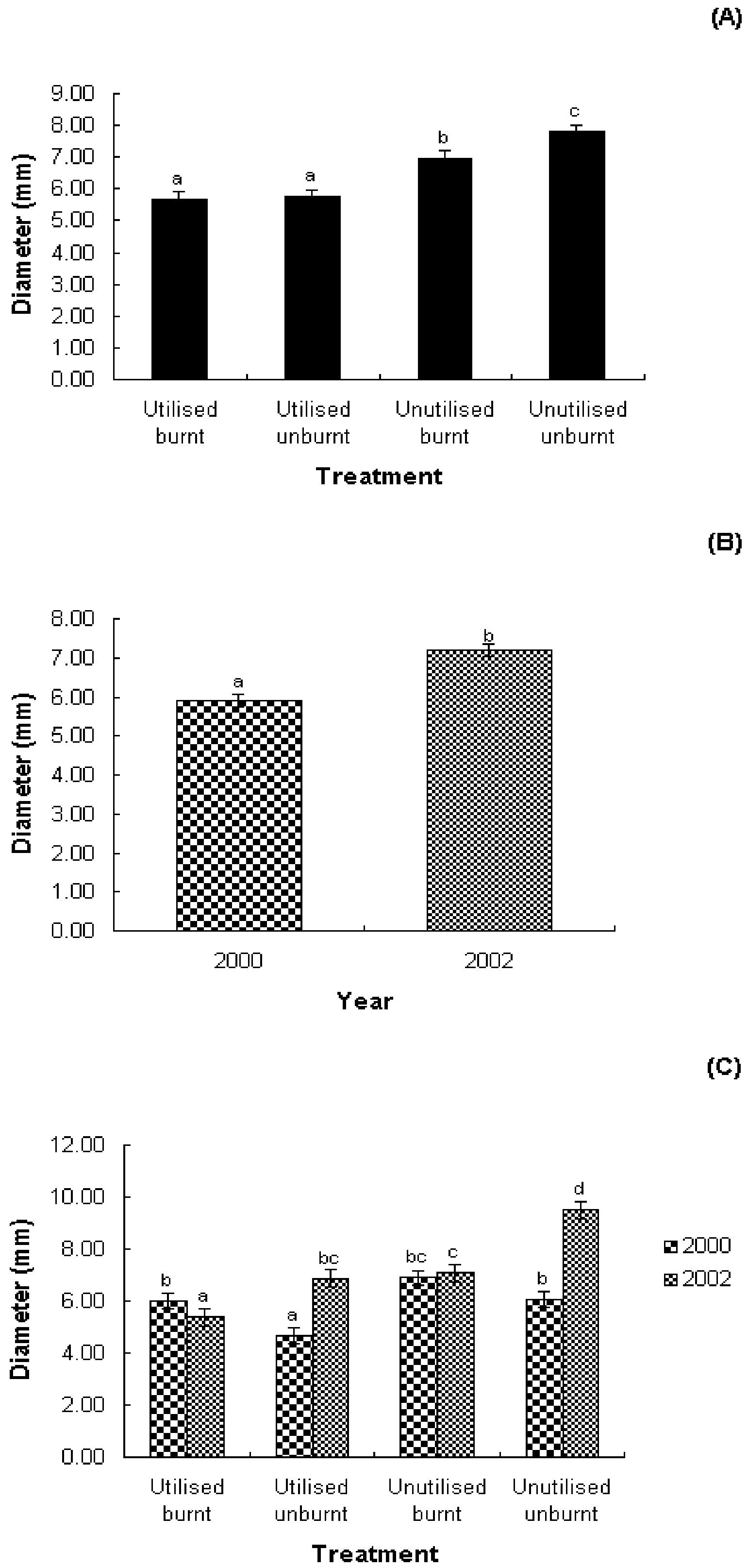


Fig. 4 Mean reed diameter under different utilisation and burning regimes in two years in the Muzi Swamp, Tembe Elephant Park. A. Marginal means for different treatment as main effect. B. Marginal means for year as main effect. C. Cell means for all combinations of treatment and year. Bars with the same superscripts do not differ significantly by Fisher's least significance test at α = 0.05.

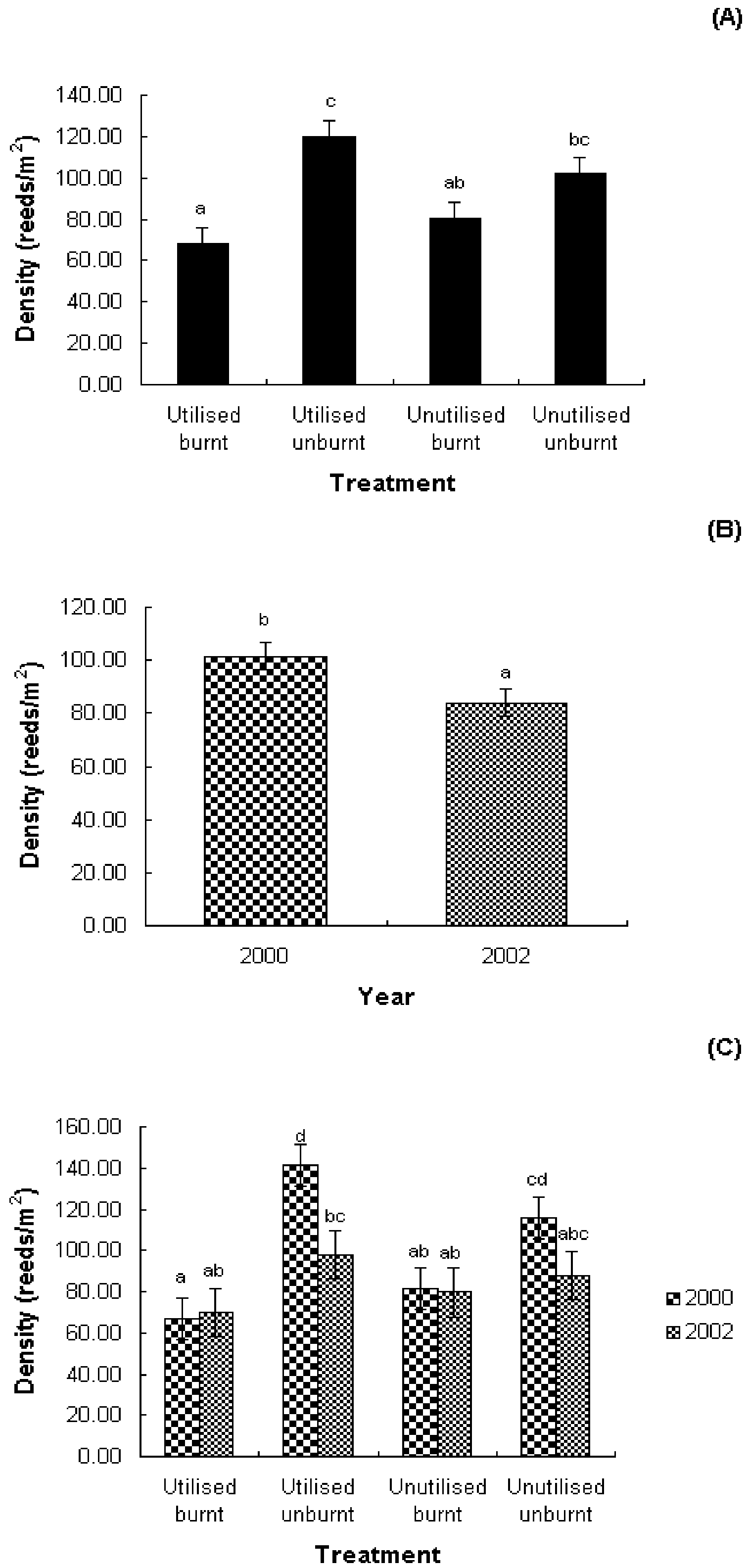


Fig. 5 Mean reed density under different utilisation and burning regimes in two years in the Muzi Swamp, Tembe Elephant Park. A. Marginal means for different treatment as main effect. B. Marginal means for year as main effect. C. Cell means for all combinations of treatment and year. Bars with the same superscripts do not differ significantly by Fisher's least significance test at α = 0.05.

Utilisation increases reed density through the reduction of apical dominance in individual reeds. This elicits a vegetative response from the reed in which an abundance of side shoots are produced. When a terminal bud is harvested, it stimulates the production of numerous side shoots from the nodes of the harvested or damaged reed, thereby increasing reed density (Haslam, 1970; Van Der Toorn & Mook, 1982). The combination of harvesting and burning reduces reed density and should not be done during the growing season because it could result in low numbers of reeds of a poor quality. When this process is repeated continually it could result in the ecological collapse of the system. Harvesting that is followed by burning should only be done when growth dormancy has set in and the translocation of nutrients from the above-ground, aerial parts to the rhizomes has been completed. One would expect then that the utilised reedbeds would have a significantly higher reed density than the unutilised reedbeds. This is not reflected in the results, however, and might be explained by the presence of dead but standing culms from previous seasons present in the unutilised areas.

It is not clear if a low reed density has a higher production rate than a high reed density in terms of good quality reeds. Good quality reeds are deemed to be of a uniform height, have a similar thickness and are relatively straight (Haslam, 1989; Ksenofontova, 1989). McKean (2001) describes a good quality, usable reed as being one that is taller than 2.5 m in height and more than 10 mm in diameter. Most of the European literature suggests that a lower reed density is optimal for the production of a better quality reed. However, there is little to suggest that this is valid for the tropics, where there are higher levels of solar irradiance and higher mean daily temperatures (Hocking, 1989). There was a significant difference between the mean number of reeds per m^2 in 2000 and 2002 (Fig. 5B). If the effects of the various treatments are removed from the data the density of reeds in 2000 (mean $\pm$ SE: 101.48 $\pm$ 5.08 reeds per m^2) is higher than in 2002 (mean $\pm$ SE: 83.92 $\pm$ 5.86 reeds per m^2). In an analysis of our data it was found that there was no significant ($P>0.05$) relationship between reed density and the number of reeds with a basal diameter thicker than 10 mm and a height greater than 2.5 m.

The analysis of variance for the combined effect of the two main effects was not significant. Therefore, direct conclusions about the significance of the main effects could be made. The results showing the combined effect of the two main treatments is presented in Fig. 5C.

Conclusions

The harvesting of reeds clearly affects mean reed height by reducing the number of taller reeds, with the remaining reeds being the shorter and thinner vegetative side shoots. Burning does not have a significant effect on reed height if it takes place at an innocuous time such as early in the growing season. When continual reed harvesting is combined with burning it results in short, poor quality reeds. The flooding of the Muzi Swamp in the 1999/2000 season resulted in an unusually high water level that may have caused structural damage to the reeds. The result was that the mean reed height in 2000 was less than that in 2002. Similar trends for main effects were found for reed diameter. The eventual reed height is linearly proportional to reed diameter. Therefore any trends in mean reed height will also be mirrored by reed diameter.

Utilisation within the Muzi Swamp negatively affects reed height and diameter. Unutilised areas in the reedbeds display improved reed quality in measurable proportions of reed height and basal diameter. There is no conclusive evidence that utilisation affects reed density. Fire has no effect on reed height and diameter when the area is utilised but does have a negative effect by reducing mean reed height and diameter when the area is not utilised. Fire considerably reduces reed density when applied in conjunction with utilisation, but has no significant effect in unutilised treatments.

Increased vigour and the production of better quality reeds in the Muzi Swamp can be attained by the correct management of the reedbeds. To accomplish this, winter harvests should be encouraged and each harvest should be followed by a resting period of 3 years. This approach will allow the complete replenishment of nutrient reserves to the rhizomes while still being able to harvest the standing crop of reeds from the growth of the previous 2 years.

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CHAPTER 6

Towards the development of a sustainable use management strategy for the Muzi Swamp, Tembe Elephant Park: an examination of trends in *Phragmites australis* reed use in the Sibonisweni Community

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ABSTRACT

Increasing rural population growth in Africa leads to an increasing reliance on natural resources for survival. Gross per capita income is supplemented by the utilisation of common pool resources within various communities in rural South Africa. The depletion of common pool resources in rural areas results in a greater demand for access to natural resources that are found in areas designated for conservation. This places reserve managers and conservation authorities under pressure to resolve the resultant issue of demands on such natural resource utilisation within the conservation areas. Management strategies for the sustainable use of natural resources within conservation areas have to be designed and implemented not only by reserve management but also by members of the local rural communities. Acceptance and implementation of suggested management

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strategies are more likely to succeed if decisions are made that recognise the need for, and incorporate the use of indigenous knowledge.

Key words: Sibonisweni, *Phragmites australis*, Tembe Elephant Park, Socio Economic, Indigenous Knowledge

INTRODUCTION

The importance and implications of incorporating local indigenous knowledge into natural resource management plans and conservation policies are underestimated and underutilised in many areas in South Africa. Although the responsible conservation bodies in the nine provinces in South Africa advocate interaction with local communities as part of their policy statements, the implementation and measurable rewards of these practices is still lacking in most cases (Els & Bothma 2000). The inclination, although correct in isolated cases, is to manage protected areas as islands. Using recognised and scientifically correct management practices, many natural areas, specifically those harbouring rare and endangered fauna and flora, have been successfully protected from the influence of increasing human population and subsequent over-exploitation of the natural resources.

Traditionally, it is believed that land-use and resource strategies that are implemented by rural populations in developing countries are in balance with nature because these people are so completely reliant upon it for survival. However, these views have become outdated as they are based mainly on ecological principles of balance and equilibrium (Thomas 2003). Rural populations are often perceived by many to be living in harmony with the land, as they have done for years, but this is not always true. Accounts of changes, from as far back as 150 years ago, in ecological conditions due to the depressive effects of man on the environment have been recorded in regions of southern Africa by Campbell and Child (1971). These changes were effected when rural populations were much smaller than at present and when the people living in these times practised a far less intensive type of agriculture than today.

There is an increasing demand for land and natural resources in rural areas as the human population increases. Increases in population densities amongst rural communities are due to greater survival rates. This comes about through the development theory of improved living conditions for the poorest of the poor without taking into account the need for subsequent economic growth (Tiffen 2003). Advancements in basic health care (including the control of disease-carrying mosquitoes and malaria), growing economies in rural towns, and the provision of basic amenities such as readily available sources of potable water in remote areas, all have an impact on the rate of human population growth. This population growth, which is often accompanied by unemployment and a consequent lower per capita income, leads to a greater reliance on natural resources for survival. Although improvement in the living conditions of rural people is desirable, the effect on natural resources within these communities is often severe. Depletion of economically important natural resources outside conservation areas has lead to greater pressure being exerted on conservation areas to allow access to said resources to the benefit of the rural population. Many of these natural resources are to be found exclusively in conservation areas such as the Tembe Elephant Park because of their complete protection or prudent management

The tendency has been to allow access to national and provincial parks and reserves only to tourists who can afford to pay for the experience. Local rural communities adjacent to these protected natural areas are often ignored and hence do not gain any financial or social benefit from an extensive natural resource base. There has to be a paradigm shift towards managing the environment for the benefit of people rather than managing and excluding them for the benefit of the environment (Els & Bothma 2000). Strategies therefore have to be devised for the sustainable use of the natural resources within protected areas.

The use of natural resources in low-income regions throughout South Africa is commonplace. People in the Maputaland region have used natural resources for thousands of years and have shaped the ecological balance in the area (Munnik 1991). The gathering of firewood, construction material, medicinal plants, fruit, honey and bushmeat (including birds and reptiles) are but a few of the resources that are known to be utilised by the people of Maputaland (Pooley 1980). Traditionally, reeds are used for hut building, craftwork and socio-cultural ceremonies (Cunningham 1985; Browning 2000). Reeds are also used for the making of fish traps, household utensils and musical instruments (Pooley 1980). Although reeds and forest timber are traditionally used for the making of huts, the more western style of housing by using concrete blocks and aluminium roofing is favoured if at all financially possible (Gaugris *pers. comm.*[1]). The trend in rural Maputaland remains a major use of natural resources that can be obtained through self-collection, or bought at a cheaper price than manufactured materials. This inclination places pressure on environmentally sensitive areas such as the sand forest and

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swampland. In the case of the Tembe Elephant Park, access is granted to permit holders to harvest reeds in a limited area within the Muzi Swamp. This was one of the terms and conditions of the proclamation of the Tembe Elephant Park as is written in a letter[2] from the regional nature conservation officer to the Tembe Tribal Authority on 26 November 1982.

The aim of the present study was to examine the extent of not only reed use, but also of indigenous knowledge regarding the dynamics of reed growth in the Muzi Swamp, within the Sibonisweni Community. One of the determining factors for the development of a sustainable use management strategy for the Muzi Swamp is to determine the demand for reeds within the surrounding communities. If there is a massive demand for reeds from such community members, the current harvesting strategy will have to be improved to yield a greater production of reeds with an improved quality, without jeopardising the ecological integrity of the Muzi Swamp.

STUDY AREA

The study area comprised the neighbouring rural communities surrounding the Tembe Elephant Park situated in northern KwaZulu-Natal, South Africa. The core focus of this study, however, was in the neighbouring Sibonisweni community, being the stakeholders with the largest interest in the condition of the Muzi Swamp. The Sibonisweni Community borders the Tembe Elephant Park to the southeast (Fig. 1), with its southern boundary extending to the main tar road. The tar road is an important factor in the development of the trade in reeds in the area. The tar road leads to the largest town, KwaNgwanase, in

[2] KwaZulu Government Services, Department of Natural Resources, File 11/14/25/1, Volume1, Ref: 11/2/2/A.

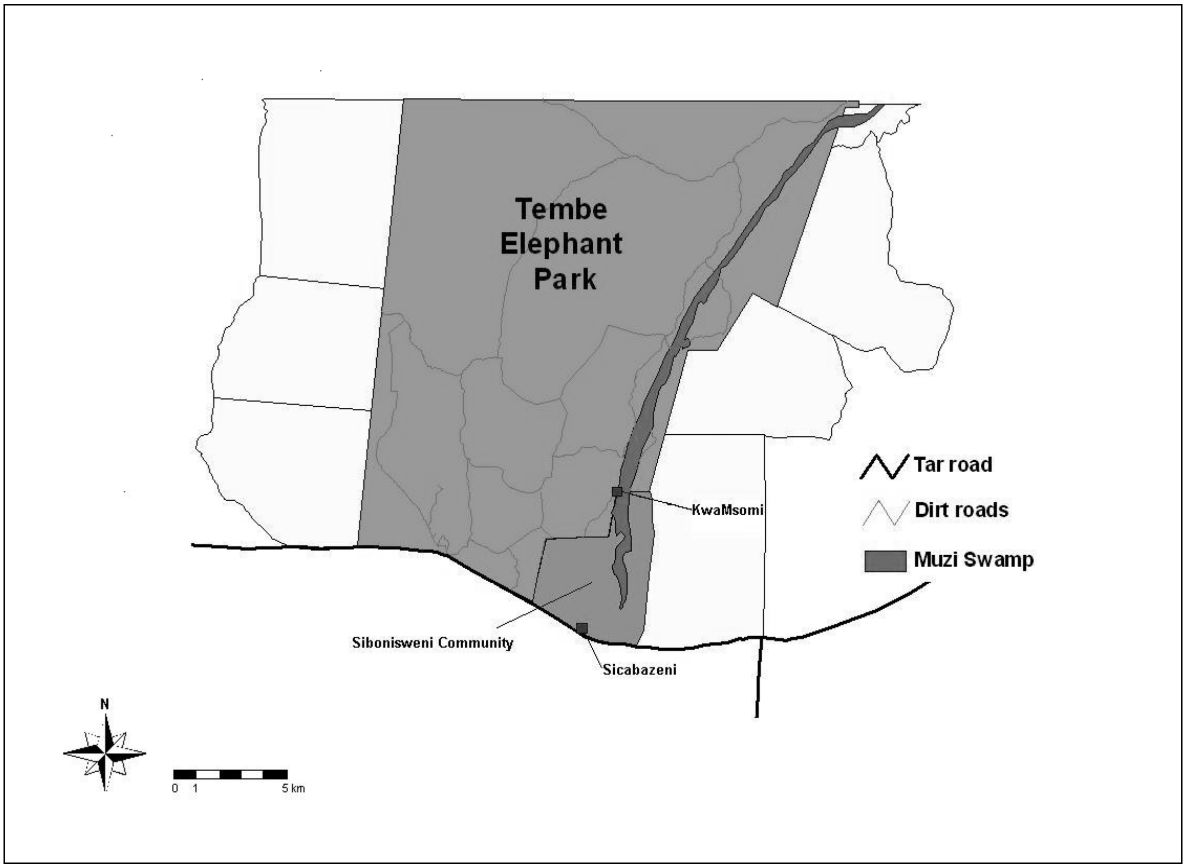

Figure 1: The study area showing the position of the Muzi Swamp within the Tembe Elephant Park as well as the Sibonisweni Community in northern KwaZulu-Natal, South Africa. Map compiled by J.L Jones (2003), University of Pretoria.

northern Maputaland as well as the southernmost border post (Kosi Bay) into Mozambique. Therefore it is also a major tourist artery for the region. The tourist traffic to Mozambique is largely responsible for the use of natural resources for the production of curios in this area, a substantial supplement to local resident's income.

METHODS

A trained interviewer conducted discussions with a representative from each of the 170 households within the Sibonisweni Community, with the questionnaires being completed by one member of each household. The interviewer was a Zulu-speaking member of the local community and as such the members of the community were quite willing and responsive during the survey process. The use of a local interviewer was found to be less intrusive than using an outsider. The questions were based on information obtained during the interview stage of the study. It is important that the researcher first gains an insight into what aspects of the study are important to the respondents before posing quantitative questions to them (Pratt & Loizos 1992). Although such questionnaire data are not statistically significant because of the non-random character of the sample (Pelto & Pelto 1978) the aim of the present study was not to do a statistical analysis, but merely to quantify the qualitative data obtained during the study. The data from the questionnaires were analysed by using a SPSS (Statistics Package for the Social Sciences) for Windows® computer package.

With the help of a local assistant to act as a translator the researcher was able to conduct interviews with members of the Sibonisweni Reed Cutters Association. Interviews were semi-structured, having predetermined questions as well as interactive conversation. Several of these qualitative data were used to structure the questions in the household survey. Some questions had to be structured in such a way as to confirm interviewee answers. These questions were basic, with the interviewer already knowing the scientifically correct answer. This was to make certain that answers were honest and not what the interviewees perceived the researcher wanted to hear. The local community members do not favourably accept research into the reeds in the Muzi Swamp as they believe that any findings will have a negative influence on their harvesting quotas. It was made clear that the research was done on behalf of an independent organisation without a vested interest in the outcome of the study.

The interviews and conversations were conducted at the KwaMsomi Scout Camp for the purpose of approximating the extent of local knowledge and understanding of the dynamics of reed production within the Muzi Swamp. Members of the Sibonisweni Reed Cutters Association volunteered their time.

RESULTS

Respondent demographics

Interviews conducted at the 170 households showed that 46 (27.1 %) of the respondents were male, while 124 (72.9 %) of the respondents were female. The respondents had a high social status (Krige 1988) within the community with the majority of the questionnaires being completed by the only wife in the household (48.8 %), the male head of the household (21.2 %) or grandmothers (10.0 %). The total population of the Sibonisweni Community is estimated at 995 people, the second largest in the area (Jones 2004 *pers. comm.*[3]). Although the survey involved all the households in the Sibonisweni Community,

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the gender demographics may not reflect a true ratio within the community. The mean age of the respondents was 43.6 years (SD= ±17.3 years). The majority (60.4 %) of the respondents were older than 36 years of age. Respondents from the 26 to 35-year age category comprised 28.6 % of the survey, while 11 % of the respondents were 25 years old or younger.

Extent of reed utilisation in the Sibonisweni Community

Of the 170 households, 164 (96.5 %) of the respondents said that they utilise reeds for various reasons. The majority response in the Sibonisweni Community indicates a preference to reeds for construction material because reeds are readily available in the area (56.5 %) and that reeds make for excellent building material (29.4 %). Six (3.5 %) respondents said that they did not utilise reeds as they preferred not to use them in construction. Reeds were used for construction by 85.9 % of the households, while 4.1 % of the respondents sold the reeds that they harvested. A further 7.6 % of the respondents harvested reeds for both construction material and to supplement their income.

Reed utilisation in Tembe Elephant Park

Within the Sibonisweni Community, 48 respondents (28.4 %) confirmed that they harvested reeds within the Tembe Elephant Park, with the majority (87.5 %) of these harvesters being women, whilst 122 (71.6 %) of the respondents did not harvest reeds within the Tembe Elephant Park. Of the 122 respondents who were not harvesting within the Tembe Elephant Park, only 10 (8.2 %) harvested reeds outside the Tembe Elephant Park. The reasons for not harvesting inside the park's boundaries included a lack of strength and time (18.7 %) and that not all the members of the Sibonisweni Community are granted access to the park (11.3 % of the respondents). The reasons for not harvesting reeds outside the park boundaries included a lack of availability of the resource (19.4 %) and not having the strength or time to harvest the reeds there (11.2 %).

The respondents harvesting reeds inside the Tembe Elephant Park suggested that it is the most desirable place to harvest reeds because the resource is readily available there. Community members also believe that the reeds inside the Tembe Elephant Park are of a better quality than those found outside the park. Yet, although the reed beds inside the Tembe Elephant Park are more extensive than those outside the park, there is a decline in reed quality in the allotted harvesting area within the park compared to reeds found in the excluded zones within the reserve. The majority of the respondents harvesting reeds inside the Tembe Elephant Park harvest them once a week (58.1 %), although 27.9 % of the respondents harvest reeds every day. Of the harvesters, 95.0 % harvest one reed bundle at a time, while 7 % indicated that they harvested two reed bundles at a time. This seven percent possibly reflects the allocation of harvesting permits to members within the same household, as it is physically impossible to harvest more than one bundle of reeds per day.

Economic importance of the reeds

When asked if the respondents bought reeds, 114 (67.5 %) of them said that they did so, while 56 (32.5 %) said that they did not buy reeds. The majority (68.6 %) of the reeds are bought at Sicabazeni (Fig. 1). Other respondents indicated that they bought reeds at KwaMsomi and/or Sicabazeni (27.9 %), KwaMsomi (1.9 %) and other markets (1.6 %). Reed prices were consistent throughout the survey, with the same prices quoted by all the respondents. The price of reeds, irrespective of the market at which they were purchased, was ZAR 4.50. The mean number of reed bundles required to construct a house was 56 .6

(SD= ± 38.42)(maximum price of ZAR 427.50) when using tall reed bundles, while the mean for short reed bundles was 231.8 (SD= ±63.1)(maximum price of ZAR 1327.05).

Sibonisweni Reed Cutters Association's interview

The summer months, September to February, are when the reeds are most productive, although in this subtropical climate they will also take shoot and grow in the winter months. Reeds that have taken shoot in the winter months are, however, not considered to be of a high quality. Side shoots develop after harvesting, but the side shoots are not of the best quality. Reeds that are tall and thick produce side shoots that are of a similar nature when cut. If the "mother plant" is strong and healthy it will produce relatively good side shoots. Wildlife such as the buffalo (*Syncerus caffer)*, warthog (*Phacochoerus africanus)* and reedbuck (*Redunca arundinum)* prefer to graze the shoots of freshly cut reeds. All the reeds produce a flower (panicle) and it is not dependent on the height of the reed but rather their age. Reeds with flowers are generally good for construction because of their thickness and height. Reeds flower in February after approximately one year. Reeds cut under the water, as close as possible to the base, will grow better than those cut above the water. Reeds cut under the water, close to the soil surface, also do not damage the feet of the harvesters. Water levels are highest in the Muzi Swamp in the summer months, during the rainy season. Reeds grow better in waist high (approximately 0.8 m deep) water, compared with drier conditions. Burning in the winter months leads to a greater fire intensity because the standing crop of reeds is drier then than in the summer months. Burning of reeds in the winter months will result in a replacement crop that is of a good quality. Burning is more beneficial than cutting to the production of a good replacement crop.

The interviews showed that the reed harvesters have a fair understanding of the conditions under which reeds perform optimally in terms of production. Recent, as well as historical literature tends to support these views, as is shown below:

Reed growth occurs mainly in the summer, with replacement buds being produced throughout the year but remaining dormant and/or stunted at or near the soil surface (Van der Toorn & Mook 1982). Buds in various stages of maturity produce a succession of replacement shoots (McKean 2001) after the reed has been damaged or cut. Ph*ragmites australis* is heavily grazed according to Zacharias (1990) and moderately to lightly grazed as a tall or mature grass (Haslam 1970; Viljoen 1976; Van Oudtshoorn 1999). Flowers are produced from December to June but not necessarily all the culms produce panicles (Gibbs-Russell, Watson, Koekemoer, Smook, Barker, Anderson, & Dallwitz 1980; Zacharias 1990; Van Oudtshoorn 1999). The cutting or harvesting of reeds below water level is, however, not desirable during the growing season. Although harvesters obtain reeds that are longer than those cut above the water, there is evidence that suggests below-water harvesting at certain times of the year (growth period) negatively influences the replacement crop the following year (Weisner & Granéli 1989) because of a reduction in oxygen transport to the root system. This is especially evident in reed beds where the substrate is highly anaerobic, such as in the peat found in the Muzi Swamp. This further increases the motivation for a winter harvest. *Phragmites australis* grows better in submerged conditions where there is constant inundation (Viljoen 1976; Van der Werff 1991). Reeds growing in water that is 0.70 m to 0.75 m deep allocate proportionately more reserves to the above-ground parts (culms) resulting in taller, thicker stems (Vretare, Weisner, Strand, & Granéli 2001). Burning of the reed beds in the winter months will result in a total replacement crop the following season (Van der Toorn & Mook 1982).

DISCUSSION

Although the questionnaires included all of the 170 households within the Sibonisweni Community the results that are reflected in this paper are merely an indication of trends regarding reed use within the community. All of the community members could not be interviewed individually as this would have proven to be too time consuming. The interviewer's mandate was, however, to interview members of the households with a high social ranking or elder position within the community. The majority of the people interviewed were indeed senior members of the household, being either the first wife or the head of the household (Krige 1988). One of the most important trends to emerge from the questionnaires was that the majority of the reed users were women. This was also reflected in the number of women harvesting reeds within the Tembe Elephant Park. Seeing that there is a significantly ($p = 0.04$) higher ratio of female to male harvesters there must be a greater input in the decision-making and involvement by women in the management of the reed beds in the Muzi Swamp. Women are also largely responsible for the management of the finances within the household, budgeting and paying for food, clothing and their children's education (Els *pers.comm.*[4]) It is for this reason that their grasp for the monetary value of commodities would be greater than that of the men within the households. Therefore it is important that women are actively involved in the formulation and implementation of the sustainable use management strategy for the Muzi Swamp.

The human population density within communities neighbouring protected areas should be taken into consideration when devising reed harvesting quotas in a management strategy.

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Communities with a high population density should be allocated a proportionately larger quota than communities with fewer members. Sibonisweni Community, being the most populous of the communities that harvest reeds in the Tembe Elephant Park should therefore have a major share of the total.

Reed use seems to be limited to construction material for the building of houses, although the interpretation of the question might have lead to a skewed answer. Many of the respondents might have interpreted the question as, "what is the end use for reeds?" instead of '"what do *you* use reeds for?" The main reason for harvesting reeds within the Tembe Elephant Park is to supplement or is indeed the only source of income for reed harvesters. Reeds are used personally if and when they need to, but the excess is sold. Although not reflected in the questionnaire data, a third of the respondents are believed to sell reeds to supplement their income.

Another important aspect was that there is little reed harvesting being done outside the Tembe Elephant Park. This was ascribed to a lack of availability of the resource. This point emphasises the belief that the Muzi Swamp has become severely degraded outside the conservation area due to uncontrolled communal use. Reed beds within the Tembe Elephant Park are possibly the last remaining viable natural population of *Phragmites australis* within the northern Maputaland region in terms of sustainable use. This is not to say that they should not be utilised. *Phragmites australis* is a resilient species and can maintain itself at relatively high levels of utilisation when compared to other species (Haslam 1969a; Van der Toorn & Mook 1982). When the resource is managed correctly harvesting can even improve production potential.

At present there are 55 permit holders (the questionnaire indicated 48), and all are members of the Sibonisweni Reed Cutters Association. In the winter months only a certain portion of these harvesters with permits are allowed to enter the reserve to harvest reeds. A further reduced quota applies for the summer months in an effort by the Tembe Elephant Park management to reduce harvesting pressure in the growing season. The reserve management has made it clear that were the harvesting to take place solely after the growing season in the winter months then the full quota would be allowed to be harvested during that period.

A large majority of the Sibonisweni Community buy reeds from various markets, the most important one being Sicabazini. Being situated next to the tar road, Sicabazini is easily accessible not only to the local members of the community but also to bulk buyers wanting to supply markets further afield. Given the nominal price for a bundle of reeds, this external commercialisation of reeds could lead to a greater demand by reed harvesters for a larger quota. The price of reeds per bundle has increased by 12.5% over the last four years, from ZAR 4.00 to ZAR 4.50 at the local markets. The mean increase of 3.1% per annum is below South Africa's annual inflation rate. If the sale price of the resource is not adjusted according to the rate of increase of the price of general goods then the demand by the harvesters for a greater volume of reeds to be harvested will increase concomitantly. In this regard there has to be a development of secondary industries surrounding and supplementing the harvest of reeds in Tembe Elephant Park. Resources should be made more profitable by manufacturing secondary products and not only by collecting the raw material for sale. The development of secondary industries and their markets will not only benefit the reed harvesters but also the sustainable use programme implemented by Tembe Elephant Park management and the Sibonisweni Community. Secondary industries undertaken in the summer months when harvesting should not take place will alleviate community pressure for year-round access to the reed beds.

CONCLUSIONS

Increasing human population will not be supported by the environment alone. For there to be decreased dependency on the environment for day to day living there have to be alternative sources of income. Correct management of a resource coupled with sustainable use will falter if it is not accompanied by secondary economic growth in the area. An increase in the demand for the resource without a proportional increase in the price of the resource over time will increase the utilisation demand.

The environment can, however, be used as a tool for economic and social growth within rural areas. Partnerships should be encouraged between wildlife reserve managers and local rural communities. Ideas and proposals shared among parties might lead to tangible benefits to both. Encouraging input in the form of local knowledge from local rural communities, especially within already existing interested parties and associations, will reduce animosity between the people who live in the area and the people that are paid to protect it. By collating local knowledge, the managers not only gain an insight into the views of resource-users, but also create a vehicle for communicating proposed management activities. Indigenous and local knowledge have been shown to correlate with research results that take years of study before firm conclusions are reached in some instances (Thomas 2003). The more public participation there is in formulating and implementing natural resource management actions, the more likely they are to succeed (Robertson & McGee 2003). The encouragement and involvement in natural areas management by local rural communities will also promote environmental education. This will benefit protected areas by stimulating conservation and wise natural resource use outside these areas, thereby reducing utilisation pressure within them. Conservation outside natural protected areas will also reduce the island effect that is created by fences, and will in turn effectively increase the diversity and range of species under protection.

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CHAPTER 7

THE DEVELOPMENT OF SECONDARY INDUSTRIES THROUGH THE SUSTAINABLE UTILISATION OF REEDS AND FOREST TIMBER IN THE TEMBE ELEPHANT PARK, MAPUTALAND, SOUTH AFRICA.

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SUMMARY

The harvesting of *Phragmites australis* reeds in the Tembe Elephant Park has to be managed pro-actively. Solutions to potential problems should be sought before they arise. This paper offers a potential solution to the problem of instating a winter-only reed harvest in the Muzi Swamp. The potential for manufacturing finished products such as prefabricated huts from sustainably harvested reeds and forest timber is examined and a cost estimate is presented. A prefabricated reed hut is three times cheaper than a similarly sized house made of bricks and cement. The manufacturing of finished products from the harvested material will add secondary value to the resource and also offer an alternative employment to harvesting reeds in the summer. The higher prices obtained for a processed article will also hopefully reduce the demand for the resource in its raw form, thereby increasing the perceived value of the resource and reducing wastage from raw materials that are not sold.

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INTRODUCTION

Poor rural communities in South Africa are hugely dependent on natural resources for subsistence use. In the past, natural resources could sustain small communities with additional resources coming from the planting of crops for their families. Rural development in South Africa in areas such as Maputaland in northern KwaZulu-Natal has increased the number of people needing a source of income to survive. Rural community members are no longer satisfied with a traditional subsistence livelihood and are looking for ways to increase their family's income through the harvesting, manufacture, and the sale of products from the environment. The raw materials are collected in the field for the production of arts, crafts and curios for the tourist market (Els 2000; Dernbach 2001). This craftwork, however, only supplies an income on an *ad hoc* basis and there are no guarantees as to the amount and regularity of the income earned. Tourists also only buy crafts that they consider to be "authentic" or truly Zulu (Van Wyk 2003). In a case like this the people with money, the tourists, hold a position of power over those that have none, the crafters. Tourists can therefore dictate to the crafters as to the price they would like to pay for the craftwork. The end result is that the crafters earn little income for an extremely labour-intensive production process (Van Wyk 2003). There are also no guarantees as to the sustainability of the natural resources being harvested. In many instances these craftworks are made of threatened hardwood species for which levels of sustainable utilisation have not yet been established.

The members of the Sibonisweni community, which neighbours the Tembe Elephant Park, harvest *Phragmites australis* reeds in the Muzi Swamp. Due to the seasonal nature of its growth *Phragmites australis* is a resource that can deliver high yields of raw material if managed appropriately and utilised in a sustainable manner. There is potential for the development of a lucrative market from the processing and manufacture of reed-related products. This paper attempts to highlight one of the possible means of making reeds more valuable as a resource, other than from their sale as raw material.

The reeds are harvested by hand and permits are issued to community members who belong to the Sibonisweni Reed Cutters Association. The current levels of utilisation in the Muzi Swamp are not threatening to decimate the reed beds. Evidence suggests, however, that the present harvesting regime has negatively affected the reed quality in the harvesting area of the Tembe Elephant Park. Harvesting at the incorrect time of year is depleting the below-ground resources stored in the rhizomes and the reeds are not allowed enough time to recover between the harvests (Tarr *et al.* 2004). A winter-only harvest of the reed beds would improve the condition of the reed beds because the mobilisation of nutrients, produced in the summer months, from the above-ground parts of the reed to the below-ground parts would be complete (Van der Toorn and Mook 1982). Harvesting cessation in the summer months will enhance the production of better quality reeds than what are currently being produced and harvested in the Muzi Swamp (Ostendorp 1989; Weisner *et al*. 1989; Tarr *et al*. 2004). The Tembe Elephant Park management have tried to encourage a winter harvest without success. Harvesters prefer a year round collection of reeds rather than condensing the harvest into the winter months when the aerial parts of the reeds are dormant. This is possibly due to the time that they would be idle in the summer months when not harvesting reeds, as it would seem to them that they are unemployed during this time. There are also social aspects to consider with regard to reed harvesting. While collecting reeds and other such resources people have a chance to interact and discuss important personal and community-related issues. This is especially important for rural African women who generally have no formal forum for discussion (Kloppers, pers comm.)[1]. This type of social interaction is an important part of African culture. Another rural

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community with close ties to the Tembe Elephant Park is the Manqakulani community. They have established a community conservation area, known as the Tshanini Game Reserve, in an attempt to encourage economic development in the area through ecotourism. With the permission of the local authority, the timber in that area is utilised for the construction of houses. Gaugris (2004) established the sustainable levels of this community stewardship for a range of highly desirable hardwood species for the Tshanini Game Reserve and Manqakulani area. Because of the similarity between the vegetation of the Tshanini Game Reserve and the Tembe Elephant Park (Gaugris 2004), the assumption was made that many of the species in the Tembe Elephant Park can be harvested sustainably, the numbers of which were calculated similarly to that of the Tshanini Game Reserve (Gaugris 2004).

The methods used in this article are based on the findings of the sustainable utilisation potential of *Phragmites australis* and forest timber hardwood in two different studies by the first two authors. The aim of this paper was to investigate the initiation of a form of secondary industry in the communities surrounding the Tembe Elephant Park. This type of industry could be practised at a time when it is suggested that reed harvesting should be halted so that the reed beds can be rested in the summer months. The unemployment and social interaction issues can also be addressed in this way. Making and selling prefabricated huts will generate income and bring community members together in the shared tasks performed whilst making the products. This elaborate form of utilisation of the sustainably collected natural resources from the area, and subsequent manufacture of finished products will add value to resources that are currently being used in their most raw form.

The making of reed and forest timber prefabricated panels for use in hut building was examined specifically. The cost of building a hut from western building materials is compared with the cost of building a hut made of ready-made panels manufactured from locally sourced materials and labour. Admittedly the calculations, measurements, building methods and quantities of the natural resources used to describe the building of the individual panels are based on the authors' somewhat limited practical experience but feel that these estimates are an adequate starting point. Sufficient time spent researching and surveying within local communities, as well as interaction with local community members, alludes to an accurate account of the practicality of the concept. The suggestions and recommendations with regard to the prefabricated huts are based on personal observation and empirical evidence. While the authors have not actually built the suggested panels and huts they believe that the dimensions, quantities and practical application of the concept are sound because they are based on what actually happens in the community (Gaugris 2004).

STUDY AREA

The Sibonisweni community borders the Tembe Elephant Park to the southeast (Figure 1). Many of these community members have lived in the Tembe Elephant Park before its proclamation as a wildlife reserve in 1983. Part of the relocation agreement was that members of the Sibonisweni community would still be allowed to harvest *Phragmites australis* reeds from the Muzi Swamp within the Tembe Elephant Park. Reed harvesting provides a substantial supplement to the household income in the area. The total value of reed bundles harvested in the Muzi Swamp in 2000 was approximately ZAR 80 000 (Browning 2000). Should all the bundles be sold this would amount to a substantial revenue augmentation in a region where the mean annual income per household is ZAR 6 000, most of which comprises state pensions (Els & Bothma 2000; Van Wyk 2003).

The Tshanini Game Reserve of the Manqakulani community is situated approximately 6 km due south of the Tembe Elephant Park, and the village where the people reside lies east of the reserve in an area bordering the Muzi Swamp. This southern part of the Muzi Swamp is not inside the Tembe Elephant Park and the resources found there are not afforded protection through controlled use.

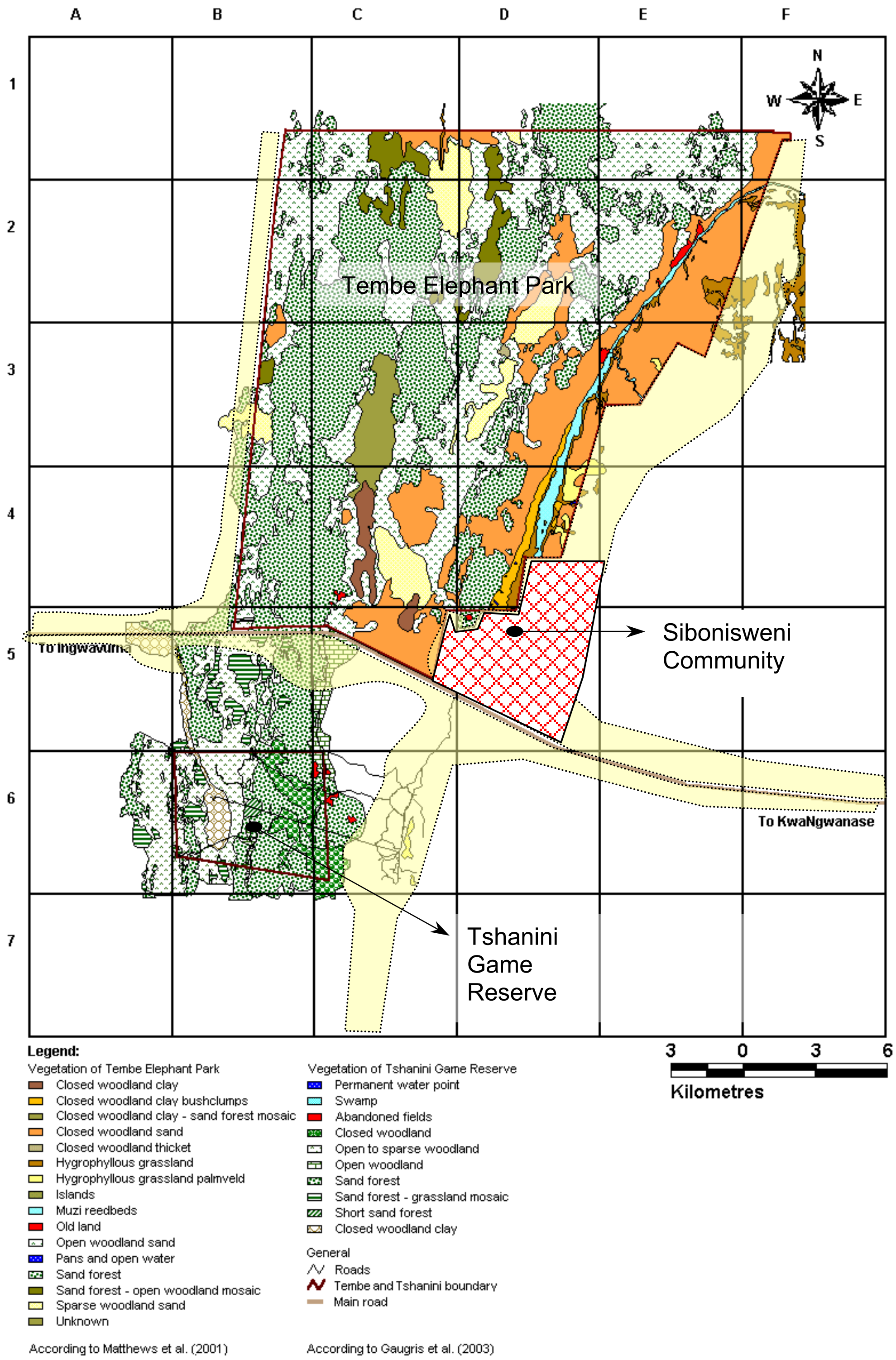

Figure 1: Grid map of the study area including the Tembe Elephant Park and the Tshanini Game Reserve area, northern Maputaland, KwaZulu-Natal province, South Africa. The area shaded in yellow indicates where human development is expected to occur in the next 50 years.

Consequently, the reeds in the Muzi Swamp outside the Tembe Elephant Park are few and of a poor quality, making them undesirable for harvesting. Much of the Muzi Swamp outside the conservation area has been converted to agriculture because of the relatively moist and fertile soils that the swamp conditions afford. These land-use trends are also reflected in the Sibonisweni community. The areas shaded in yellow (Figure 1) indicate where human settlements are expected to expand to within the next 50 years.

METHODS

Baseline data on the extent and implications of reed use within the Sibonisweni community were obtained by conducting interviews with members of the Sibonisweni Reed Cutters Association and through quantitative information obtained in questionnaire surveys. Information such as the mean number of bundles of reeds required in the construction of a hut, the price per bundle of reeds, where there reeds were bought, and preferences in the type of material used in construction were gathered from questionnaires. The game rangers at KwaMsomi Scout Camp noted the number of bundles harvested per annum. Reed bundle characteristics were measured from a sample of the harvested bundles as they were removed from the Tembe Elephant Park. Reed characteristics, such as the mean reed diameter, mean reed height and the mean number of reeds per harvested bundle were recorded. Each year the total number of bundles of reeds harvested and their mean morphometric characteristics were therefore quantified.

If the revised management strategy for the Muzi Swamp were to be accepted by the Sibonisweni community and Tembe Elephant Park management, then 6714 reed bundles can be harvested in the first harvesting season. It was calculated that there were 508 (SD ± 162) reeds per reed bundle, that the mean basal diameter of the reeds was 10.17 mm (SD ± 1.59) and that the mean reed height was 2.46 m (SD ± 0.45). By using these parameters the number of reeds that it would take to construct a 2 X 2 m reed panel that is three layers of reeds thick could be calculated. The layering of the reeds is necessary to create a robust panel and to improve its wind- and waterproofing qualities. The number of reeds needed to construct a 2 m length of three-layered panelling would be 590 reeds. It would therefore require 12 m of reed panelling to construct a typically sized hut of 2.0 X 4.0 m. This implies that the total number of reeds required to construct the panels for one hut would be 3 540, or seven harvested reed bundles.

According to Gaugris (2004), the proposed harvesting rate for poles of a diameter ranging from 50 to 80 mm for selected tree species equates to approximately 16 poles per hectare. The Tshanini Game Reserve is considered a current benchmark for the eastern Sand Forest vegetation type as it has not been significantly utilised either by humans or animals (Gaugris *et al.* 2004). In the Tembe Elephant Park, the Sand Forest has been utilised by large herbivores, especially the elephant *Loxodonta africana*. The harvesting rate for the Tembe Elephant Park should take the potential impact by large herbivores into consideration, and it is therefore suggested that the Tshanini Game Reserve's harvest rate of poles should be halved when calculating sustainable harvesting rates for the Tembe Elephant Park.

Matthews *et al*. (2001) determined that the extent of the Sand Forest vegetation type in the Tembe Elephant Park is approximately 4 500 ha. If a minimum area of 1 933 ha of the Sand Forest in the Tembe Elephant Park is set aside for complete preservation as suggested in Gaugris (2004) then harvesting should only be allowed on the remaining 2 567 ha. This area takes into account the additional precaution, suggested by Gaugris (2004), that the Sand Forest patches that are less than 200 ha in size should not be harvested.

RESULTS

Preliminary results suggest that it is possible to harvest a maximum of 20 530 poles in the 50–90 mm size class per year in Tembe Elephant Park, this size class being favoured for hut construction (Gaugris 2004). The estimated requirement to build one hut is 50 poles, which consists of six anchor poles, eight roof supports and 36 poles for the construction of the panel frames. Based on the known annual sustainable harvesting rates, a total of 410 huts can be constructed from the available natural resources annually. The harvested trees should be reduced to standard length poles of 2.5 m, debarked, and treated against termites and various other wood damaging insects. Harvested reeds should also be treated to prevent termite damage. To maximise the harvest output, the remaining usable length of each harvested tree should be equally treated and prepared, as it could be used in the assemblages where short lengths are required.

In the above evaluation, the harvesting of poles is only estimated for Tembe Elephant Park, and therefore the number of poles, and not the number of reeds that can sustainably be harvested is the limiting factor. The reeds harvested by the Sibonisweni reed harvesters would be enough to construct 960 huts, or 5 760 panels, per annum.

The value of the harvested materials is currently estimated to be 20% of the cost of bought materials. It is estimated that the value of a thin (50<70 mm), harvested pole is ZAR 6, while the value of a thick (70<90 mm), harvested pole is ZAR 12. The manufacture of the huts would require 44 thin poles for use in the panels and the roof supports. The anchor supports for a hut would comprise six thick poles. An illustration of the proposed panels showing the number of poles needed is given in Figure 2. This means that the total value of the poles used in the hut would be ZAR 336. The value of a total of seven reed bundles needed to manufacture the reed panels for a hut would be ZAR 175 at a cost of ZAR 25 per bundle. The estimated cost of sundry materials required for a single hut is ZAR 100. This includes

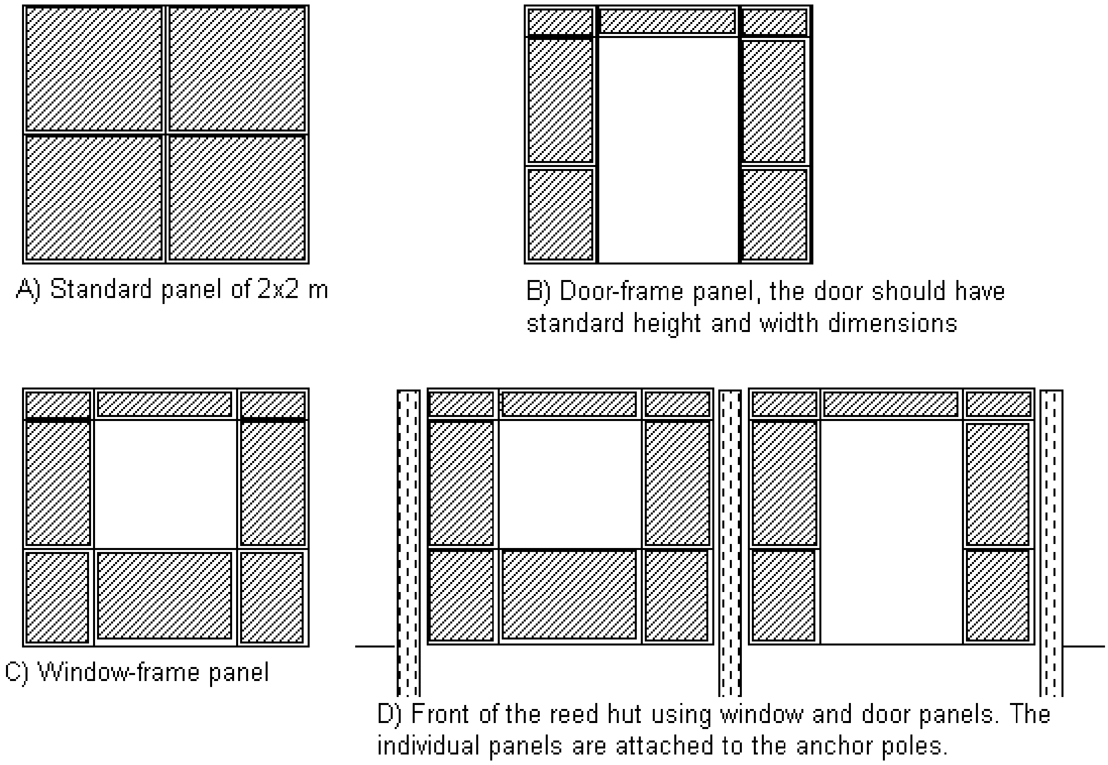

Figure 2: Illustration of the proposed prefabricated reed and forest timber panels to be used in hut construction.

nails, binding material, nuts, bolts and creosote for the treatment of the poles. The cost of corrugated-iron roofing is estimated at ZAR 50 for a 0.7 x 2.5 m panel. Six of these panels would be required for sufficient roofing, totalling ZAR 300. The hut would also include a window (ZAR 195) as well as a door (ZAR 110). The labour cost for one person to erect the hut would be ZAR 45 per day, or a total cost of ZAR 90 for two people for one day. The total value of the materials and the labour used for the erection of the hut will therefore be ZAR 1306.

In comparison, the cost of building a house of similar size that is made of cement blocks, roof supports and corrugated-iron roofing would cost approximately ZAR 6 500. Such a house would be 4 m x 3 m x 2.3 m in size, a total of 12 m^2 and therefore will be 4 m^2 larger than the proposed prefabricated reed huts. The price quoted includes ZAR 1 500 labour for the builder, two windows, a single door, and six corrugated iron sheets. Calculations based on the cost of materials for a concrete-block house of the same size as the proposed prefabricated reed huts would total ZAR 4 333.33. This is more than three times the cost of a completed house made of natural, renewable resources. The main difference lies in the cost of labour. Man-hours in an economically challenged area such as Maputaland are not worth as much as skilled labour in urban areas in other parts of South Africa. The lack of employment opportunities in the region means that families have time to spend building their own houses. Builders are rarely employed to build a house on behalf of others because it is simply too expensive.

Although the cost of a completed house made from natural renewable resources is cheaper than the cost of modern building materials, the preference is still to live in a house made of concrete even if it is not professionally built. It might seem unique and quaint for tourists to spend a few nights in a reed hut whilst on holiday, but to live permanently in a reed hut has its drawbacks. This does not mean, however, that there will be no local market for prefabricated reed and forest timber huts. In any given household in the Maputaland region there is more than a single dwelling. The household head's main room can still be built of cement blocks but there might well be a demand for secondary reed and forest timber dwellings that are used as sleeping quarters for extended family, kitchens or grain stores (Gaugris 2004). Furthermore, the people in the communities perceive the cost of building a brick house as prohibitive at present (Mthembu, pers comm.)[2] The demand for reed panels can also potentially reach further than the local market. There is also an increasing trend in the use of non-permanent structures for tourist accommodation. This is especially evident in the national and provincial parks and reserves within South Africa. Non-permanent structures are less intrusive, merge more effectively with, and are less disfiguring to the natural environment. Reed huts would be a perfect alternative to tourist facilities made from non-biodegradable materials.

Reed panels are also used in the urban environment to improve interior and exterior décor. Reed panels are sold in Europe at around ZAR 300 m^{-2} (www.thatch.co.uk/trolleyed). Beachfront concession stands (Figure 3) are also sold as "kits" where the structures are pre-manufactured and then assembled on site (www.greenbuilder.com/thatch/concstand). Many other practical and useful interior décor items are available on the market, and are sold at a much higher price than unprocessed reed bundles. The problem for the people living in the Maputaland region is their lack of business acumen, resulting in an inability to penetrate these lucrative markets.

DISCUSSION

A major concern for the conservation areas in South Africa is that they rarely offer value to people directly neighbouring them. This brings about conflict between local rural communities and wildlife managers. Viable partnerships between neighbouring communities and, specifically, South African National Parks, need to be promoted.

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Figure 3: Beachfront concession stand made from reeds and thatching material, an example of what could be made with sustainable natural resources available in the Tembe Elephant Park.

The dual objectives of which should be to improve economic conditions whilst instilling among the communities a culture of conservation (Mandela 2000). Improvements to standards of living and infrastructure in poor communities neighbouring protected areas and private game ranches are essential if the reserve in question is to remain viable as an asset to the country as a whole (Els and Bothma 2000). Barrow and Fabricius (2002) concur that natural resources must contribute to people's well-being and that local people must be involved in their management:

The ground rules have changed: no protected area is an island, and people and conservation cannot be separated…Ultimately, conservation and protected areas in contemporary Africa must either contribute to national and local livelihoods, or fail in their biodiversity goals (Barrow and Fabricius 2002).

There have to be tangible benefits to neighbouring communities to justify excluding large areas of land from human use. One of the ways to change the negative attitude towards wildlife reserves is to sustainably utilise some of the vast resources within its protected boundaries. The problem in the past has been the lack of data available to scientifically quantify a sustainable harvest of certain resources. Once the quantity of the resource that can be harvested without doing irreparable damage to the environment has been established, these resources should be put to good use. This can be achieved by converting natural assets into financial assets.

To merely harvest a resource and sell it as a raw material is not acceptable. The raw, harvested material has to be processed so as to add value to it. Reeds should no longer only be sold as unprocessed bundles for a meagre sum. If the reed bundles were to be processed as described above and the prefabricated huts were sold for around ZAR 2 000, still less than half the cost of materials of a concrete-block hut, the value added to the reeds by manufacturing a product would be ZAR 644.00. This equates to an additional ZAR 92.00 per reed bundle. The value of the reed bundles would then represent ZAR 117.00 as opposed to the original ZAR 25.00 per unprocessed reed bundle. The above figures ignore the value of the poles, for which there are no data on the market-related price, as poles have not yet been utilised on a commercial basis. Even taking into consideration the value of the poles the value of the reed bundles would still be significantly improved. The processing and subsequent increase in value per harvested bundle might protect the resource from overutilisation and misuse. Community involvement in the monitoring, management and setting of harvesting quotas will hopefully quell any fears of an increased demand in the resource that now fetches a higher price and generates more income than it did in the past. Interactive participation by local communities in using and protecting natural resources will reverse the historical mistrust in the conservation authorities. Quotas and regulations regarding the utilisation of resources will to a degree be self-imposed and easier to assimilate (Fabricius 2004).

Excess reeds from the quota offered and that were not used for the manufacture of prefabricated panels would still be sold in their raw form. Trees must, however, not merely be cut down and sold as untreated poles. They also need to be processed as part of a finished product to increase their value. If the demand for prefabricated panels is less than anticipated then the quota should not be harvested. The trees should only be harvested as and when they are needed, and not stockpiled, because the poles were not previously sold in their raw form.

CONCLUSIONS

The manufacture of prefabricated reed and forest timber huts may not be the panacea for the Sibonisweni community and the Tembe Elephant Park. There are no doubt more complex problems and issues resulting in conflict situations between community members and Tembe Elephant Park management. It is hoped, however, that a recommendation such as the above one will alleviate certain problems relating to sustainable use issues of the natural resources within the park. If the Sibonisweni community and the Tembe Elephant Park management were to agree to such a programme then the entire harvesting quota of reeds could also be harvested in the winter months. Manufacture of the prefabricated panels could largely take place in the summer months, thereby ameliorating the negative effects of a summer harvest on the reed beds in the Muzi Swamp, and result in an overall improvement in the reed quality. Moreover, by processing the raw resource the community can expect to receive larger financial benefits per harvested unit. Increasing the value of the resource will hopefully instil a greater respect for it, encouraging a community culture of conservation for the resource. Ultimately, it should be the community that sets the harvesting quota based on their own monitoring and insight as to how much the reed beds can offer whilst still providing for them in the future.

Livelihood strategies need to be modified to meet the needs of a rapidly growing population and monetary based economy. A subsistence economy in rural South Africa can possibly maintain small, isolated communities for a period of time as it has done for centuries. It will, however, ensure that such communities are neglected while other more innovative communities develop into thriving economically independent units. Community-based natural resource management programmes can be used effectively to raise living conditions, improve education levels and build capacity amongst the rural poor.

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CHAPTER 8

GENERAL DISCUSSION

The focus of this study was to understand the extent and nature of *Phragmites australis* reed use by the neighbouring communities of the Tembe Elephant Park. The utilisation of reeds by the Sibonisweni community was specifically examined because the area that members of this community utilise is by far the largest and presents the most concern for the Tembe Elephant Park management. It is foreseeable that trends regarding the effects of reed utilisation in the other neighbouring communities are similar, but the trends are not as pronounced there because of the lesser scale and intensity at which these communities harvest reeds.

To learn more about how the Muzi Swamp is being affected by reed harvesting, various facets were considered. Visually, it appeared at the beginning of the study that reed quality was generally poorer in the southern parts of the Muzi Swamp then elsewhere and that there was a gradual improvement in reed quality further away from the gate of the Tembe Elephant Park at KwaMsomi. It was believed that this was brought about by the tenet that people will use the least amount of energy to obtain maximal rewards. Because the reed harvesters have to carry their harvested reed bundles out of the Tembe Elephant Park at the gate at KwaMsomi in the south, it was hypothesised that there would be a degradation gradient in reed quality from south to north. As reed harvesting was expected to be concentrated in the south, it would then result in much fewer and poorer quality reeds in these areas, with a gradual increase in reed quality further north of the entrance and exit point at KwaMsomi Gate.

It was for this reason that a study of the reeds in a south to north direction was conducted to determine whether there was indeed such a degradation gradient. The effects of reed harvesting were measured in terms of measurable properties that included reed height, reed diameter, reed density, reed yield and mean reed mass. The effects of reed harvesting were shown to be similar for reed height and diameter, with both these properties being inextricably linked (Van der Toorn & Mook 1982; Hara *et al*. 1993). However, reed height and diameter did not reflect a degradation gradient from south to north. However, mean reed height and diameter oscillated at various intervals along the gradient because of the nature of the harvesting regime employed by the reed harvesters. Once an area, which is often discrete, has been harvested, the harvesters will only return after they regard this area to have recovered sufficiently. This was shown by the significant positive linear correlation between reed height and the time elapsed since the reeds of a specific area were last harvested.

There was also no distinct degradation gradient when reed density was examined at the various intervals along the south to north transect. In fact, reed harvesting in the Muzi Swamp had no predictable effect on reed density whatsoever. These conclusions are contrary to what Granéli (1989) found in southern Sweden, when he concluded that reed density and above-ground biomass in a winter-harvested area was significantly higher than in an area that had not been harvested. An increased amount of light resulting from the removal of reeds in the winter is one of the factors that have been believed to cause to this response. The increased light is believed to stimulate the emergence of latent buds on vertical rhizomes. The other possible factor given for the higher reed density was the increase in water temperature because of higher solar radiation, which in the case of the Muzi Swamp is not relevant because of its subtropical climate when compared to Granéli's study, where the climate was temperate. Reed density can be affected by various environmental and human causes with the number of standing but dead culms being dependent on the degree of damage inflicted by man and the environment over time (Thompson & Shay 1984; Marks, Lapin & Randall 1994). Burning of the reed beds, whether it is a natural or man-induced fire, can increase reed density depending on the frequency and temporal range of these fires (Thompson & Shay 1984). Burning of the reeds in the winter months would have a similar effect on reed density as a winter harvest (Granéli 1989). Accurate dates cannot be given as to when the fires in the Muzi Swamp occurred but it is presumed that they spread from areas outside the Tembe Elephant Park in the autumn months (April to May) when widespread burning takes place in Maputaland. Purposely lit fires are common in Maputaland at this time of year, as it is believed to stimulate the production of forage for cattle in the spring. Other environmental factors such as the type of substrate that the reeds are growing in and the water depth will also affect the density of reeds (Van der Werff 1991). The substrate in the Muzi Swamp is consistently similar throughout the study area (Grundling 1999) and was not considered to be a significant environmental variable. The environmental variables that were recorded in this study did not show any significant relationship with the reed densities at the respective harvesting intervals. This is possibly because harvesting, especially that of the large reeds and dead culms, had a dominant influence on the reed densities in the harvesting areas. Further study of the effects of environmental factors on reed density in the unharvested areas could provide more conclusive answers.

Trends regarding reed yield and mean reed mass were similar to those for reed height and diameter. There was a positive linear relationship between reed height and mean mass. The mean reed yield did not correlate directly with mean reed mass at a specific site along the south to north transect. This was because of differences in reed density along the transect. Some of the harvested areas had a high density of shorter and thinner reeds, producing a high reed yield, whereas other areas had taller and thicker reeds but they occurred at a much lower density, producing similar yields. One of the aims of reed bed management in the Muzi Swamp should be to get a positive correlation between mean reed mass and yield. It would be preferable to have a relatively low reed density, but with a greater proportion of the reeds having a high mean reed mass resulting in an increased abundance of harvestable reeds.

It was shown conclusively that there was no degradation gradient in a south to north direction in the Muzi Swamp where the Sibonisweni community harvests their reeds. There was, however, evidence that the general condition of the reeds in the harvesting area is deteriorating. This was supported by the results of the study of the long-term effects of burning and utilisation on *Phragmites australis* in the Muzi Swamp.

The mean reed height and diameter in areas that are utilised was lower than the mean height and diameter of reeds in the unutilised areas. Ideally, sustainable utilisation of reeds should not have any effect on the production potential, and therefore on the mean reed height and diameter, of reed beds over time (Granéli 1984). The reduced mean reed height and diameter in the harvesting area, when compared to the unutilised areas, was a direct result of continual harvesting throughout the year. Summer harvests reduce reed quality substantially and this type of harvesting system is used in other parts of the world to eliminate *Phragmites australis* from wetland systems (Haslam 1969; Granéli 1984; Ostendorp 1989; Marks *et al*. 1994).

The results showed a significant difference in the mean height and diameter of reeds in 2000 and 2002 over the entire sampling area. The reduced mean reed height and diameter in the unutilised and unburnt areas in 2000 could be attributed to the catastrophic floods that occurred there just before the present study in 2000. The rapid flow of water and prolonged elevation of water levels damaged the already standing reeds and could have also prevented the emergence of replacement shoots because of the extended inundation period caused by the flooding (Armstrong *et al*. 1999). The unutilised unburnt reed beds in 2002 showed a markedly significant increase in mean reed height and diameter from that of 2000, indicating a good recovery after this catastrophic event. Were it not for the flooding that took place before the study in 2000 it might have been expected there to have been a significant difference between the mean reed height and mean reed diameter in the utilised areas of 2000 and 2002. Harvesting of reeds throughout the year might well have reduced the mean reed height and diameter of reeds in the utilised areas between the two years of sampling, and this would have been reflected by a reduction in these mean reed characteristics for 2002.

There were no conclusive tendencies with regard to mean reed height and diameter when burnt and unburnt areas were compared in the utilised areas. The opposite is true for reed density. Both the burnt treatment plots had similar reed densities, whether they were utilised or not. The burnt, utilised treatment plots had a significantly lower reed density than the utilised unburnt treatment ones. The combination of stresses of burning and utilisation therefore markedly reduced the number of reeds present per unit area.

Reducing the amount of accumulating material in the Muzi Swamp could happen in one of two ways. Reeds could either be burnt in the winter to the early spring, or they can be harvested in the winter (Mook & Van der Toorn 1982; Granéli 1984). A thick litter mat, which forms as a result of the accumulation of decaying reed material, was often found in areas that were not burnt or utilised. The litter mat reduced the density of reeds by preventing light from reaching the developing shoots (Thompson & Shay 1985). A combination of the two actions will be detrimental to the production and quality of the reeds produced. Burning also resulted in a lower mean reed mass than what would be expected in unburnt areas, which was not ideal for the production of a high proportion of good quality reeds (Thompson & Shay 1985). The lowered mean reed mass was the result of the breaking of apical dominance of the parent reed and subsequent formation of vegetative side shoots. The use of fire in the spring to promote the vegetative spread of *Phragmites australis* has been used with great success in the past (Thompson & Shay 1985) and this type of management should be implemented in the Muzi Swamp in an attempt to re-establish a healthy, utilisable reed bed outside the Tembe Elephant Park.

The re-establishment of *Phragmites australis* in the Muzi Swamp outside the Tembe Elephant Park is a fundamental concern for the Tembe Elephant Park Management. Although reeds do occur in these communal areas of the Muzi Swamp, the extent and condition of the reed beds was believed to be inadequate for sustainable use. Overutilisation of reeds in the communal area, as well as an indiscriminate and unmanaged use of the resource, was responsible for its current state. It has become a “tragedy of the commons” situation in which reeds in the communal areas are utilised by members of the Sibonisweni community as and when they need them. Management programmes designed and implemented for the Muzi Swamp inside the Tembe Elephant Park should be applicable and be implemented outside the conservation area as well. There should be a broader understanding of the management programme that is implemented in the Muzi Swamp, not just by the Tembe Elephant Park management and the Sibonisweni Reed Cutters Association, but also by the Sibonisweni community as a whole.

In order to understand the local community needs for sustenance, cultural requirements, and their impacts on natural resources, baseline data were collected in the Sibonisweni community. This type of information is invaluable to reserve managers if they are to successfully coordinate decision-making with resident political structures, as well as for setting sustainable levels of local economic activity, whilst still protecting the Tembe Elephant Park's objectives (Machlis 1995). Although this part of the study was somewhat superficial and mostly addressed the concerns regarding reed use in the Sibonisweni community it did emphasise the importance of incorporating social sciences in protected area management strategies. It is important that natural resource managers are continually updated on the key issues relevant to the communities neighbouring nature reserves. Information that is made available to conservation authorities must be imminently usable and should also be predictive. Protected area managers must know what the consequences of their actions will be before they apply new management decisions. The social sciences can provide useful strategies for dealing with the consequences of management decisions. These include the use of economic incentives, communication techniques and conflict resolution (Machlis 1995).

Research based on interviews and questionnaires performed in the Sibonisweni community showed that the majority of people living in this area are completely reliant upon reeds. Most of the respondents (96.5 %) used reeds for the building of huts and other structures on their homesteads. The reason that reed use was so dominant was because reeds are easily obtainable in the area and reeds are also relatively inexpensive when compared with the more modern construction materials.

Only a small percentage of the community is allowed to harvest reeds in the Tembe Elephant Park as a result of the permit allocation. Most of these permit holders are women, with only a handful of men making the decisions regarding reed utilisation. An even smaller percentage (<10 %) of the rest of the community harvest reeds outside the Tembe Elephant Park. They ascribe this small percentage of use to a lack of availability and poor quality of reeds found in the communal area. Most of the people of the Sibonisweni community have to buy reeds from the reed markets at Sicabazeni. Although a seemingly nominal price by western standards of ZAR 4.50 per bundle was paid for the reeds, the mean number of 57 bundles required to complete one hut was quite substantial. This equates to an expenditure of ZAR 427.50. This is almost a full month's income to most of the community members. Results also indicated that the same price was paid for reed bundles containing thinner and shorter reeds, but it requires four times the number of bundles to complete a hut. It was therefore obvious from these results that the production of better quality reeds would be beneficial to all community members, including the harvesters. The number of bundles being harvested and the number of bundles being sold would then reach equilibrium, reducing wastage and increasing earnings. Reed buyers will also benefit from the improved reed quality, which will save them money in hut construction.

Members of the Sibonisweni Reed Cutters Association realise the benefits of producing and delivering a better quality reed. Interviews conducted with them showed that their understanding of reed growth dynamics was reasonable. Evidence found in the present study, including well-documented results from the literature, support their comments and statements. The Sibonisweni reed cutters commented that reeds usually take shoot and grow in the late spring and summer months, but can produce replacement shoots all year round. These replacement shoots are not of a good quality and rarely suitable for use in hut building. This is confirmed by Haslam (1969), Mook & Van der Toorn (1989) and McKean (2001). According to the reed cutters, a water depth of about waist deep (0.7 m) also seemed to be an important factor that would result in the production of good quality reeds. Viljoen (1976), Van der Werff (1991) and Vretare *et al*. (2001) have all published data that corroborate this statement, suggesting that *Phragmites australis* grows better in submerged conditions and that the plant will allocate proportionately more nutrient reserves to shoots growing in water that is around 0.7 m deep. The shoots growing in these conditions will benefit from the increased allocation of reserves and if they are allowed to mature will become tall and thick. The reed cutters also prescribe a winter burn to produce a replacement crop that is similar, if not better than the previous year's crop. The literature, however, states that a winter burn will have similar effects on the following year's production as a winter harvest (Van der Toorn & Mook 1982; Thompson & Shay 1984). The reed cutters also say that they prefer to harvest the reeds under the water, at substrate level, as they will then grow better the following season. It is possible that they said this because they were able to obtain a longer reed by cutting it under the water, rather than above it. The reed cutters also mentioned that reeds that are cut as close to the substrate as possible resulted in a reed stubble that did not hurt their feet while they were harvesting other reeds. The depth at which reeds are cut will be a contentious issue. It is obvious from a practical standpoint that they should be cut as close to the substrate as possible, not only because of the added length of the reed in deeper water, but also to reduce the damage that the reeds cause to the harvester's feet. In theory, however, cutting the reeds below water level is damaging to the rhizosphere. It is known that cutting reeds below the water in the growing period (or summer months) will reduce gaseous exchange between the atmosphere and the rhizomes. This results in an almost total inhibition of re-growth of shoots the following season (Brix 1989; Weisner & Granéli 1989). It is not clear what the effect of the reduction in gaseous exchange has on the reeds in the Muzi Swamp and this is a possible direction for further study.

Indigenous knowledge is not employed as well as it should be. One of the reasons for this is a communication problem between researchers, reserve management and community representatives. Not only is the language barrier a problem but there is also little understanding as to the correct way to approach and talk to members from these different societies. The lack of will to implement strategies that the reed harvesters themselves admit will benefit reed production in the Muzi Swamp is problematic and not easy to explain. One theory is that reed harvesters view the harvesting of reeds as a job, one in which there is a potential to earn income from the products of the harvest. If they only harvest in the winter months then they are effectively "unemployed" for the rest of the year. The solution to this problem might be to explore secondary industries evolving from reed harvesting. In this way reeds could be harvested in the winter and for the rest of the year value added reed products can be manufactured to supplement the Sibonisweni Reed Cutters Association income.

One suggested secondary industry was explained in Chapter 7 where the manufacturing prefabricated panels made of sustainably harvested forest timber and reeds are examined. The making of huts from the assembly of these panels was compared with the cost of building a hut from bought reeds or modern construction material. The cost of materials for a prefabricated reed and forest timber hut was calculated as being less than half the cost of materials for a cement-block house. Although this seems like a more reasonable price to pay for a habitation, the trend in rural Maputaland is for the head of the household to have a hut made of western building materials. This does not mean, however, that there is not a potential market for prefabricated reed and forest timber huts. Families living in the poor rural communities neighbouring the Tembe Elephant Park will probably only be able to afford one such professionally built brick hut. The cost of builder's fees will favour the erection of prefabricated reed and forest timber huts for use as secondary living quarters. These secondary living quarters are used for extended family, children's sleeping quarters, kitchens and grain stores.

The research hypothesis behind this chapter was to offer an alternative employment opportunity during the summer months, thereby ameliorating the negative effects of a year-round reed harvest. Harvesting reeds and forest timber according to the suggested management recommendations and scientifically based harvesting quotas would mean that the reed harvesters could produce the reed and forest timber panels when the harvesting season was finished, effectively “employing” them during this time. The manufacture of prefabricated reed and forest timber panels would also add value to the resource. The sale of processed articles from natural resources would amount to a greater income earned per harvested unit as opposed to merely selling the raw materials.

The financial value added through the processing of the reed resource can possibly result in two very different conclusions. The increased value of manufacturing finished articles form the harvested reeds might well increase the demand for the resource because of the greater income generated from it. This could place further strain on the Tembe Elephant Park management in terms of a more vociferous call for freer access and increased reed harvesting quotas in the Muzi Swamp. It is hoped that the Sibonisweni Reed Cutters Association will have the foresight to appreciate what could be done with the resources available to them, utilising the same resource, at the same levels, for an increased profit. It is also hoped that the reed harvesters’ involvement in the monitoring and subsequent setting of quotas will be based on scientific evidence and an appreciation for the value of sustainability, maintaining the resource for future use, not merely seeing how much financial reward can immediately be gained. This culture of conservation has to be instilled through education, involvement in management decisions and processes and tangible benefits offered by the resources that are being protected.

There will undoubtedly be reservations to the proposal of allowing sustainable forest timber harvesting in the Tembe Elephant Park. Although there is scientific evidence that suggests that forest timber harvesting in the Tembe Elephant Park is sustainable there will more than likely be political issues that decide whether or not this can take place. In the Tembe Elephant Park, as in most protected areas surrounded by rural communal land, it will be difficult to allow one neighbouring community access to a newly available resource and not another. The Tembe Elephant Park management will be loath to go ahead with another resource-use programme when the current programme is such a political headache. In all likelihood the other neighbouring communities will have to be apportioned similar quotas, depending on the population size of the community, thereby reducing the effective harvesting area and harvesting quota of the Sibonisweni community. Perhaps the correct way forward in this case would be to encourage a pilot project within the Sibonisweni community only. Thereafter, should there be continued interest by other communities, new quotas and designated harvesting areas can be apportioned. In this way neighbouring communities will also be able to learn from mistakes and successes made by the Sibonisweni community.

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CHAPTER 9

MANAGEMENT RECOMMENDATIONS

Communicating conservation actions

Communication is the process of exchanging thoughts and ideas between two or more parties and it is essential for the formulation and implementation of the proposed management strategy for the Muzi Swamp. Management efforts should, however, be concentrated in the southern sections of the Muzi Swamp at first. The southern Muzi Swamp is of greatest concern to the Tembe Elephant Park management because of the increasing pressure on it from the neighbouring Sibonisweni community for more free access to the reeds growing there. The first step in this process is to identify the various stakeholders that are, or would like to be, included in the process. These stakeholders may include members of the Sibonisweni community, Tembe Elephant Park staff, Ezemvelo KwaZulu-Natal Wildlife and the local government (Tembe Tribal Authority).

Recognising the increasing importance of the role that women play in rural communities one immediate concern that has to be addressed (Ellis & Biggs 2001; Rahman & Westley 2001). The majority of the world's rural poor are women who face the challenge of providing water and fuel, food and fodder every single day. Faced with ever dwindling supplies of these mostly natural resources, women have a huge incentive to protect the environment (Astolfi 1995), and are thus potentially powerful allies to protected areas. The Sibonisweni Reed Cutters Association members are mostly women but the heads of the association are men who make all-important decisions regarding the reed harvesting. Women should have greater influence in the decision-making process as they are the ones who are most affected by the eventual outcomes. The inclusion of interested parties in the Sibonsweni-Tembe Elephant

Park partnership should secure the successful implementation of the proposed natural resource management plan for the Muzi Swamp. Many management plans, such as the one devised for a National Park in the Abuja province in Nigeria (Gbadegesin & Ayileka 2000), that have excluded and marginalised local communities have failed due to a top to bottom approach in management. Management decisions made by people in positions of authority are difficult to enforce properly. It is preferable to have collaboration between interested parties to ensure voluntary participation because there then will be consensus on the strategy, implementation and the rewards gained from the management plan (Munro 1995). The rural poor should have greater control over their environment, but they should also be made aware of the options available and any possible repercussions of their actions (Gbadegesin & Ayileka 2000; Johnson 2001; Rahman & Westley 2001).

Barriers to communication do exist, but can be overcome if there is a will to do so. Differences in language, culture and educational levels may exist, but the ability to communicate despite these differences is essential. Ezemvelo KwaZulu-Natal Wildlife must be alert to the possibility that they might not have people within their institution that have the necessary communication skills to overcome such barriers. There is a case to be made that natural scientists have not been taught to work with other people, let alone develop productive relationships. Unlike other professions where human contact and teamwork are valued assets, people involved in the natural sciences have mostly been trained to work with data or with species other than our own (Von Droste 1995). Many managers of reserves admit that they are not trained to deal with the social aspects of conservation. Obviously there are also barriers that cannot be overcome easily, such as financial constraints. Perhaps a restructuring of the budget towards employing communication specialists, such as people in the social sciences, to address community-based problems and issues in and around KwaZulu-Natal Parks would be more beneficial, especially in the long-term, than allotting more resources to improve fencing and security. Both natural scientists and social scientists can contribute to the better understanding of the processes surrounding wetland management (Machlis 1995; Turner *et al*. 2003). An interdisciplinary study of these processes should lead to the formulation and successful implementation of a management strategy for the southern Muzi Swamp.

In developing a management programme, defining the problem has to be done as diplomatically as possible. The issues involved should rather be stated in broad terms, and the positive aspects of the situation must be highlighted. It should not be stated that the problem in the Muzi Swamp is the over-utilisation of reeds by local community members. The use of natural resources in the Tembe Elephant Park was originally supposed to be on a subsistence use basis only and the fact that reed harvesting has escalated to commercial levels is no longer a relevant concern because the levels of use will never return to that of a subsistence basis. The concern should therefore focus on how to manage the southern Muzi Swamp in such a way as to improve the reed quality while maintaining current harvesting quotas. The clear objective of meetings for the development of a management scheme for the southern Muzi Swamp should be that of maintaining and/or improving reed quality in a sustainable manner. In this way the Tembe Elephant Park will maintain its conservation goals while the Sibonisweni community will benefit by having a continual natural resource base from which to harvest. The conservation of the Muzi Swamp through its sustainable use should be the ultimate goal of all parties.

Goals should be clearly stated for both the resource and the parties involved. The major goal for the Sibonisweni community should be to achieve a level of resource use that maintains reed quality over time. The harvesting of reeds should also be considered as a tool to develop the community in terms of the infrastructure and the economy. The growing tendency in sub-Saharan Africa is towards part-time farming and the supplementation of family income by other activities and resources (Ellis & Biggs 2001). Income from reed "farming" should be supplemented by processing the resource, thereby creating secondary industries. The emphasis on community reed management, however, should not take the form of increasing the amount of reeds that can be harvested, but rather on an approach to find more efficient and profitable ways of utilising the current quota. Reeds can be used as a resource, providing economic means to improve the community's basic living standards. Money generated in the community from the sound utilisation of natural resources can be put to positive use through the building of clinics and improvements to schools. It must be realised that natural resource (reed) harvesting on its own will not sustain the community indefinitely (Woodhouse 2003).

The economic growth that is necessary to sustain the current levels of human population growth will not be met with the sale of reeds alone. Secondary industries associated with the sustainable use of this and other natural resources will have to be developed in order to add value to the resource. In this way the benefits of sound natural resource management will be enhanced above and beyond merely those people who harvest and sell reeds, and will reach the community as a whole. In this way not just the individuals who are fortunate enough to be allocated a harvesting permit will benefit from this approach. Members of the Sibonisweni Reed Cutters Association must bear in mind that they are privileged to have access to the resource, which by all rights belongs to the whole community. This re-iterates the importance of identifying all the interested parties, especially the community leaders, and allowing them the opportunity to become involved in discussions regarding the potential of the southern Muzi Swamp as a community development vehicle. The use of the southern Muzi Swamp as a developmental tool for rural development should therefore become a more democratic process. Allowing the majorities to have an input into the use of the resource will reduce animosity to those directly benefiting from it. The challenge of encouraging democracy in rural areas, where people such as *Indunas*, traditional healers and small numbers of powerful elites reign over a large number of others by cultural default is daunting (Johnson 2001).

The goals of Ezemvelo KwaZulu-Natal Wildlife should fit in with the broad definition of their mandate as custodians of the Tembe Elephant Park. The primary aim of the establishment of the Tembe Elephant Park in 1983 was to protect the people from crop and other damage caused by elephants, and to afford protection to the elephants and the unique sand forest vegetation type along with the unique fauna associated with it, such as the suni antelope *Neotragus moschatus*. The then KwaZulu-Natal Nature Conservation Service indicated in its management plan that one of their aims was also to promote the well-being of the neighbouring community through economic and social development. One of the means through which this was to be accomplished, was to foster a culture of sustainable living within the neighbouring communities (KwaZulu-Natal Nature Conservation Service Protected Area Management Plan 1997). The Tembe Elephant Park management have, by their own admission, expressed concern that they have not succeeded in doing this to date. Simple conservation semantics, such as sustainable use, might make sense to those who have undergone formal training in nature conservation, but it might be lost on those who have little or no formal education of any kind (Woodhouse 2003). The future emphasis should be on communicating such conservation ideals effectively.

Rotational resting of the utilisation area in the Muzi Swamp

Reed harvesters appear to be allowing for the regeneration of reeds after harvesting, but the period of rest between successive harvests is not long enough. The tendency in the harvesting area within the Muzi Swamp is for the reeds to be of a poorer quality than those found outside the harvesting area. This can be attributed to the small area within the Muzi Swamp in which the reed cutters are allowed to harvest at present. There is an area of approximately 1.8 by 0.2 km (36 ha) of reed bed in which the Sibonisweni harvesters are currently allowed to harvest reeds. Increasing the size of the current harvesting area while maintaining similar quotas will allow for the implementation of a rotational resting system. Such a system will allow for a longer recovery period between successive harvests. At present the harvesters appear to return to a previously harvested site once they deem it to have recovered sufficiently. The extension of the recovery period will result in a healthier rootstock in the long-term, and will produce reeds that are comparable in quality to those found outside the utilisation areas in the Tembe Elephant Park.

The expansion of the harvesting area by 30 percent by extending it for 540 m in a south to north direction, and the division of the entire area into three equal harvesting areas for a tri-annual harvest would allow sufficient time for the recovery of the reed beds to their full potential. Harvesting of these three harvesting areas should also occur only in the winter, once the growing season is complete and nutrient transfer to the rootstock has been completed. The harvesting of reeds in the growing season is in fact used successfully elsewhere to eradicate reeds (Haslam 1969a; Granéli 1984; Marks, Lapin & Randall 1994).

The first years' harvest should take place in the predominantly unharvested area, from 1 601 to 2 400 m north of the fence at KwaMsomi Gate. The second years' harvest should start at a point 801 m away from to 1 600 m north of the fence at KwaMsomi Gate. The third years' harvest should occur from the fence at KwaMsomi Gate to 800 m north of it. Easily distinguishable cut-lines, or preferably marking posts, that divide these harvesting areas should be put in place to avoid any confusion as to the location of the relevant areas. Harvesting quotas should be adjusted to the projected quotas given in Table 1, with the goal being to harvest the yearly quota within the winter months and not to spread the harvest over the entire year as was previously done. Yearly monitoring of the size, number and structure (basal diameter, height and reed density) of the reed bundles being harvested is essential. Destructive sampling and subsequent monitoring of the reed bed structure in the areas to be harvested in the following years should also be implemented. Continual monitoring of the effects of the rotational harvesting regime is required.

Calculation of the harvesting quota

The harvesting quota should always be examined, and adjusted if necessary, following yearly monitoring of the reed beds in all three harvesting areas. The harvesting quota has to be calculated according to the size of the harvesting area (m^2) and the number of usable reeds in the harvesting area. The measurable proportions of each reed harvester's bundles determine the characteristics of the usable reeds. These measurable proportions include mean reed diameter and height, as well as the mean number of reeds per harvested reed bundle.

Based on the values given in Table 1, the harvesting quotas should be adjusted to these new levels. Although the adjusted quota for the first year might be marginally lower than the current level, the adjustments have to be viewed positively in order to obtain higher quotas in following years. The motivation behind setting quotas based on the amount of usable reeds available is to promote reward-based outcomes for the successful implementation of a rotational resting programme. Should the management programme function successfully then one would expect the ratio of usable reeds per m^2 to increase. This increase in good quality reeds would be indicative of an improved root-stock because of the more effective relocation of nutrients produced in the growing season from the aerial parts to the rhizomes.

Table 1: *Projected reed harvesting quotas for the various tri-annual harvesting areas in the Muzi Swamp, Maputaland, South Africa.*

Item	Harvesting area		
	1	2	3
Distance from fence (m)	1 601 - 2 400	801 - 1 600	0 - 800
Surface area (m^2)	160 000	160 000	160 000
Reed density (per m^2)	88	96	83
Total number of reeds	14 128 000	15 424 000	13 264 000
Percentage usable reeds (diameter > 9 mm)	24.14	13.40	8.71
Number of usable reeds per m^2	21	13	7
Total number of usable reeds	3 410 499	2 066 816	1 155 294
Mean number of reeds per harvested bundle	508	508	508
Currently available number of bundles	6 714	4 069	2 274
Number of years rested from beginning of proposed harvesting programme	1	2	3
Total number of bundles produced after resting	6 714	*	*
Projected annual harvesting quota	6 714	*	*

* = Data will not be available untill monitoring of harvesting areas after a resting period has been completed.

The calculation of the harvesting quotas for the second and third harvesting areas should be determined in a similar manner, but should be calculated after monitoring the reed bed in these particular areas. Were these areas to be harvested immediately, according to the criteria as set out above, the harvesting quota would be well below the current quota. This is mainly due to the high number of inferior quality reeds that currently occur in these areas and not to a reduced reed density. It is expected, however, that following a system where reeds would be harvested in one area in the winter months, followed by a period of rest for three years, would improve the reed bed conditions dramatically over a relatively short time. The formerly harvested areas that have been rested will also then produce an increased number of good quality reeds. It is hoped that after such as rest period, the previously harvested areas will have a higher proportion of good quality reeds per m^2, these accruing from not only the current season but also from the accumulation of reeds that takes place over the previous seasons. *Phragmites australis* has a tendency to produce large reeds when the rootstock is healthy, allocating more resources to a single large reed than to numerous small reeds (Van der Toorn & Mook 1982). This is especially true for reeds growing in deep water (Vretare, Weisner, Strand & Granéli 2001), but water depth is unfortunately beyond the control of reserve management because the Muzi Swamp is an open system.

Although there is a tendency for reed beds that have been rested to have a lower reed density than harvested ones, it is expected that the proportion of good, usable reeds will increase after a period of resting. Good quality reeds that have grown in the previous seasons might not necessarily be wasted because large reeds can remain erect for up to three years (Haslam 1969; Björk & Granéli 1978; Granéli 1984; Hocking 1989). This is even more pronounced in areas where continuous destructive elements such as wave action and wind are less prevalent. This is the case in the Muzi Swamp, which does not experience fast-flowing water except in occasional extreme cases of flooding, such as was experienced in the 1999 and 2000 rainy season. The Muzi Swamp is also protected from wind by the fact that it is a low-lying area and is protected by closed woodland along both its western and to a lesser degree its eastern peripheries.

Implementation of the harvesting quota

Harvesting should occur from May to August, effectively the dormant season. This yields a harvesting season of four months or approximately 100 working days. Harvesting should be allowed to take place every weekday in this period because the harvesting period is condensed into a relatively short time when compared with how the harvesting is currently being done. If this harvesting schedule were to be implemented, then that would equate to the harvesting of 6714 reed bundles in 100 days, or approximately 67 reed bundles per day. This would mean that all the members of the Sibonisweni Reed Cutters Association would be allowed to harvest one bundle of reeds every day for this period.

Condensing the harvesting quota into these 100 days will make harvesting the quota strenuous. The added distance being covered by the harvesters due to the expansion of the current harvesting area would make it difficult for them to maintain their current daily regime of reed collection. This could be made easier by allowing the removal of their harvested bundles from the Tembe Elephant Park by using some kind of transport. Perhaps the park management could allocate, if financially possible, the use of a tractor and trailer to transport the harvested bundles from the harvesting area to the gate at KwaMsomi. This type of co-operation would go a long way towards ensuring the success of the management programme for the Muzi Swamp. If reed collection was quicker and easier during this condensed harvesting period it would allow reed harvesters more time in the day to complete other necessary chores, making daily harvesting feasible.

Fire management in the Muzi Swamp

Fire in a reed swamp is notoriously difficult to control. The accumulation of large volumes of moribund material and varying water depths both contribute to unpredictable fire intensity. An exceptional accumulation of moribund reed material and a low water level will result in a much more intense and hotter fire than if there were little standing litter and a high water level. Varying fire intensities have different effects on reed beds. A hot fire in a reed bed that has a low water depth can retard reed shoot development (Van der Toorn & Mook 1982). In contrast, canopy burns after the growing season when the reeds are driest will have little effect on the reed beds, while a slow surface burn when the substrate is very dry can damage the root stock of the reed beds and retard the following season's growth (Van der Toorn & Mook 1982). When dry, Peat can burn for a long time, sometimes even for many years. After such a burn a wetland can become colonised by terrestrial plant species and reduce or remove the water supply to the wetland (Grundling & Blackmore 1998). This would have adverse effects on the animals and human population that rely on the Muzi Swamp for water because it is the only permanent natural supply of water in the area.

It was shown that burning combined with continual harvesting had a more negative effect on the quality of the reeds in the Muzi Swamp than only harvesting or only burning. This might be related to the time that the swamp was burned. If it were harvested in the growing season and then followed by a burn almost directly afterwards it would further decrease nutrient relocation to the root stock. Research by Mook and Van der Toorn (1982) has shown that a spring burn would result in an increased shoot density, with the majority of the reeds being thinner, shorter and more likely to be damaged when compared with the reeds that they were replacing. A fire in the harvesting area of the Muzi Swamp after a winter harvest, if the fuel load were sufficient to carry a fire, would not necessarily negatively influence the reed production the following growing season. The most important concern regarding fire treatment in the reed beds, as with harvesting, is the timing of the burn (Thompson & Shay 1985).

Burning in the Muzi Swamp as part of a management regime is not recommended because it will not have a significantly different effect on the reed beds when compared to the effects of harvesting. Burning and harvesting in the winter months have similar effects on the following year's reed production, and a winter burn (or harvest) is a common practice to ensure the future production of reeds (Granéli 1989). The dilemma in the case of the Muzi Swamp is the proximity of the three harvesting areas to one another. If the fire were to jump from one harvesting area to another then the reeds remaining from the previous season's production would be destroyed. This would negate the accumulation of reeds for the following harvest. The only direct benefit of a burn in the reed beds would be to encourage the vegetative spread of reeds and not necessarily to improve the quality of the already existing reed beds (Van der Toorn & Mook 1982; Thompson & Shay 1985). The burning of reeds shortly after the onset of spring has been used to promote the growth of uniformly proportioned reeds and for the removal of accumulated reed litter. This type of treatment would be beneficial when trying to encourage the spread of reeds in the re-establishment programme. Treatment of this nature should also only take place after two to three years after the initial planting of the reed bed, once the reed beds in these areas are well established and the underground biomass is sufficient to cope with the loss of even the slightest amount of nutrients.

Monitoring the reed beds

Yearly monitoring of the effects of human management and use is essential to avoid the degradation of the reed resource. Monitoring of how effective the management actions have been will determine if they are to continue or not. Monitoring is the basis of adaptive management, through which trends can be timeously noted and management actions can be justified and adjusted, if necessary, to meet the management goals previously set out (Bothma 2002).

In the Tembe Elephant Park the reed characteristics should be determined in the area that is to be harvested in April, before the start of winter, or the proposed harvesting period. Four monitoring sites should be set out at 200 m intervals in each of the harvesting areas. The results of the monitoring, following the methods discussed in previous chapters, will give the mean reed characteristics for the harvesting area. Mean reed height, diameter, density per m^2, and mass per m^2 can be calculated for the harvesting areas. Environmental factors such as water depth and degree of trampling should be noted. Recent use by harvesters will not have to be estimated, as this will be known if the new rotational harvesting regime is implemented.

Monitoring sites do not have to be mapped and placed in a specific, pre-determined area within the harvesting area. Rather, they should be randomly selected at the recommended 200 m intervals within the harvesting area and they should also be considered to be representative of the area as a whole.

For the proper evaluation of trends regarding the production and recovery of the reed beds after a harvest a similar monitoring approach should be used in the harvesting areas that are being rested that year. These resting areas should be monitored when the data are being collected for the area that is to be harvested in the current year. This should make the trends in reed production more accurate and relative to the area as a whole because it would include overall environmental conditions. Continuous destructive harvesting of the same monitoring site during the growing season will result in a localised degradation in reed quality, providing a negatively skewed perception of reed quality for that harvesting area. Care should be taken to ensure the random selection of monitoring sites within each harvesting area.

Re-establishing reed beds outside the Tembe Elephant Park

There is a portion of the Muzi Swamp outside the Tembe Elephant Park's borders that can contribute to the sustainable use philosophy within its borders. Re-establishment of reed beds in these areas will, over time, alleviate pressure on the Tembe Elephant Park for this resource. A community decision has to be made, however, to support such a programme. Financial and technical assistance will not be forthcoming if there is a risk that the endeavour could fail because of community negligence and non-participation by some, or all, of its members.

Various methods of reed bed re-establishment have been successfully used around the world. Björk and Granéli (1978) describe reed cultivation for the purpose of harvesting during the winter for the production of an alternative energy source. They describe the preparation of the substrate, making it suitable for the cultivation of *Phragmites australis,* as well as the planting of reed shoots, the sowing of seeds and the planting of reed rhizome pieces. Reed shoots would have to be planted in an area where they would not be submerged in water. Reed shoots cannot tolerate extended periods of submergence because it results in the death of approximately 20 percent of the planted reed shoots (Mauchamp, Blanch & Grillas 2001). The planting of reed shoots would also be difficult to implement because it would require the construction of greenhouses and of related equipment to grow reed shoots that would be able to survive once transplanted. This would not be cost-effective and will be too time consuming to implement. The aerial sowing of seeds would be too expensive and the germination rate of seeds is low in conditions that are not ideal. Such conditions include areas that are already vegetated or are overly waterlogged. The aerial sowing of *Phragmites australis* seeds was used most successfully over large uniform areas that had been prepared specifically to vegetate the area subsequent to land consolidation (Björk & Granéli 1978).

The planting of rhizome pieces seems to be the most promising method of re-establishing reed beds in the Sibonisweni community. Rhizome pieces can be selected from reed beds inside Tembe Elephant Park that have good reed characteristics as the genetic predisposition of the rhizomes will produce similar reeds if managed correctly. Management and monitoring of the reed beds outside the Tembe Elephant Park should follow the guidelines of the management plan for the harvesting area inside the reserve. The most effective means of *Phragmites australis* spread is through vegetative growth of the rhizomes (Granéli 1984; Van der Werff 1991; Chambers, Meyerson & Saltonstall 1999). However, the use of rhizome transplantation requires that the substrate be fairly well drained so that the water level is not above that of the soil level. Rhizomes should be planted so that some part of each rhizome is exposed to the atmosphere for gaseous exchange until root formation has taken place (Granéli 1984). Rhizomes should be harvested from the Muzi Swamp in late winter and be prevented from desiccating. Rhizome pieces should be collected by using a soil auger in those reed beds that are deemed to be of a good quality. Areas within the reed bed that have good quality reeds will tend to have a healthy nutrient-rich rhizome component. Rhizome pieces should be rinsed by using a sieve to remove excess soil and undesirable organic components. The rhizome pieces must then be planted just before the onset of spring (middle to late August). This should allow time for the rhizome to establish roots necessary for gaseous exchange before the onset of the seasonal rains, and thereby survive inundation by water.

The establishment of a healthy reed bed will take time, and more than one growing season is required before the underground biomass is sufficient to produce a harvestable crop in the winter months. An exclosure that surrounds the planted areas would be preferable in the re-establishment process to prevent domestic livestock from grazing the newly emerging reed shoots in the summer months. As the area will initially be small it is not entirely impossible for such domestic animals to destroy newly planted areas. The trampling effect of large numbers of domestic stock will also damage new shoots. This damage will lead to reduced nutrient accumulation in the root stock of the reed bed and a delay in vegetative growth.

An exclosure plot surrounding a newly planted area within the community would allow the successful and rapid establishment of a reed bed. A simple fence with three or four strands for keeping animals out would allow the vegetative spread of the reeds into the surrounding areas. This would effectively act as a source area for other parts of the swamp that occur in the Sibonisweni community. The re-establishment process will take time, but it will have long-term benefits for the community.

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CHAPTER 10

CONCLUSIONS

Sustainable use can be defined, in the context of the reed beds in the Muzi Swamp, as the use of the resource (*Phragmites australis*) at a rate within its capacity for renewal; maintaining the ecological integrity of the natural system (Muzi Swamp) which produces the resource; minimising or avoiding the risk of irreversible change induced by humans (reed harvesters); and adequate investments (management systems) being made to ensure the conservation and sustainable use of biodiversity (URL: http://www.gov.za/whitepaper/1997/conservation). For a resource to be considered sustainable it must have the ability to recover to its previously recorded environmental potential after the use thereof. In the case of the Muzi Swamp and its current management, the resource is being managed sustainably only in the sense that at the current harvesting intensity it is unlikely that the resource will disappear. The Muzi Swamp could however be managed more effectively in order to improve the overall condition and structure of the reed beds.

Pro-active adaptive management systems need to be put into place as soon as possible to ensure the integrity of the reed beds. The adaptive management systems should meet with the goals and standards of both the Tembe Elephant Park and the neighbouring rural communities. The adaptive management systems should include continual monitoring of the resource over set time intervals. The monitoring of a living resource is essential because environmental conditions invariably fluctuate causing the maximum sustainable yield to fluctuate (Becker & Ostrom 1995). The proper adjustment of harvesting quotas following the analysis of monitoring data will ensure that current management strategies will not have to change due to over-harvesting of a certain sector within the reed beds. It must be understood by all concerned that harvesting quotas will be set according to the results of a yearly monitoring programme. Should environmental conditions vary from year to year, so too will the harvesting quotas. That is the basis of sustainable utilisation of any natural resource. Resources sustained naturally are more affected by climatic conditions than man-made crops; their productivity cannot be altered and augmented by the application of additional nutrients and water. Catastrophic events such as drought and flooding can temporarily reduce the productivity and stored resources in the reed beds in the Muzi Swamp. These events, coupled with unadjusted harvesting quotas, might very well cause irreparable damage to the standing crop as well as limit the next season's production potential.

One could also argue that a resource is only considered sustainable when people derive direct benefit from it, whether it is for subsistence use or financial gain (Branch 2000; Sanderson *et al.* 2002). This argument is associated with the paradigm shift towards managing our environmental and wildlife resources to the benefit of the country's human population, rather than continuing with the present theory of how we manage the country's human population so as to benefit our environmental and wildlife resources (Els & Bothma 2000). There is no doubt that increased pressure will be placed on protected natural areas, and the authorities that govern them, for access to natural resources within their boundaries (Sanderson *et al*. 2002). A positive population growth rate combined with a negative economic growth rate (Stauth & Baskind 1994) has left no other option but for local rural communities to derive direct benefit from a wealth of resources within protected areas. Whether access is controlled and supported by the governing bodies involved in the protection of the natural areas or not, the use of resources will still take place.

Protected natural areas such as Tembe Elephant Park and Ndumo Game Reserve, both in Maputaland, are experiencing ever increasing incidences of illegal harvesting of natural resources. Poaching of small game in Ndumo Game Reserve has increased by about 350 % over the last few years. A lack of financial resources and a reduction in manpower in this reserve has lead to the inability to cover all the terrain as regularly as reserve management would like to. The Tembe Elephant Park also experiences, but to a lesser degree, the poaching of small game, the illegal harvesting of medicinal plants and honey. The poaching of small game in these protected areas is mainly for the pot and small-scale commercial endeavours. The lack of economic development in rural areas surrounding the protected areas is partly to blame for the increase in illegal harvesting. Community members neighbouring Tembe Elephant Park and Ndumo Game Reserve see these game reserves as the only form of economic growth and "industry" in the region. The game reserves, however, cannot meet all the economic growth needs, such as job creation, in the area (Mostert & Rynard 2003 *pers. comm*[2,3].).

The onus however is not placed fully on the game reserve managers to "supply" local rural communities with resources and additional income. A working relationship has to exist between heads of local rural communities and game reserve managers. Understanding of the goals and objectives of both parties should be properly communicated at regular meetings. One of the greatest flaws in natural resource management has been the widespread neglect of understanding the complex relationship that African rural poor have with their natural environment. The tradition in natural resource management has been to train managers in the biological understanding of fauna and flora, yet once involved as managers they realise that they are increasingly drawn into situations where they are required to manage people rather than the actual resources (Hilborn, Walters & Ludwig 1995). There needs to be a greater understanding of, and cooperation with, rural communal communities by

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game reserve managers. Training future and current protected area managers in effectively dealing and communicating with people from communities bordering reserves is essential for the future of conservation in South Africa. Educating people in, and the transfer of basic ecological principles should not be a one-way stream of information. Game reserve managers must realise that final decisions regarding the management of natural resources should be discussed with the end users of the resource. Autocratic decisions on such management steps, however scientifically and ecologically sound, excludes and marginalizes community members (Fuggle 1994). People who have lived closely with the environment for generations should be accredited with having some knowledge of the workings thereof. Similarly, community leaders in rural South African communities that rely on natural resources for survival should appreciate what conservation authorities have done to ensure that resources such as reeds are still available in areas such as the Tembe Elephant Park. Were it not for the Tembe Elephant Park the Muzi Swamp might not exist today. Large-scale conversion of pans and wetlands to exotic forest plantations in the northern Maputaland region is commonplace. Affording protection to an area in the name of conserving elephants and sand forest has ensured that the Muzi Swamp has remained a productive natural resource base from which local communities can derive financial benefit. The use of indigenous knowledge coupled with adaptive management techniques and a sound scientific background will result in achieving not only environmental aims and goals but also uplift and empower local rural communities by giving them the opportunity to make informed decisions about the environment they live in.

There is a solution to the current problem of reed harvesting in the Tembe Elephant Park that need not be to the detriment of any of the concerned parties. Working as a team to find solutions and common ground upon which sound scientific and indigenous knowledge can be implemented in a management strategy will bode well for the future of the Tembe Elephant Park and the Sibonisweni community. The potential for *Phragmites australis* to be utilised sustainably in the Muzi Swamp does not seem to be in question. There seem to be far greater concerns that have to do with the levels of communication and cooperation between the Tembe Elephant Park and the Sibonisweni Community that need to be resolved first in order to achieve this.

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SUMMARY

Phragmites australis (Cav.) Trin. ex Steud., or the common reed, has been harvested in the Muzi Swamp in Maputaland for generations. Local rural communities on the eastern border of the Tembe Elephant Park have limited access to this resource within its boundaries. These same neighbouring communities have all but depleted the reed resource outside the Tembe Elephant Park's boundaries due to overutilisation of this communal resource. Over the last 10 years a flourishing trade in the reeds harvested within the Tembe Elephant Park has developed, thereby adding to the demand for the resource. Ezemvelo KwaZulu-Natal Wildlife are concerned that the current rate and intensity of harvesting is unsustainable and is depleting the reed resource. The neighbouring rural communities, especially the Sibonisweni community, would like access to a greater proportion of this resource. This study examined the effects of reed harvesting on the Muzi Swamp, and specifically, the level of degradation of the reed beds both spatially and temporally. The reliance of neighbouring communities on the reeds for survival, and alternative uses for reeds that will alleviate the current cause of the reed bed degradation were also examined.

The hypothesis was put forward that a degradation gradient exists in a south to north direction in the Muzi Swamp that lies within the Tembe Elephant Park, with the most severe degradation occurring the closest to where community members enter the park in the south, and the least degradation further north of this point. The results of this study, however, show no distinct degradation gradient. Yet, the overall condition of the reeds in the harvesting area is poorer than in the non-utilised area. Expansion of the current harvesting area, coupled with active and adaptive harvesting systems and yearly monitoring will improve the quality of the reeds within the harvesting area without affecting the harvesting quotas.

The long-term effect of burning and utilisation of *Phragmites australis* was investigated in the Muzi Swamp over a two-year period from 2000 to 2002. Four different treatments, these being the combinations of utilisation and/or burning, had varying effects on the density and size structure of the reeds in the Muzi Swamp. Continual harvesting combined with burning markedly reduced reed production in terms of reed density. Uncontrolled utilisation resulted in the overall decrease of reed quality with regard to reed height and diameter. The implications of the results are integral to the further management of the reed beds to provide good quality reeds for neighbouring communities, and to secure the ecological integrity of the ecosystem for conservation.

Increasing rural population growth in Africa has lead to an increasing reliance on natural resources for survival. Gross per capita income is supplemented by the utilisation of common pool resources within various communities in rural South Africa. The depletion of common pool resources in rural areas results in a greater demand for access to natural resources that flourish in areas designated for conservation. This places reserve managers and conservation authorities under pressure to resolve the resultant issue of demands on such natural resource utilisation within these protected areas. Management strategies for the sustainable use of natural resources within conservation areas need to be designed and implemented by the reserve management and also by the members of the local rural communities. Acceptance and implementation of suggested management strategies are more likely to succeed if decisions are made that recognise the need for, and incorporate the use of indigenous knowledge. An examination of the trends in reed use in the Sibonisweni community indicated that the livelihood strategies of these community members are centred on reed utilisation in the Tembe Elephant Park. There is also a strong indication that members of the Sibonisweni Reed Cutters Association are aware of correct management practises that enhance reed production. However, the reasons for not implementing these strategies are unknown.

The harvesting of *Phragmites australis* reeds in the Tembe Elephant Park has to be managed pro-actively and solutions to potential problems should be sought before they arise. The potential for manufacturing finished products, these being prefabricated huts, from sustainably harvested reeds and forest timber was examined. This offers a potential solution to the problem of instating a winter-only reed harvest in the Muzi Swamp. The manufacturing of finished products from the harvested material will add secondary value to the resource and also offer alternative employment to harvesting reeds in the summer. The higher prices obtained for a processed article will also hopefully reduce the demand for the resource in its raw form, thereby increasing the perceived value of the resource and reducing wastage from raw materials that are not sold.

The reed harvesting problem in the Tembe Elephant Park can be resolved by implementing the suggested management recommendations, that are based on the results of the study. The question will undoubtedly remain: is there enough political will and the potential for amicable collaboration among the interested parties to ensure the future of the Muzi Swamp, not only as an ecologically sound entity, but also as a vehicle for rural development amongst the Tembe people?

OKUFINGQIWE

I*Phragmites australis* (Cav.) Trin. ex Steud., noma umhlanga ususikwe iminyakanyaka exhaphozi elibizwa nge*Muzi Swamp* eMaputaland. Imiphakathi yasemakhaya eseduzane nale ndawo engasemnceleni osempumalanga weTembe Elephant Park ayingeni ngokuthanda kule ngcebo. Yona kanye le miphakathi eyakhele le paki yehlise ingcebo yomhlanga ngaphandle nasemaphethelweni eTembe Elephant Park ngenxa yokuyisebenzisa ngokweqile le ngcebo yomphakathi. Kule minyaka eyishumi edlule uhwebo oluthembisayo lomhlanga osikwe ngaphakathi kweTembe Elephant Park lwaqala, ngaleyo ndlela lwenyuswa ukudingeka kwayo le ngcebo. Umnyango owaziwa nge-Ezemvelo KwaZulu-Natal Wildlife ukhathazekile ukuthi izinga nokuqina komkhankaso wokusikwa komhlanga awusekelekile futhi unciphisa le ngcebo. Imiphakathi yasemakhaya engomakhelwane, ikakhulukazi owaseSibonisweni, ungathanda ukuvunyelwa ungene uthole ingxenye enkulu yale ngcebo. Lo msebenzi uhlole imiphumela yokusikwa komhlanga exhaphozini elaziwa ngeMuzi Swamp, futhi ikakhulukazi, izinga lokwehla kwezindima zomhlanga ngokwendawo nasekuqhubekeni kwesikhathi. Ukuthembela kwemiphakathi engomakhelwane emhlangeni ukuze iphile, nokusetshenziswa ngendlela ehlukile komhlanga okungaqeda imbangela ekhona yokwehla kwezindima zomhlanga kwacutshungulwa.

Kwabekwa ukuhlawumbisela kokuthi kukhona ukwehliswa komhlanga uma usuka eningizimu uya enyakatho yexhaphozi laseMuzi elingaphakathi kweTembe Elephant Park. Kube nokwehla okubi kakhulu okutholakala maduzane nalapho amalunga omphakathi engena khona ipaki eningizimu, nokwehla okuncane uma uqhubekela ngasenyakatho yale ndawo. Nokho, imiphumela yalo msebenzi ayikhombisi kwehla okusobala. Yize kunjalo, isimo sonke somhlanga endaweni yokuwusika sibinyana kunalapho ungathintiwe khona. Ukunwetshwa kwale ndawo yokusika, nesimo sokusika esikhona manje, nezindlela ezikhona zokuhleleka kokusika, kanye nokuqapha kulowo nalowo nyaka, kuyosiza ukuthuthukisa ubuhle bomhlanga endaweni lapho usikwa khona ngaphandle kokuthi ukhubaze inani elilindelekile lesivuno.

Imiphumela yesikhathi eside yokushiswa nokusetshenziswa kwe*Phragmites australis* exhaphozini laseMuzi kwaphenywa iminyaka emibili kusukela ngo-2000 kuya ku-2002. Ukukhuhlumeza noma ukuhlola okune, okungokuhlanganisa ukusebenzisa nokushisa, kwaba nemiphumela ehlukene ekuminyaneni nasesilinganisweni sesimo somhlanga exhaphozini iMuzi. Ukusika okuqhubekayo kuhlanganiswa nokushiswa kwehlisa ngendlela egqamile umkhiqizo womhlanga lapho kubhekwa ukuminyana kwawo.

Ukusetshenziswa okungalawuliwe kwabangela ukwehla jikelele kobuhle bomhlanga okuthintene nobude nobubanzi. Okuvezwa imiphumela kubaluleke kakhulu ekuqhubekeni kokuphathwa kahle kwezindima zomhlanga ukunikezela izinga eliphezulu lomhlanga emiphakathini, kanye nokuvikela ukuphelela kwemvelo nohlelo lokuyigcina.

Ukukhula kwenani labantu basemakhaya e-Afrika kuholele ekuthembeleni okukhulayo engcebeni yemvelo ukuziphilisa. Imali engenayo ngosebenzayo (Gross per capita income) yelekelelwa ukusetshenziswa kwenhlanganyela yengcebo efanayo emiphakathini ehlukene yaseNingizimu Afrika esemakhaya. Ukwehla kwale nhlanganyela yengcebo ezindaweni zasemakhaya kuholela esidingweni esikhulu sokungenela ingcebo yemvelo ethembisayo ezindaweni eziqokelwe ukugcinwa. Lokhu kubeka abaphathi beziqiwi nezikhulu zokugcinwa kwemvelo ngaphansi kwengcindezi ukuxazulula isikhalazo esivelayo sokudinga ukusebenzisa le ngcebo yemvelo kulezi zindawo ezivikelwe. Izindlela zokuphatha ukusetshenziswa ngokusekelekile ingcebo yemvelo ezindaweni zokuyigcina kumele ziqanjwe futhi ziqale zisetshenziswe abaphathi bayo namalunga omphakathi oseduze wasemakhaya. Ukwamukeleka nokuqala kokusetshenziswa kwezindlela zokuphatha eziphakanyisiwe zingaphumelela kakhulu uma izinqumo zenziwa zibhekelela, futhi zifaka ukusetshenziswa kolwazi lwendabuko. Ukuhlolwa kwezinkambiso ekusetshenzisweni kwemihlanga emphakathini waseSibonisweni kwaveza ukuthi izindlela zokuzondla zamalunga alo mphakathi zigxile ekusetshenzisweni komhlanga eTembe Elephant Park. Futhi kunezinkomba eziqinile zokuthi amalunga enhlangano yabasiki bomhlanga eyaziwa ngeleSibonisweni Reed Cutters Association ayazi ngezinkambiso ezilungile ezingakhuphula umkhiqizo womhlanga. Kepha, izizathu zokungaqali ukusebenzisa lezi zinkambiso azaziwa.

Ukusikwa komhlanga i*Phragmites australis* eTembe Elephant Park kumele kuphathwe ngendlela enokukhuthala kungakaveli izinkinga, futhi izixazululo ezinkingeni ezingaba khona kumele zitholakale ngaphambi kokuvela kwezinkinga. Amandla okwenza imikhiqizo eseyiphelele, lokho kungaba izindlu zotshani noma amaqhugwana okwakhiwe kuqala, ngomhlanga osikwe ngokwesekelwa nangezingodo zasehlathini kwabhekisiswa. Lokhu kunikeza isixazululo esingayiso enkingeni yokuqalisa uhlelo lokusikwa komhlanga exhaphozini laseMuzi ebusika kuphela. Ukukhiqizwa kwezimpahla eseziphelele ngomhlanga nangezingodo kuzoletha ingcebo ethe xaxa kuphinde kunikezele ngamathuba ahlukile omsebenzi ekusikweni komhlanga ehlobo. Amanani aphezulu atholakele ezintweni esezenziwe kunethemba lokuthi anganciphisa ukudingeka kwale ngcebo esimweni sayo semvelo, ngaleyo ndlela kukhuphule intengo yayo kwehlise nokumosakala komhlanga ongadayiswanga.

Inkinga yokusikwa komhlanga eTembe Elephant Park ingaxazululwa ngokuqala kusetshenziswe izincomo zokuphatha eziphakanyisiwe, ezibhekiswe emiphumeleni yalo msebenzi. Umbuzo okungangabazeki ukuthi uzosala owokuthi: ingabe sikhona yini isifiso esanele sabezepolitiki nethemba lokubambisana okunobungani kulezo nhlangothi ukuqinisekisa ikusasa lexhaphozi laseMuzi, hhayi kuphela njengendawo yezemvelo ezimele, kodwa futhi njengendlela yentuthukiso ebantwini baseTembe?