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Report

Mangrove Utilisation and Implications for Participatory Forest Management, South Africa

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Abstract

South African rural coastal communities have utilised mangrove products for generations. However, the factors determining use are poorly understood and utilisation is rarely acknowledged in natural resource management. Since the post-apartheid government came to power in 1994, there has been a paradigm shift in government forest policy, and Participatory Forest Management (PFM) has been selected to implement these changes. This study was initiated to determine the utilisation of mangrove products, locally available alternatives and the implications for PFM. Combinations of methods were employed, including a participatory walk, group discussions, observation and semi-structured interviews. The main use of mangroves was for construction of buildings, with *Bruguiera gymnorrhiza* and *Rhizophora mucronata* being preferred. Diameters of stems selected for construction were approximately between 5–7 cm for poles and 2–3 cm for laths. Indigenous and exotic woods, and mud and sand blocks were also used for construction of buildings. PFM should include a plan for the sustainable utilisation of mangroves. The plan should be guided by national legislation and address the biology of the mangrove species. The plan should include livelihood issues and should in the long term promote the use of alternative construction materials to mangroves, and should enhance the non-consumptive value of the mangrove ecosystem.

Keywords: community-based natural resource management, construction timber, forest products, South Africa, wetlands

INTRODUCTION

MANGROVES ARE DEFINED as tropical trees restricted to inter-tidal and adjacent communities (Tomlinson 1986). The morphological and ecophysiological characteristics of mangrove trees make them structurally and functionally unique. The standing crop of a mangrove forest is generally larger than other aquatic ecosystems (Alongi 2002). Mangroves play an important role in nutrient cycling, nutrient export, sediment trapping and coastal protection, and act as breeding and nursery grounds for marine and estuarine organisms (Lugo & Snedaker 1974; Hogarth 1999; Mumby *et al*. 2004). The mangroves of South Africa are a sub-tropical outlier, at the southernmost limit of their African range. In the 1980s, mangroves were estimated to cover an area of 1058 ha: 785 ha in KwaZulu-Natal Province and 273 ha in the Eastern Cape Province (Ward & Steinke 1982). The area covered by mangroves is dynamic; in the Wild Coast area of the Eastern Cape, an area loss of 6.5 per cent over 17 years has been reported (Adams *et al*. 2004).

Globally, products from mangrove ecosystems have been utilised for generations and these include firewood, charcoal, construction timber, fish traps, tanning compounds, dyes and medicinal products (Semesi 1992; Dahdouh-Guebas *et al*. 2000; Barbosa *et al*. 2001). In South Africa, mangroves are utilised as fuelwood, building materials and fish traps (Bruton 1980; Ward *et al*. 1986; Rajkaran *et al*. 2004), whilst within the mangroves stock grazing and collection of the mangrove crab (*Sesarma meinerti*) occurs (Steinke 1999; Kyle 2004). The impacts of mangrove utilisation are unclear and a recent assessment of the degree of use of forest products rated mangrove use and impact as being nil/not significant for all products (Lawes *et al*. 2004). However, in some South African estuaries that lack conservation protection, Adams *et al*. (2004) reported that harvesting had removed more than 50 per cent of the mangrove trees.

Within South Africa the management of mangrove ecosystems has been problematic for several reasons. Firstly mangroves tend to be fragmented into 'small, isolated estuarine pockets along the coast' (Steinke 1999:136), with over forty separate areas of mangroves ranging in size from less than 0.5 ha to 428 ha being documented (Ward & Steinke 1982). Secondly, different land tenure systems exist such as protected areas, unprotected areas, state land and communal land. The institutions and processes for resource management vary between the different land tenure systems (see von Maltiz & Shackleton 2004). Thirdly, there is limited understanding and quantification of the utilisation of mangrove products. Furthermore, the environment should be perceived as a social, political and physical construct where a continual interaction and inter-dependency exists (King *et al*. 2007).

Since the post-apartheid government came to power in 1994, many new government policies have recognised the essential obligation South Africa has to manage natural resources in order to facilitate rural development. As a consequence more participatory approaches are being adopted (Willis 2004). In the coastal areas of the Eastern Cape Province of South Africa, the bio-physical environment with a high biodiversity is seen as a valuable economic resource (Kepe 2002). An initiative that aims to incorporate both these aspects is the Eastern Cape Estuaries Management Programme (ECEMP), of which the study region of the Mngazana estuary is an integral part. The ECEMP established the Mngazana Mangrove Management Forum (MMMF). The forum consists of representatives from three local villages, the local municipality, the Department of Land Affairs, the Department of Water Affairs and Forestry, the Department of Environmental Affairs and Tourism, and a non-governmental organisation (NGO), the Institute of Natural Resources (INR). The INR is a non-profit organisation that promotes the wise and sustainable use of natural resources; it co-manages the ECEMP. The forum's vision is that local communities and the government should cooperate to ensure the protection and sustainable management of the mangroves (Masibambane n.d.). This embraces Participatory Forest Management (PFM), a strategy the government has adopted to provide the framework for the implementation of management plans in selected indigenous forests (Grundy & Michell 2004).

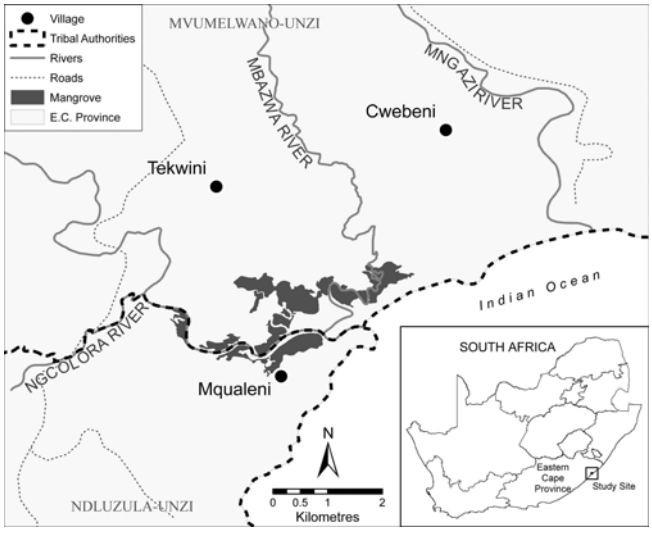
MATERIALS AND METHODS

Study Area

The Mngazana estuary (31°42′S, 29°25′E) is located in the Eastern Cape Province, South Africa (Figure 1). The Mngazana system is a riverine mangrove forest, covering an area of 137 ha (Dayimani 2002) and is the third largest mangrove forest in South Africa (Ward & Steinke 1982). The forest is dominated by species like *Avicennia marina*, *Bruguiera gymnorrhiza* and *Rhizophora mucronata*. Mngazana is rated high for both its botanical (Colloty 2000) and conservation importance, and is ranked twenty-second out of the 250 estuaries in South Africa (Turpie *et al*. 2002). Within the region, Mngazana estuary acts as a dividing point between estuaries: those to the south are dominated by salt marsh species and those to the north contain swamp forest species (Colloty *et al*. 2002). The estuary contains approximately double the number of invertebrate and fish species recorded in other estuaries in the region (Branch & Grindley 1979). The mangroves provide an important source of primary carbon utilised by fish (Mbande *et al*. 2004). The mechanical breakdown of mangrove leaves by crabs and tidal action produces particulate organic carbon that contributes to nearshore food webs in the adjacent marine environment (Rajkaran & Adams 2007).

The Mngazana estuary lies in the former Transkei, an area delineated as a homeland by the then South African apartheid government. This region is predominantly rural and is not as well developed as the rest of the Eastern Cape Province (Ashley & Ntshona 2003). The estuary and surrounding land is owned by the state and have been allocated to the Tribal Authorities (TAs) of Mvumelwano-Unzi and Ndluzula-Unzi. The three villages, Mqaleni, Cwebeni and Tekwini, come under these TAs and are situated close to the estuary (Figure 1). Within these villages, educational and formal employment opportunities are limited: 29 per cent of the population have received no schooling while 51 per cent have attended some years of primary school (SSA 2001). Opportunities to generate income are also few: 38 per cent of the labour force is between the ages of 15 and 65 years, have no fixed income, and only 8 per cent of the possible labour

Figure 1
Location map of the Mngazana estuary, Eastern Cape Province, South Africa



force is formally employed (SSA 2001). Ninety-four per cent of the population live in traditional dwellings, huts or structures made from traditional materials and 63 per cent of homesteads are headed by women (SSA 2001). In the Wild Coast area natural resources play a significant role in local livelihoods. A well developed trade in thatch grass, grass brooms, weaving reeds and woven products has been reported (Shackleton *et al*. 2007). Medicinal plants are also extremely important for domestic use and trade (Kepe 2007). Communities have also engaged in struggles to gain access to natural resources, which has generated new notions of who forms a part of the community (Fay 2007).

Field Methods

This study investigates the utilisation by local villages of products from the Mngazana mangrove forest. The key research questions were: (1) Which mangrove species are harvested and how are they utilised? (2) Are there preferences for certain mangrove products and what are the locally available alternatives? (3) What quantities of mangrove wood are used in buildings? Data and information relating to these questions will be integrated to consider the final research question: (4) What are the implications of the findings for PFM initiatives?

Combinations of methods were employed, including a participatory walk, group discussions, observation, household surveys and semi-structured interviews (Casley & Kumar 1988; Mikkelsen 1995).

A participatory walk in the mangrove forest was undertaken with five male members of the MMMF who harvested mangroves for construction. Only men were chosen for the walk because only men harvest mangrove timber. The walk was approximately 5 km and was directed to areas where utilisation had been observed. During the walk, areas where humans had had an impact were identified and the authors facilitated a discussion on what had taken place and the reasons for the activity.

Three group discussions were held between October 2003 and October 2004. The groups comprised ten to twenty-five people from Mqaleni, Cwebeni, Tekwini and the MMMF. Although discussions were conducted in English, Xhosa (the vernacular language spoken in the area) translations were provided. The group discussions were part of a wider meeting, where an NGO was facilitating the formulation of a plan to manage the mangrove forest.

The semi-structured interviews were conducted in Xhosa with English translation. The mangrove species used by members of homesteads were determined, the attributes of each species discussed and preferences recorded. The durability of mangrove buildings and locally available alternatives to mangrove products were also identified. The style, shape and number of buildings within each homestead were determined through observation and semi-structured interviews. Buildings constructed from mangrove wood were identified by the homestead owner. The timber utilised was verified by comparing it with samples of timber collected from the mangrove forest. The building 'units' were assessed and the total number of mangrove stems per unit was calculated. 'Units' were classified as wall poles (vertical support within the walls), wall laths (horizontal support within the walls) and roof poles (poles that support the main roofing material).

The diameter of the mangrove stems used in each unit was determined to the nearest millimetre by random sampling of ten exposed stems and measuring the diameter at the mid-point of the length of the stem using metal callipers. The length of the stems used for the different units was ascertained through group discussions. An approximation of the value of mangroves was elicited by using the 'own reported values' approach (Cavendish 2001). Homestead owners who purchased mangrove stems were asked to report the costs of the materials.

Homesteads were randomly selected and a minimum of twenty-two homesteads that utilised mangroves were visited in each of the three villages. In total, seventy-six homesteads that used mangroves were surveyed (13 per cent of the total number of homesteads) and seventy-one homestead occupants were interviewed. Homesteads visited that did not utilise mangrove stems were also recorded and interviewed. In total 108 households were visited (19 per cent of the total number of homesteads). The fieldwork took 7 days to complete.

FINDINGS

Utilisation of Mngazana Estuary and Mangrove Species Harvested

A government permit is required to harvest *B. gymnorrhiza* and *R. mucronata.* However, legislation is poorly communicated and enforced. Mngazana estuary and its mangroves are in fact perceived as a so-called open access resource by the villagers. People freely discussed mangrove utilisation and value because they viewed the resources in this way. The participatory walk in the forest revealed that gastropods and prawns were collected from the estuary and that fishing also took place. All the mangrove species present at Mngazana, *R. mucronata, B. gymnhorrhiza* and *A. marina,* had been subject to disturbance by cutting. Typically in *R. mucronata* and *B. gymnhorrhiza* the main stem had been cut and collected, whilst in *A. marina* the branches rather than the stem were cut. Seventy per cent of the homesteads surveyed utilised *R. mucronata* and *B. gymnhorrhiza* for building houses (n=108), whilst 3 per cent of homesteads used mangroves for other construction purposes such as fencing (n=108). The number of stems used per homestead (a value that reflects the numbers presently utilised in

homesteads regardless of time) ranged from eight to fifty and *R. mucronata* and *B. gymnhorrhiza* were preferred. These species were also utilised in the construction of fish traps within the estuary. Branches of *A. marina*, where bees had established hives, were cut to gain access to honey. Construction of fish traps and honey collection were infrequent and opportunistic activities. Approximately 20 per cent of the respondents collected *A. marina* for fuelwood, and because of its superior burning qualities, deadwood was preferred to greenwood. The frequency of collection and quantity gathered was low—less than one headload per month per homestead. A typical headload of fuelwood in South Africa weighs approximately 30 kg (Liengme 1983). None of the mangrove species were used for medicinal purposes or for dyes.

The group discussions revealed that within the MMMF it was understood that harvesting *R. mucronata* and *B. gymnhorrhiza* without a licence was illegal. The MMMF wished to apply for licences so that harvesting could be legal; however, they were unaware of the process involved in applying for a licence. Some members were sceptical of the general application process as they had previously applied for fishing licences but reported that they received no response to such applications. Within all the villages there were Community Committees; if there were disputes over forestry resources these would be brought before the committee. There were no specific community rules regarding mangrove tree harvesting; however, there was agreement that all trees harvested should be utilised and wastage should be minimal.

Styles and Shapes of Homestead Buildings

Homesteads in all the villages comprise a number of buildings which have an array of styles and shapes. Four building styles were observed in the villages: (1) lath-woven/wattle and daub/*uPhico* (*sensu* Cunningham & Gwala 1986; Timmermans 2002); (2) wood and stone (*sensu* Muir 1990); (3) block (*sensu* Liengme 1983); and (4) the modern house, a multi-roomed structure made from bricks and mortar (*sensu* Timmermans 2002). Circular, rectangular and octagonal shaped buildings were observed. Certain styles were used only in specific shapes; for example all lath-woven styles were circular and all modern houses rectangular.

The Use of Mangroves for Building Houses

Homesteads generally comprise a number of circular and rectangular buildings. Twenty-five per cent of homesteads bought mangrove stems and 75 per cent collected stems (n=39). The number, diameter, length and volume of mangrove stems used for building units varied with building shape. Circular and rectangular shapes used a similar quantity of poles; however, rectangular buildings used more than three times the number of laths than circular buildings (Table 1). The average diameter of poles used for building houses indicates that wall poles tend to be approximately 6–7 cm, roof poles 5–6 cm and laths 2–3 cm. Group discussions with the MMMF and villagers revealed that all stems over 2 m in height with the desired diameter would be harvested. The MMMF stated that the average length for wall poles was 3 m, wall laths 3–4 m and roof poles 4 m. Thus, if all the units of building are constructed from mangrove wood, a rectangular building would utilise 1.34 cu m, which is double the volume of mangrove wood that circular buildings utilise (0.66 cu m).

The preferred mangrove species for construction of buildings were *R. mucronata* (41 per cent), *B. gymnorrhiza* (21 per cent), and 38 per cent ranked these species equally (n=38). Discussions revealed that *R. mucronata* was perceived as being more plentiful and was therefore preferred. Furthermore, mangroves were preferred to indigenous timber species because the mangrove trees were concentrated in an area and hence were easier to collect. The mangrove wood was straight, strong and termite resistant, qualities which were perceived as desirable for construction. Interviewees stated that the typical durabi-

Table 1

The average number, diameter and volume of mangrove poles and laths used to construct building units in circular and rectangular buildings constructed entirely from mangroves

Building shape	Building unit		
	Wall poles (vertical)	Wall laths (horizontal)	Roof poles
Average number of mangrove stems ± SD			
Circular	23 ± 8 (n=4)	111 ± 17 (n=4)	21 ± 6 (n=60)
Rectangular	25 ± 9 (n=10)	335 ± 151 (n=35)	18 ± 15 (n=5)
Average diameter of stems ± SD (cm)			
Circular	6.7 ± 1.0 (n=40)	2.3 ± 0.5 (n=40)	6.2 ± 1.7 (n=510)
Rectangular	5.8 ± 0.9 (n=182)	3.3 ± 1.0 (n=510)	5.4 ± 2.2 (n=55)
Average volume (cu m)			
Circular	0.25	0.16	0.25
Rectangular	0.20	0.97	0.17

n=number of samples; SD=Standard deviation.

lity of a building constructed from mangroves was just over 20 years; the minimum quoted was 7 years and the maximum 100 years (n=32).

Alternatives to Mangroves

Alternatives to mangrove stems for building purposes were indigenous and exotic woods as well as mud and sand blocks. In 44 per cent of homesteads, non-mangrove wood was utilised: 2 per cent used mud blocks and 2 per cent sand blocks (n=91). The indigenous species, *Ptaeoxylon obliquum* and *Milletia grandis*, for wall posts, and the exotic species, *Cestrum laevigatum*, for wall laths, were the commonly used wood alternatives. Sawn timber, typically *Eucalyptus* sp. or *Pinus* sp., was often utilised for roof poles. In general, mud blocks were not preferred to mangroves, because during construction, protection from the rain was required. Sand blocks made from local sand deposits mixed with cement and moulded into durable blocks were the preferred building materials; however, costs prevented widespread use of sand blocks. Only three interviewees provided estimates of mangrove stem price; they paid on average ZAR (South African Rand) 1.3 ± 0.3 per stem (n=3: 1 ZAR=USD 0.16, April 2006). Using this value, the approximate cost for a circular building constructed from mangroves is ZAR 180. Locally produced sand blocks sell for ZAR 5 each. A typical circular building requires 800 blocks, so the total block cost is ZAR 4000. Thus, it is approximately twenty times more expensive to use locally produced sand blocks than to purchase mangrove stems to construct a circular building.

DISCUSSION

Implications of Findings for Participatory Forest Management

Nationally, mangrove utilisation is regulated under the National Forests Act No. 84 of 1998 (RSA 1998) and destruction of indigenous trees without a licence is prohibited. *R. mucronata* and *B. gymnhorrhiza* are protected trees and harvesting them requires a special permit. Although regulation exists, no licences have been issued for Mngazana, so mangrove harvesting is currently illegal. While the mangrove trees themselves are protected, the area under mangrove forests and the associated estuarine habitat have not been designated as a nature reserve or protected area. Adams *et al*. (2004) note that only 6 per cent of mangrove forests lie within protected areas in the Eastern Cape Province. Furthermore, in four of the fourteen estuaries with mangroves, harvesting removed over 50 per cent of the trees and mangrove survival was threatened (Adams *et al*. 2004). Biologically important and with an unusual high density of *R. mucronata*, the Mngazana mangroves are of conservation importance (Adams *et al*. 2004).

Furthermore, the extensive area containing mangroves and the high diversity of habitat types also indicates that the Mngazana estuary is of high conservation importance (Turpie *et al*. 2002). Cutting of mangrove stems has been reported to occur within 80 per cent of the mangrove forest area and selective harvesting has altered the size structure within *R. mucronata* stands (Rajkaran *et al*. 2004). Studies in Kenya have shown that there may be a change in the floristic composition of mangrove forests subjected to harvesting, with a change from the species locally preferred for harvesting to less preferred species (Kairo *et al*. 2002). A social survey conducted in the villages in 2003 showed that approximately 75 per cent of respondents (n=212) perceived the mangroves to be in an excellent or good condition (Ford *pers. comm.*). Furthermore, the majority of respondents regarded harvesting as sustainable or believed that the mangrove system had the capacity to regenerate (Ford *pers. comm.*).

Participatory management plans should acknowledge the biology and ecology of the Mngazana mangroves. Published data concerning the growth rates of the utilised species can be used to estimate regeneration timescales. The relationship between stem diameter and biomass has been investigated in *B. gymnorrhiza* by Steinke *et al*. (1995). Their data suggest that a stem diameter of 3 cm (laths) and 6 cm (poles) would equate to approximately 3 kg and 10 kg of above-ground biomass respectively. They quote an annual growth increment of 0.78 kg for *B. gymnorrhiza*. This suggests that, after seedling establishment, 4 and 13 years' growth would be required prior to harvesting laths and poles respectively. No detailed data is available for *R. mucronata*, however, *R. mucronata* is faster growing than *B. gymnorrhiza* (Ward *et al*. 1986). The years of growth required prior to harvesting *R. mucronata* would be less than that for *B. gymnorrhiza*. At Mngazana, *A. marina* has been reported to be the only species that regenerates by coppicing (Adams *et al*. 2004). Regeneration estimates for *R. mucronata* and *B. gymnorrhiza* must therefore be from propagule establishment.

The challenge at Mngazana is to enhance local socio-economic development through natural resources whilst achieving sustainable mangrove management within the confines of relevant legislation. The ECEMP recognises the role that communities who use resources can, and must, play in the management of natural resources; the ECEMP therefore facilitated the establishment of the MMMF. Part of the forum's mission is to produce and implement a mangrove management plan. The plan must acknowledge that the greatest demand for mangrove products in the study area is for *R. mucronata* and *B. gymnhorrhiza* stems that are 2–3 cm and 5–7 cm in diameter, and that these diameters are required in approximate ratios of 6:1. It would be advisable that harvesting be guided by national legislation where possible and that a workable permit system be devised with transparent monitoring and reporting procedures.

The management must extend beyond ecology and also embrace livelihood issues. Therefore, alternatives to mangrove construction materials need to be promoted and awareness of non-consumptive values of the mangroves should be enhanced. Increased utilisation of locally available construction materials, such as *C. laevigatum*, an exotic invasive weed (Palgrave 2002), will reduce demand for mangrove stems. Utilisation of sand blocks could also reduce mangrove utilisation and improve employment and economic opportunities. The use of conveniently located sand resources for building purposes has been reported in a coastal village in the Eastern Cape Province. Furthermore, sand was used in preference to wood (Shackleton *et al*. 2007) indicating the potential of this material. Robertson and Lawes (2005) have reported that where there is a subsistence level existence and dependence on forest resources, alternatives to forest resources must be affordable for resource use to alter; this is probably also the case at Mngazana.

As 25 per cent of households had purchased mangrove stems, there are necessarily individuals who financially benefit from the collection and sale of mangrove poles. These individuals should be identified and integrated into the sand block production initiative to ensure that their livelihoods are not negatively affected. Currently, the Mngazana mangroves are valued mainly for the direct, consumptive uses of its products such as construction materials, fuelwood and food like honey, gastropods and prawns. Appreciation needs to come to the fore within the community for non-consumptive uses of mangroves such as recreation, education and provision of habitat for fish nurseries, and protection from erosion and wave action. Through strategies such as establishing mangrove apiaries and training local canoe guides, the ECEMP has enhanced awareness of non-consumptive uses. The mangrove apiaries and canoe guiding are activities with income-generating potential and these will increase the social and economic development of the area as espoused in many of South Africa's new government policies.

To date the achievements of PFM at Mngazana include collaboration between the diverse stakeholders within the MMMF. Furthermore, members of the forum have identified shortfalls in their knowledge and capacity that may prevent them from achieving their aims. To overcome these shortfalls, meetings between communities who use mangroves and provincial government departments have been requested in order to clarify natural resource regulations. The MMMF is aware that harvesting *R. mucronata* and *B. gymnhorrhiza* is currently illegal; they aim to implement the licensing system so that harvesting activities are legalised. Community members have expressed the need for forest monitoring and management training to successfully implement the mangrove management plan. These locally driven initiatives are encouraging and a positive indication of what the PFM process at Mngazana can achieve. The MMMF is trying to incorporate two critical issues that have hindered past PFM initiatives in South Africa. First, there is a lack of capacity building at the start of PFM processes required to enable government and communities to manage resources successfully. Second, there is limited collaboration and a lack of awareness regarding relevant policy and legislation between different stakeholders (Grundy & Michell 2004). In the region, emerging local resource management institutions have also enlisted the support of the state rather than opt for exclusive community control of resources (Fay 2007) or expressed a preference for participatory rather than community or state forest management structures (Robertson & Lawes 2005).

CONCLUSIONS

These findings have relevance to the conservation and management of mangroves, particularly unprotected mangroves that are subject to high utilisation pressures. Sustainable management can be achieved through understanding mangrove tree biology and the characteristics of mangrove tree utilisation, and through providing locally appropriate alternatives to mangrove products. In addition, sharing management responsibilities plus enhancing socio-economic development through non-consumptive mangrove utilisation also plays a crucial role. These options require an intimate understanding of the livelihoods of communities that use mangroves, their product requirements, and the linkages and relationships with the mangrove ecosystem. The adoption of a similar approach to that at Mngazana could be appropriate at a national and global scale where estuarine species, particularly key mangrove species, are under threat from over-utilisation and under-management. A co-management process, involving all stakeholders from communities, conservation bodies and government institutions, needs to be put in place for the sustainable utilisation and conservation of this important resource.

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