THE KUNENE RIVER MOUTH: MANAGING A UNIQUE ENVIRONMENT

by

JOHN RICHARD BERNARD PATERSON

Submitted in partial fulfillment of the requirements for the degree of
Master of Environment and Development in the Centre for Environment, Agriculture and Development, School of Applied Environmental Sciences University of KwaZulu-Natal

Pietermaritzburg

2007

Abstract

The Kunene River Mouth (KRM) is one of only two river mouths in Namibia. The Kunene river and river mouth is bisected by the international border between Namibia and Angola, and lies between two protected areas, Iona National Park in Angola and Skeleton Coast Park in Namibia. The governments of Namibia and Angola have signed a Memorandum of Understanding (MoU) to link these two parks as a transfrontier park. This study further proposes a transfrontier Marine Protected Area to protect the marine environment surrounding the KRM and the Angola Benguela Front. The KRM is a fluvially dominated freshwater river mouth. The area is a biogeographically important biodiversity hotspot. The remoteness and pristine character contribute to the aesthetic appeal of the area. This study provides a profile of the KRM addressing its conservation value in terms of both biodiversity and aesthetic value, making use of the concept of "sense of place". An analysis of all current and potential stakeholders is presented and their interests, activities and potential threats are evaluated. The main stakeholders are Government: the Ministry of Environment and Tourism, the Angolan Government, Ministry of Fisheries and Marine Resources, Namwater, Ministry of Mines and Energy, and the Kunene Regional Council. The private sector presently has a small stake in the area, with the exception of the Northern Namibia Development Corporation who is prospecting for diamonds at the KRM. Although the area has great tourism potential there is no tourism development currently underway or planned. The threat analysis suggests that the KRM is under severe threat from inappropriate development, both locally as well as within the catchment. Mining and prospecting were identified as the greatest threat, whereas tourism poses the least threat to the area. It is suggested that appropriate tourism is the most suitable development for this sensitive area. There is currently no coherent management strategy in place for the KRM. The current environmental legislation is ineffective. The need for a stringent adaptive management regime is identified and management goals for the area are suggested. It is further suggested that the concepts of "Thresholds of Potential Concern" and "Limits of Acceptable Change" are useful to monitor indicators for biophysical components and development activities respectively and to maintain a "Desired State" for the area. This "Desired State" must be the result of a participatory process. To be effective stakeholders must reach consensus on the “Desired State”. An eight step participatory process is proposed to develop and implement an adaptive management and development strategy for the KRM.

The research described in this mini-dissertation
was carried out at the Centre for Environment,
Agriculture and Development, University of KwaZulu-Natal, Pietermaritzburg,
under the supervision of Dr. Chris Dickens and Mr. Drummond Densham

This mini-dissertation represents the original work
of the author and has not otherwise been submitted in any form
for any degree or diploma at any university.
Where use has been made of the work of others
it is duly acknowledged in the text.

John Paterson - candidate

Dr. Chris Dickens - Supervisor

Mr. Drummond Densham - Co-Supervisor

In memory of

my mother, Heather

and for

my father, Peter

For all you have done

Table of Contents

Table of Figures

Table of Maps

Table of Tables

Acknowledgements

I would like to thank the following people who have assisted with this work; Hannes Holtzhazsen for support and encouragement, Eugene Marais for ideas and many fruitful discussions, Mark Boorman for company during field work at the Kunene. I thank the Ministry of Environment and Tourism for allowing me to conduct the research. My supervisors Dr. Chris Dickens and Drummond Densham for their support, helpful comments and much patience. Sue Kuyper at the ADU thank you for your time, ideas and support and giving me space to work in Cape Town. The BCLME programme is thanked for the logistical support during the October 2004 field trip. Without Barbara I do not know what I would have done, thank you for your support and encouragement, proof reading and advice. I will never put another . after *et*

List of acronyms used in the text

AIS	Aesthetic Impact Score
BCLME	Benguela Current Large Marine Ecosystem Programme
BENEFIT	Benguela Environment Fisheries Interaction & Training Programme
CZM	Coastal Zone Management
EIA	Environmental Impact Assessment
EPL	Exclusive Prospecting Licence
IBA	Important Bird Area
IUCN	International Union for the Conservation of Nature
KRM	Kunene River Mouth
LAC	Limit of Acceptable Change
MAWRD	Ministry of Agriculture, Water and Rural Development
MET	Ministry of Environment and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MME	Ministry of Mines and Energy
MoU	Memorandum of Understanding
MPA	Marine Protected Area
MWTC	Ministry of Works, Transport and Communication
NACOMA	Namibian Coast Conservation and Management
NNDC	Northern Namibia Development Corporation
NNF	Namibia Nature Foundation
PR	Probability Rating
RL	Risk Level
RS	Risk Score
SADC	Southern African Developing Countries
SCP	Skeleton Coast Park
SPAN	Strengthening the Protected Areas in Namibia
TMPA	Transfrontier Marine Protected Area
TPC	Threshold of Potential Concern

Chapter 1: Introduction

1.1 Aims and Objectives

The aim of this study is to propose a framework to guide the process of designing and drafting a management and development plan for the KRM.

To realise the aim the following objectives have been set.

- Describe the ecological processes, characteristics and conservation importance of the Kunene River Mouth (KRM)
- Describe the activities, proposed and ongoing, and their potential impact on the KRM
- Identify stakeholders and their key interests in the KRM
- Identify the key aspects for inclusion in an adaptive management strategy for the KRM

This analysis will provide the information base to inform proposals for future management strategies and appropriate development goals for the KRM and surrounding area.

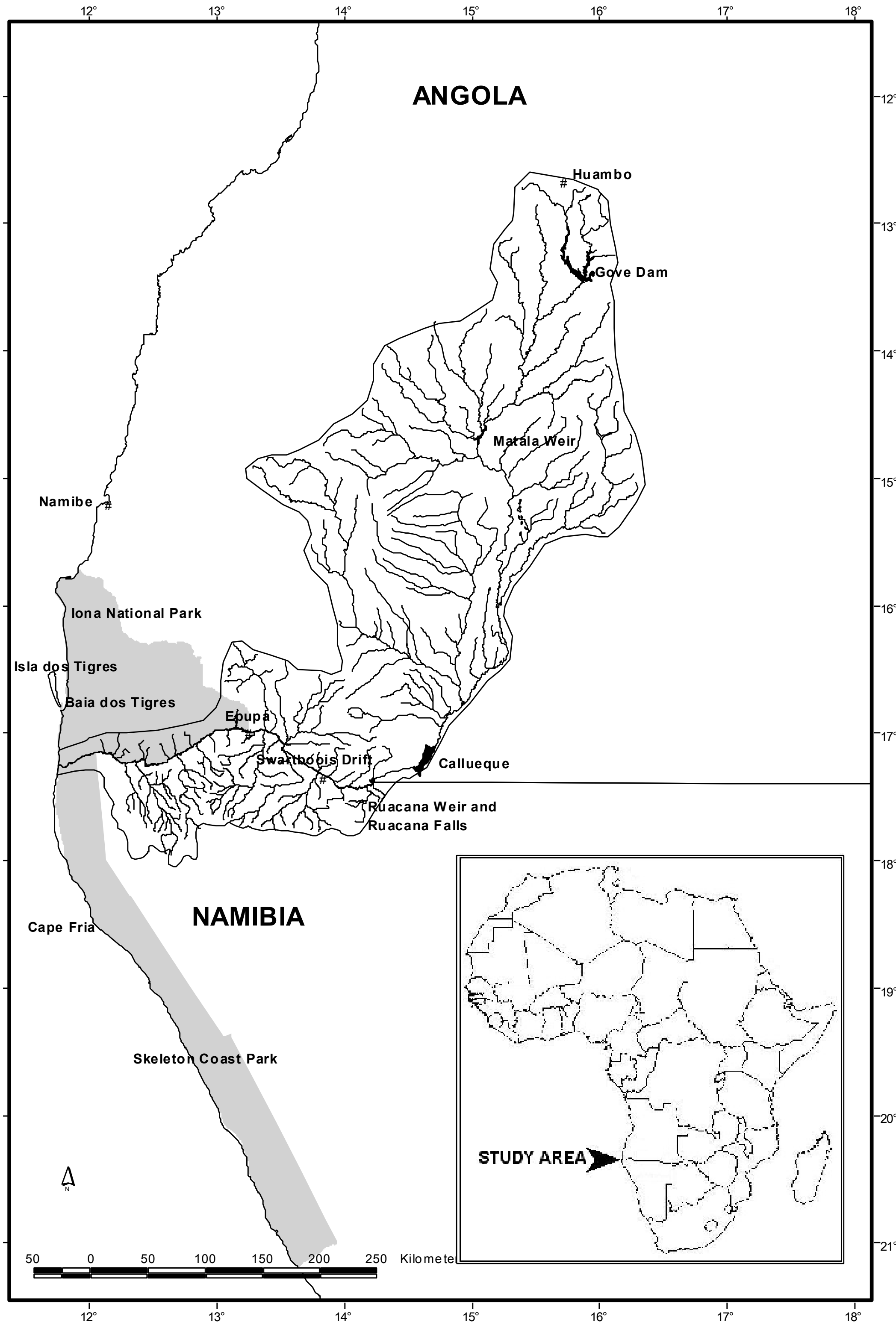
1.2 Context

South African rivers and estuaries have been well studied as is documented by a comprehensive body of literature (cf. Chapter 3).The Kunene River on the other hand has had little academic attention. There is currently no active management of the river. The river mouth is rich in biodiversity and is considered a hot spot on the Namibian coast (Barnard & Curtis 1998). The Kunene River Mouth (KRM) as a habitat is unique on the Namibian coast, and although it falls within a protected area, the Skeleton Coast Park, there are no specific management objectives for the area. One of the key objectives of a recent survey was to recommend management strategies for the KRM (BCLME 2007). The survey revealed that a co-ordinated bio-monitoring programme, a conservation management plan and eco-tourism development is critical for the KRM.

This study provides the framework for developing a co-ordinated monitoring strategy, conservation management plan and development plan, thus filling an important gap.

1.3 Background

The Kunene River forms the international border between Namibia and Angola entering the Atlantic Ocean in an extremely remote location at 17^0 15’ S 11^0 45’ E. Here the Kunene forms the only permanent river mouth on the Namib Desert coast between the Orange River 1350km to the South and the Catumbela River 563km to the North (BCLME 2007, Map 1.1). The river forms a linear oasis in a hyper arid environment providing habitat suitable for many species in an otherwise hostile environment. This habitat is dependant on the river, which is totally fluvially dominated. In other words the area functions as a river mouth rather than an estuary, consequently lacking the rich benthos typically associated with estuaries (Morant and Carter 1996). The KRM is considered to be biogeographically important (Simmons *et al.* 1993, Morant and Carter 1996). This importance is indicated by the presence of the edible freshwater prawn, *Macrobrachium vollenhovenii*, which is thought to be geographically, eco-physiologically and morphologically distinct due to the physical characteristics of the KRM (Carter and Bickerton 1996). Further indicators of this importance are occurrence of the Nile soft-shelled terrapin, *Trionyx triunguis,* and the Nile crocodile, *Crocodylus niloticus,* (Simmons *et. al.* 1993). Although the KRM is considered to biogeographically important (Simmons *et al.* 1993, Morant 1996b) it is also biogeographically isolated and is susceptible and vulnerable to environmental change (de Moor *et al.* 2000). More recently Atlantic Hump-backed Dolphins, *Sousa teuszii*, have been recorded in the vicinity of the KRM (M. Griffin Senior Conservation Scientist Ministry of Environment and Tourism October 2004 *pers. comm.*) adding to the conservation significance of the marine environment. The frequently observed large congregations of Green Turtles, *Chelonia mydas* in the river mouth and fresh water plume suggest that the system is an important site for these turtles at the southern limit of their West African distribution. The Kunene is listed as an Important Bird Area (IBA) (Simmons *et al.* 2001).



Map 1.1 Kunene River catchment basin

The Kunene River Mouth is remote and difficult to reach. Access is strictly controlled on the Namibian side and 30 years of civil war in Angola ensured seclusion. The area has thus enjoyed minimal impacts resulting in a relatively natural and undisturbed environment. Both Angola and Namibia afford the area formal conservation status through the Iona Park (Angola) and the Skeleton Coast Park (Namibia).

There is no evidence to suggest that the area has been inhabited or utilised by indigenous people in recent history. The Himba people who currently inhabit North-western Namibia and South-western Angola do not utilise the coast. However, sporadic occurrence of potsherds upstream of the mouth indicates that historically people did use the river as a corridor between the coast and inland. The absence of remains of structures south of the KRM suggests that these people were nomadic visitors to the area as is the case further south along the coast. The area does not have any documented history of systematic utilisation. There is no record of any displacement of indigenous communities from the Kunene River Mouth to make way for colonial activities.

During the Portuguese occupation of Angola a small town, Foz do Kunene, was built approximately 5km upstream from the mouth with the purpose of pumping water to the fishing settlement on Isla dos Tigres 60km north (Map 1.1). During this period diamond prospecting was carried out with little rehabilitation, the scars are still visible today. This settlement was abandoned in 1975 and all human related activities ceased.

In 1995 the proposed Epupa hydroelectric scheme prompted a large-scale feasibility study during which environmental studies were conducted at the river mouth (Morant 1996a). Scientists conducting these studies were based at Foz do Kunene. The Angolan authorities reacted by stationing a small military detachment permanently at Foz do Kunene. There is evidence to suggest that the soldiers stationed at Foz do Kunene both deliberately and opportunistically fish for Green Turtles, *Chelonia mydas*, (*pers. obs.*) and it is possible that the Nile Soft-shelled Terrapin, *Trionyx triunguis*, is also targeted. There is a suspicion that a certain amount of hunting of the resident Gemsbok, *Oryx gazella,* and Springbuck, *Antidorcas marsupialis,* populations occurs. While there are no recent observations of turtle fishing or hunting it remains an issue of conservation concern.

Since the end of the civil war tourism has been increasing in Angola with an emphasis on fishing. The Kunene mouth falls within a fishing tourism concession. More recently self-drive tourists are visiting the area from the north. These activities are largely unregulated as current management activities in the Iona Park are severely constrained. The warden in charge of Iona National Park is based in Namibe. He has only visited the KRM twice in the last 2 years (E. Afonso Nature Conservator Iona National Park, Angola October 2004 *pers. comm.*).

On the Namibian side of the river the situation is somewhat different as regards conservation. The area has been managed as part of the Skeleton Coast Park (SCP) since 1972 and is being monitored and visited by park staff on a regular basis. The MRM was zoned as IUCN Category 1 in the Skeleton Coast Park Master Plan (Ministry of Environment and Tourism 1993). This zonation has, however, been a paper exercise as it has not been institutionally supported. Nonetheless access to the Kunene has been severely restricted and there has been no tourism development on the Namibian side.

Since independence in 1990 Namibia has been striving to address unemployment through development of various commercial sectors. To this end prospecting has been allowed in parks under various conditions (Ministry of Environment and Tourism 1999). The Skeleton Coast Park has been targeted by diamond prospectors focussing on the northern areas of the park. There is a prospecting operation on the southern bank of the KRM. This prospecting operation is currently expanding with commensurate impacts on the KRM.

In 1991 the governments of Namibia and Angola ratified the 1969 Agreement on the Cunene River as the official guidelines for development. This agreement was originally entered into between the Republics of South Africa and Portugal (NAMANG 1997). In line with this agreement a hydroelectric power scheme has been investigated on the Kunene River about 180km upstream of the mouth between the Baynes Mountains and

Epupa Falls (Map 1.1). The feasibility study for this project was completed in 1998 with three potential sites identified (NAMANG 1997). It is suspected that the lack of agreement between Namibia and Angola regarding the ideal site for the scheme along with environmental and socio-political implications may have resulted in the temporary shelving of the project. The project has been revived with support from Angola (Dentlinger 2005).

Integral to opening trade corridors within the Southern African Developing Countries (SADC) the construction of a major harbour is being considered at Cape Fria, 150km south of the KRM (Map 1.1). The implications of this project are the construction of a major tar road linking the coast to Ondangwa and ultimately to the trans-Caprivi highway facilitating the import and export of goods to and from south central Africa. These plans include a town at Cape Fria and water abstraction from the Kunene River (S. Nujoma then President of the Republic of Namibia January 2004 *pers. comm.*, Ministry of Works Transport and Communication 2007). Although this development is not situated on the KRM the proximity to this remote area will affect its isolation and naturalness by making it more accessible. Water abstraction might affect river flow impacting on the ecological functioning of the mouth.

Isolation and restricted access have made the Kunene River Mouth a sought after destination for many Namibians. There is pressure to open the area to the public. Several tour companies have expressed interest in developing lodges or tourism operations at the mouth. The diamond prospecting company has expressed an interest in combining a tourism operation with their prospecting activities at the river mouth. The Kunene Region regional government would like the coast to be developed for tourism to generate economic growth and benefit for the region (S. Tjongarero Governor of the Kunene Region January 2004 *pers. comm.*). Following the successful Coastal Zone Management (CZM) project in the Erongo Region (Bender *et al.* 1999) the World Bank has recently provided funding for the Namibian Coast Conservation and Management (NACOMA) project (Shigwedha 2005, NACOMA 2007).

The trends outlined above have alerted protected area managers to the fact that the future of this formerly restricted area might be threatened. The focus of the governments of Namibia and Angola on major development projects on the Kunene River such as the rehabilitation of Matala hydro electric project, the Gove Dam (NIGC 2005), Epupa hydro electric scheme (NAMANG 1997, NIGC 2005) and the Cape Fria Harbour project (Ministry of Works Transport and Communication 2007) are indicative of a national desire to capitalise on the development potential of the region. The mining sectors' focus is on the mineral resources immediately adjacent to the Kunene River Mouth and potentially poses the most serious threat to the area. The unique scenery, remoteness and sense of place of the Kunene River Mouth are the aspects attractive to the tourism sector. If the activities of these various interest groups are not reviewed against an acceptable planning framework to coordinate them this area with its unique resources, both aesthetic and physical, faces an uncertain future. This project provides the framework against which the various activities relating to the Kunene River Mouth can be reviewed in terms of the environmental goals for the area.

1.4 Rationale of this Study

The Kunene River is a unique habitat within the context of the Namib Desert. It is both geographically and biologically isolated (Simmons *et al.* 1993, Carter and Bickerton 1996, Bethune 1998, Barnard and Curtis 1998, de Moor *et al.* 2000) and is amongst the most threatened habitats in Namibia (Barnard and Curtis 1998). The Kunene River Mouth forms an important coastal wetland with high avian diversity and tropical reptile fauna unique in Southern Africa and is a site of conservation importance that faces significant threats through dam construction for hydro electricity (Simmons *et al.* 1993, Kolberg and Simmons 1998).

Prior to 1992 little scientific investigation had been conducted on the functioning of the Kunene River Mouth or the biodiversity of the area. Prompted by proposals for the construction of a dam on the Kunene in the region of Epupa Falls a broad ecological study of the river mouth was conducted in 1992 (Simmons *et al.* 1993). In April 1994 a survey concentrating on the biodiversity on the Namibian side of the river mouth was conducted and some water quality and sediment load sampling was done (NNF 1994). A comprehensive ecological survey done in November 1995 (Morant 1996a) as part of the Epupa Dam feasibility study provided good baseline ecological information on the mouth of the Kunene River. A survey that concentrated on river processes and hydrology, but also included birds and other large vertebrates was carried out in October 2004. Part of the terms of reference of this survey was to consider management aspects (BCLME 2007). These last 2 surveys are probably the most detailed scientific work that has been carried out on the functioning of the Kunene River Mouth. However these surveys were of short duration and conducted during low flow periods. The survey conducted in 2004 (BCLME 2007) identified several threats. Conservation goals were suggested without developing or suggesting any strategies to achieve these goals. Conservation goals are of little value without the strategies in place to achieve the set goals (Morant and Quinn 1999). There is now sufficient technical information available on the Kunene River Mouth to support informed management strategies for the area.

The body of available technical information on the Kunene River Mouth is not sufficient in itself to guide the areas management. Management of protected areas comprises two types of decision, technical decisions and decisions of preference or aesthetic decisions (Bell 1983a and Bell 1983b). Goals at usually describe the desired state of a system, i.e. that which is perceived as being optimum (Bell 1983b). Defining a desired state is an aesthetic or preferential decision that cannot be determined by technical information alone (Bell 1983b). This project will concentrate on the aesthetic decisions and strategies to achieve a perceived desired state.

1.5 Structure of the Thesis

The structure of the thesis follows the conceptual framework as outlined in Figure 1.1 culminating in a proposed process for developing a management plan for the KRM.

Chapter 1 provides the context and rationale for the study. Chapter 2 describes the physical boundaries and terrain of the study area. Some pertinent aspects are mentioned supporting the choice and the extent of the study area. Chapter 3 provides an overview of the relevant literature. A description of the biophysical environment and ecological functioning is given. The importance of the area to conservation and its vulnerability to local and extraneous anthropogenic threats are highlighted. Background is provided on the various concepts and strategies suggested for developing a management plan for the area. Various activities that are currently underway at the KRM as well as several proposed projects are described in Chapter 4. These are discussed in the context of the effect that they might have on various components of the KRM study site. A stakeholder analysis is presented in Chapter 5 identifying and ranking the relevant stakeholders based on their interest in the KRM. In Chapter 6 these interests are analysed in terms of the threat they pose to the area. Threats to both the biophysical environment and the aesthetic value of the KRM were assessed. In Chapter 7 suggestions are made how the concepts of Thresholds of Potential Concern and Limits of Acceptable Change may be used to maintain a Desired State for the KRM. Chapter 8 proposes a process for developing an adaptive management plan for the KRM.

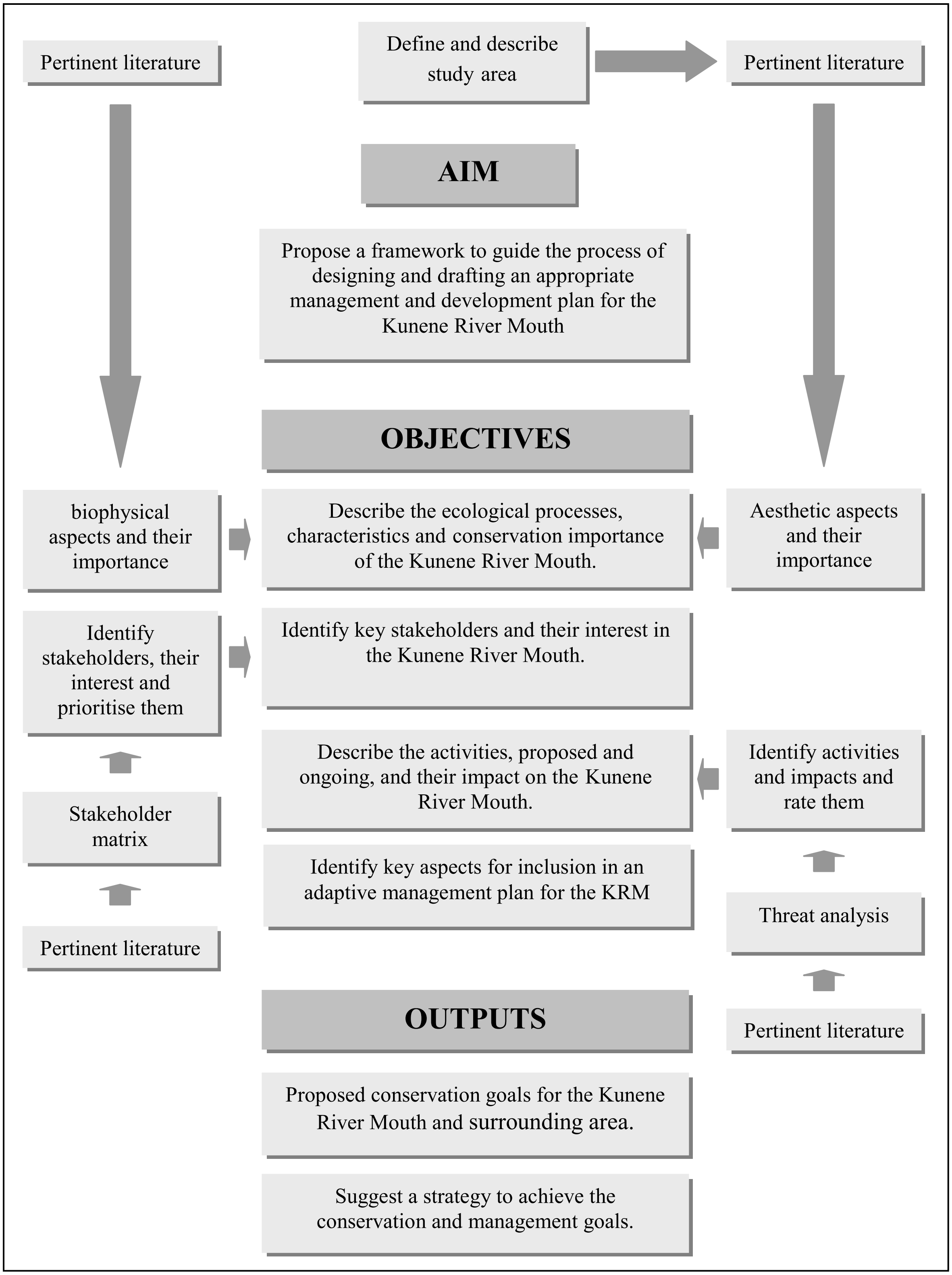


Figure 1.1 Conceptual framework for this study

Chapter 2: Study Area

2.1 Location

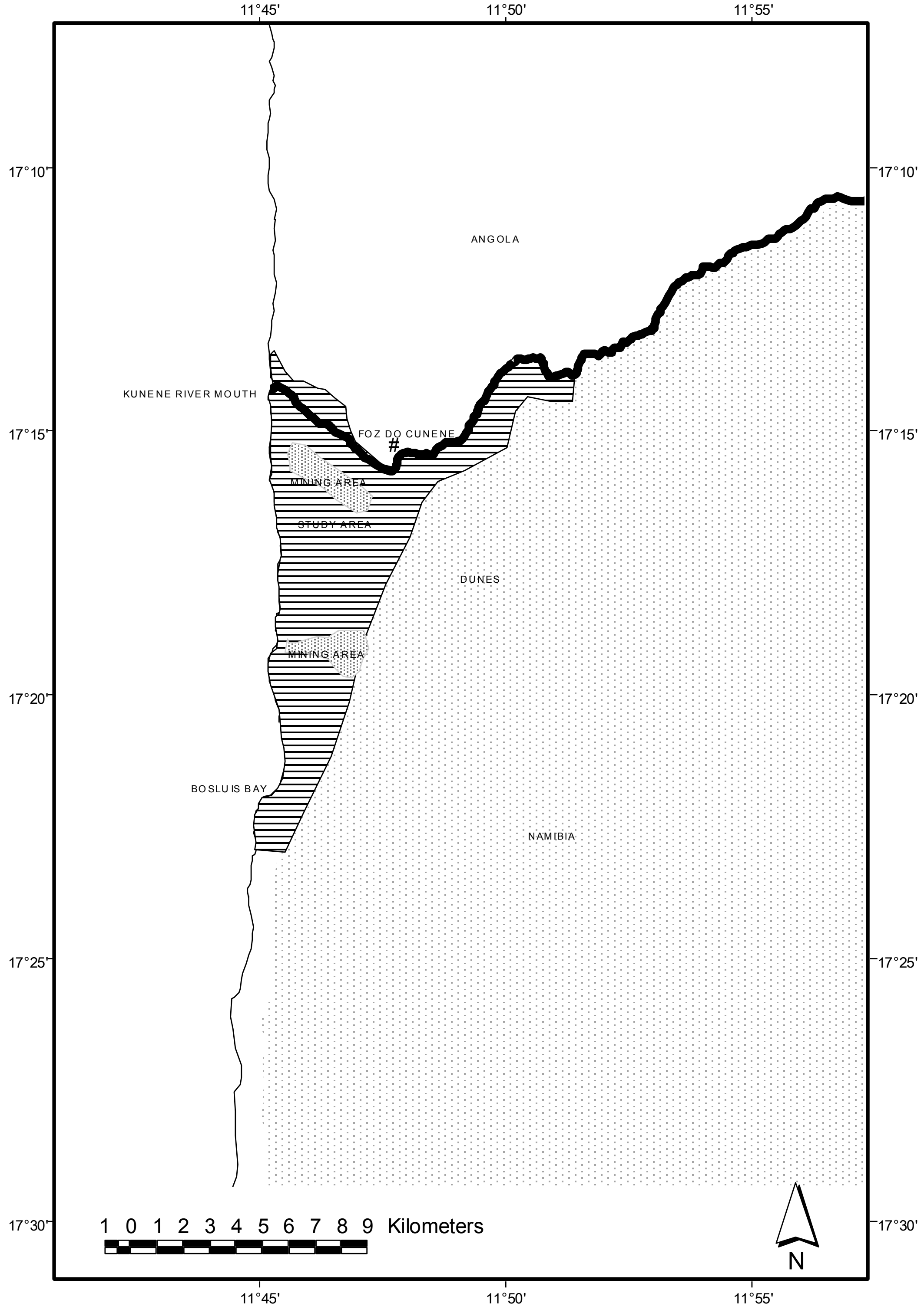
The approximately 1,570 km long Namibian coastline is situated on the South Western coast of Africa. The marine environment is characterised by the cold northward moving Benguela Current upwelling system (Shillington 2003) and sporadic intrusions of the warm Angola current from the north (BCLME 2007). The hyper arid Namib Desert provides the terrestrial setting. The coastal region is sparsely populated. The absence of large towns and heavy industry creates an almost pristine coastal environment (Molloy and Reinikainen 2003).

There are only two permanent river mouths in Namibia which bracket this coastline. To the south, the Orange River forms the international border with South Africa, and in the north the Kunene River marks the border with Angola. Apart from these river mouths Sandwich Harbour and Walvis Bay are the only other natural coastal wetlands. The salt works at Walvis Bay, Swakopmund and Cape Cross provide an additional three, man made, coastal wetlands. Luderitz lagoon and Walvis Bay are the only two large sheltered embayments with tidal mud flats that provide suitable habitat for migrant shore birds (Simmons *et al.* 1993).

2.2 Focus Area

This study focuses on the Kunene River Mouth (KRM) for about 15km upstream to the first rapids. The KRM is situated on the northern most point of the Namibian coast and straddles the international boundary between Namibia and Angola (Map 1.1 page 3). The Kunene River and river mouth with their associated vegetation and mud flats are fundamental to the survival of the majority of the area's biodiversity (Morant 1996a) and will be the focal point of the study area (Map 2.1). The study area concentrates on the KRM but its boundaries form a triangle that includes a 15km stretch of river and the coastal strip to Bosluis Bay (Map 2.1).

The area south of the mouth is included because it is utilized by game and includes Damara Tern, *Sterna balaenarum,* breeding sites (Simmons 1993). The current diamond prospecting operation is located in this area (Map 2.1) and other future developments would most likely take place in this area. The estuary or mouth extends upstream for 15km to the first rapids, which create a barrier effect preventing saline penetration and species movement further upstream.



Map 2.1 Detail of study area

The Angola component of the area is smaller because information is limited and access is restricted. The study also considers the adjacent marine environment, from the high water mark to approximately 10km offshore stretching from Isla and Baia dos Tigres in Angola to Bosluis Bay in Namibia which has the potential of becoming a Transfrontier Marine Protected Area (Map 2.2).

Baia dos Tigres is a large sheltered bay protected on the seaward side by a sand spit and island, Isla dos Tigres. This shelter creates an important wetland providing a feeding station for migrant birds and flamingoes (densities of 33 birds km^{-1}) and is possibly favoured by marine turtles (Simmons *et al*. 2006a, Simmons *et al.* 2006b). Isla dos Tigres supports a breeding population of Great White Pelicans, *Pelecanus onocrotalus*, White-breasted Cormorants, *Phalacrocorax carbo*, and Cape Cormorants, *Phalacrocorax capensis*, as well as a Cape Fur Seal, *Arctocephalus pusillus pusillus*, colony (Simmons *et al*. 2006a, Simmons *et al.* 2006b). Both the bay and Island require formal protection because they are not included in the Iona Park (Simmons *et al*. 2006a, Simmons *et al.* 2006b).

An estuary is an interface between terrestrial and marine environments and is thus affected by both processes (Harrison *et al.* 2000). The KRM is not an estuary so if the current status quo is maintained, marine processes will not affect the river dominated fresh water systems within the mouth. But the fluvial processes significantly affect the salinity north of the river mouth creating estuarine conditions along the shoreline (BCLME 2007).

From a development perspective the river is the main attraction to the area and any developments would likely be centered on the river and be dependant on water abstracted from the river.

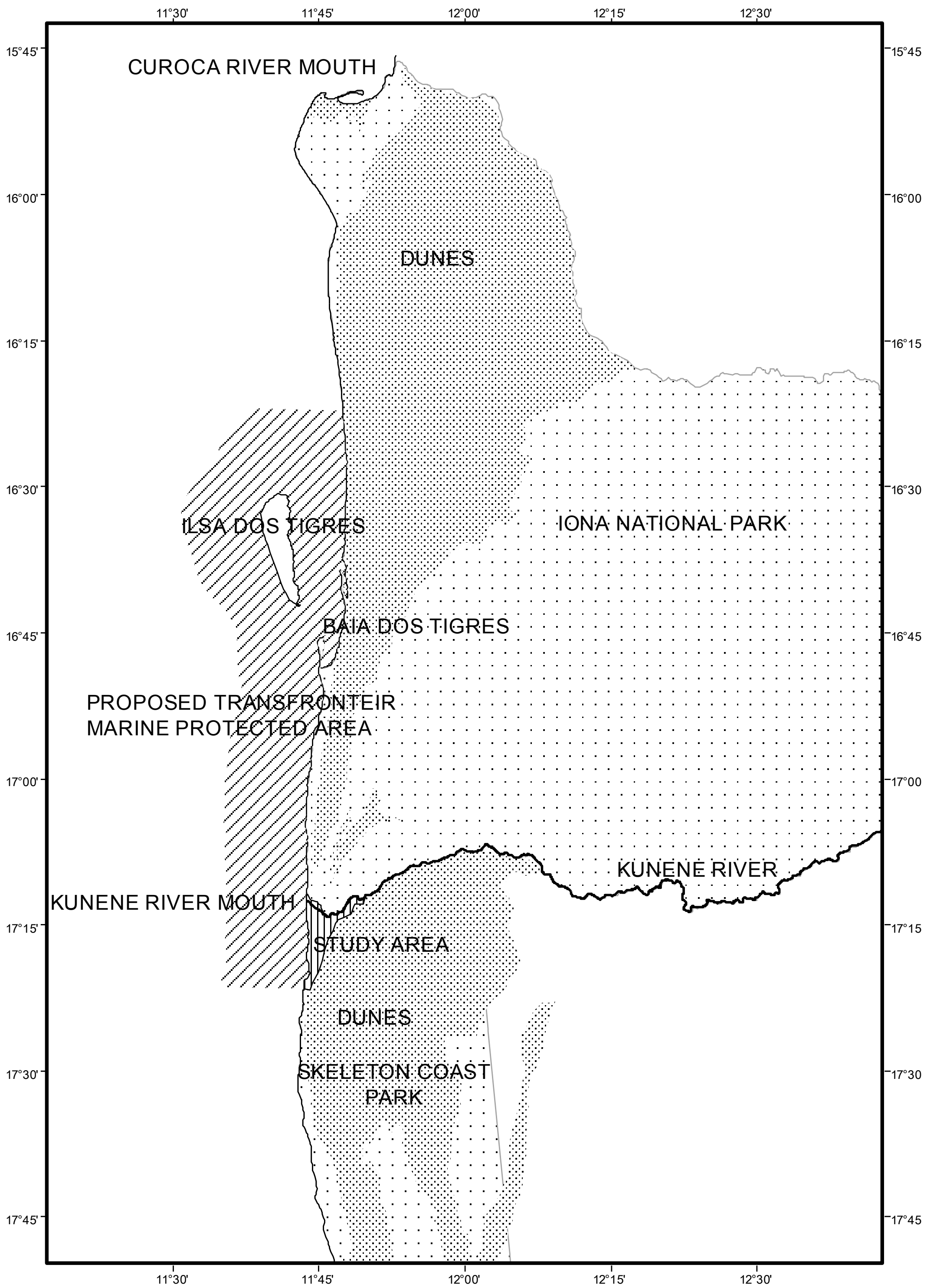
2.3 Terrestrial Environment

On the Southern bank the area is predominated by massive sand dunes that cascade into the river. These dunes start about 4km upstream of the mouth and continue inland for approximately 60km. The river marks the northern boundary of the northern

Namibian dune field. From the point where the dunes enter the river they form an almost straight South Westerly line excluding Bosluis Bay. These dunes are covering a rocky ridge rising sharply above the exposed coastal plain. This coastal plain between Bosluis Bay and the river is an elongated triangle of exposed granite bedrock covered in places by wind blown sand, paleo-beaches and alluvial gravel deposits. Running parallel to the coast are a series of Salsola (*Salsola sp.*) hummocks that form a fixed dune field at Bosluis Bay and South of the river, in the sharp southern end of the triangle. Apart from these vegetated dunes there is little physical relief on the coastal plain except that the river bed and associated floodplains are some 20m lower than the exposed bedrock and alluvial deposits. The alluvial gravel deposits form a mini scarp that is bisected by a drainage line from the south. The entire area is extremely exposed to the prevailing South Westerly wind that blows with an average speed of 25.3 km/h for 80% of the year and has reached a recorded maximum of 64 km/h (Simmons *et al.* 1993). Wind blown sand builds up against any barrier, thus forming a new dune that will eventually engulf the barrier. Apart from the Salsola hummocks and vegetated dunes the only other permanent vegetation is confined to the riverbanks and floodplain areas.

On the Angolan bank the terrain is broken with deep rocky gullies coming down towards the river. There are extensive marine and alluvial deposits along the coast. Inland towards the northeast a vast open plain dominates the landscape. A dune field starts north of the river with the southern end forming a narrow point that widens rapidly to encompass an area of approximately 393,502 ha stretching as far north as the Curoca River (Map 2.2)

The coastline is made up of exposed, sandy beach as far as Baia dos Tigres, approximately 60 km north of the KRM. Here a sheltered embayment is formed with Isla dos Tigres forming a protective barrier on the western side (Map 2.2)



Map 2.2 The KRM and the potential Transfrontier Marine Protected Area

Chapter 3: Literature Survey

3.1 Introduction

In South Africa there are at least 250 to 370 estuarine systems, depending on what classification system is followed (Whitfield 1998, Harrison *et al.* 2000, Turpie 2005). Namibia has only two permanent river mouth, both of which are shared with neighbouring countries. The Kunene in the north is the border with Angola, while the Orange is Namibia's southern border shared with South Africa. Southern Africa has a comprehensive body of literature covering research on various aspects of riverine, estuarine and wetland management of the regions river systems (Day 1981, Whitfield 1992, Whitfield 1998, Allanson *et al.* 1999, Harrison *et al.* 2000, Breen *et al.* 2001, Dickens *et al.* 2003, Breen *et al.* 2004, Hay and McKenzie 2005, Nel *et al.* 2004, Turpie 2005). Specific research has been conducted to develop protocols for assessing water requirements, breaching guidelines, health indices, botanical importance ratings, conservation importance ratings and biodiversity importance ratings (Turpie 1995, Coetzee *et al.* 1997, Harrison *et al.* 2000, Turpie *et al.* 2002, Taljaard *et al.* 2003, Adams and McGwynne 2004). The Orange River is generally considered as a South African system and has been included in Southern African surveys. The Kunene River has had only two major surveys, a hydrological study for dam feasibility (Midgely 1966) and an Environmental Impact Assessment for a specific hydro electric scheme (Morant 1996a, NAMANG 1997). More recently a comprehensive survey has been conducted at the Kunene River Mouth following protocols suggested for assessing Southern African Rivers (BCLME 2007).

The work done in South Africa has been on estuarine systems that are generally heavily impacted by anthropogenic influences and activities. Many management recommendations have been made for these heavily utilized systems and developed catchment areas. The Kunene is unique on the Namibian coast and in the Region because it is a freshwater system and has a large catchment that is mostly undeveloped. The Kunene system is comparatively natural. Developing management strategies for this system was recognized as a priority (BCLME 2007).

3.2 The River

The Kunene Rivers is approximately 1050 km long and is the only perennial river to cross the hyper arid Namib Desert (Midgely 1966, Greenwood 1999). The river has a catchment of approximately 106,500 km^2, most of which (92,400 km^2) are in South West Angola. The remaining 14,100 km^2 fall within Namibia (Midgely 1966, Morant 1996b, Greenwood 1999, BCLME 2007). On its course to the sea the Kunene traverses an extremely harsh environment, thus forming a linear oasis providing suitable habitat intrinsic to the survival of many species in the (Morant 1996a). The large size of the catchment and length of the river expose the mouth, as the "end user", to an array of potential impacts that are exogenous to the KRM itself (Whitfield 1998, BCLME 2007).

The Kunene is a fast flowing river with an average drop of 1:1,455 from where it rises in the vicinity near Huambo in South Western Angola at between 1,700 and 2,000m above sea level to the mouth (Midgely 1966, de Moor *et al.* 2000, Map 1.1 page 3) Over the last 2.5km of river drastic channel expansion of 1m river length to 1m width has resulted in massive aeolian sediment deposition which forms the Kunene Deltaic Complex some 4,130m^2 in extent comprising braided channels and sand bars terminating against a linear littoral barrier with at least one, but at time several, openings to the sea (Greenwood 1999). The origin of this aeolian sediment is locally from the dunes washed down the river and from sand originating from the beaches to the south (Greenwood 1999). These sediments are coarse providing unsuitable substrate for benthic communities (BCLME 2007). The vegetated islands in this delta area comprise the most productive areas of the lower Kunene (Simmons *et al.* 1993).

3.2.1 River Mouth or Estuary?

The KRM characteristic of a river dominated mouth system as described by Whitfield (1992). The river mouth forms a lagoon with adjacent mud flats immediately inland of the beach. A periodically flooded lagoon lies to the south of the mouth and is protected from sea wash by a substantial sand berm of about 2.5km long running parallel to the coastline (Greenwood 1999). Although the mouth has changed little in general appearance over the last 25 years the channels, exposed sand bars and the opening to the sea are highly variable (*Pers. obs*). These are characteristics typical of a river mouth system (Whitfield 1992).

Some authors (Simmons *et al.* 1993 and Barnard 1998) consider the Kunene River to have an estuary with tidal influence, whereas van Zyl (1991) citing Penrith considers it to be a river mouth. These authors do not present any data to support their definitions. There is debate as to the definition of an estuary as opposed to a river mouth. While this debate may seem trivial on the surface it becomes significant when these terms are used in legislation and different regulations may apply (Day 1981). Ecologists may be comfortable with a certain amount of fuzziness around the definition of a system, but managers need a legally unambiguous definition that describes more than just the ecological functioning of the system (Morant and Quinn 1999). In an attempt to clarify these murky waters Day (1981) discusses various definitions for an estuary and proposes the following definition:

> "An estuary is a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage."

The definition offered by Day (1981) was again amended and the following definition was presented at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (CSIR 1992 cited in Morant and Quinn 1999):

> "In South Africa an estuary is considered to be that portion of a river system which has, or can from time to time, have contact with the sea. Hence, during floods an estuary can become a river mouth with no seawater entering the formerly estuarine area. Conversely, when there is little or no fluvial input an estuary can be isolated from the sea by a sandbar and become a lagoon which may become fresh, or hyper saline, or even completely dry."

The legal definition provided by the National Water Act No. 36 of 1998 (Republic of South Africa 1998) is as follows:

> "estuary" means a partially or fully enclosed body of water -
>
> *(a)* which is open to the sea permanently or periodically; and

(b) within which the sea water can be diluted, to an extent that is measurable, with fresh water drained from land;”

The Namibian Water Act does not provide an official definition of estuary or river mouth (Government of the Republic of Namibia 2004a).

Although all these definitions differ slightly there is a commonality in that an estuary is considered to have a connection with the sea, either permanent or temporary, and that a mixing of saline and fresh water takes place to varying degrees. The definition provided by the CSIR (1992) distinguishes between a river mouth and an estuary through the influence of sea water.

In the literature there is no definition of estuary or river mouth for Namibia and some authors have indiscriminately applied the term “estuary” and “river mouth” to the KRM without defining the terms (van Zyl 1991, Simmons *et al.* 1993 and Barnard 1998). Survey work conducted as part of the Epupa Hydro Electric Project during 1995 (Carter and Bickerton 1996, Carter 1996) provides data to classify the KRM as a river mouth rather than as an estuary according to the South African definition. A further survey as part of the BCLME Rivers project in 2004 supports this classification (Holtzhausen 2003, BCLME 2007).

Salinity is regarded as the primary indicator of an estuary. A fresh water system lacking any salinity must, therefore, be considered a river mouth. In a river mouth water levels may be influenced by tide cycles for considerable distances upstream, but no mixing of fresh and saline water occurs within the confines of the riverbanks (Day 1981).

Traditional whole river classification has proved unsuccessful due to high variation over a large spatial scale. Classifying on a small spatial scale has proved more effective (Naiman 1998). An estuary or mouth area is spatially small in relation to the entire river and is therefore suitable for classification. There are two classification systems of South African estuaries (Whitfield 1992, Harrison *et al.* 2000, Turpie 2005). Harrison *et al.* (2000) classify estuaries according the geomorphological characteristics and recognize six major types while Whitfield (1992) recognizes five types according to physiographic, hydrographic and salinity features. Wood *et al.* (2004) found the classifications proposed by Whitfield (1992) and Harrison *et al.* (2000) too complex when classifying the estuaries of the Eastern Cape in South Africa given the lack of specific knowledge and high level of estuarine uniqueness. Instead an approach was adopted that considered mouth state and exploitation that recognizing nine estuary classes in the Eastern Cape (Wood *et al.* 2004). The classification of South African Estuaries by Whitfield (1992) and adopted by Turpie (2005) recognizes River Mouth as a category of estuary. A river mouth is a river dominated system with often oligohaline conditions and a salinity of less than 1% dissolved solids (the salinity of seawater is 3.5%). The opening to the sea is usually small preventing sea water intrusion, but during periods of high flow the fresh water can influence sea salinity and water temperature within the mouth (Whitfield 1992). For the purpose of this study the classification according to Whitfield (1992) will be adopted which uses salinity, i.e. a defining separator between estuarine categories, as one of the classification criteria.

There is evidence of a rise and fall of river level at the KRM corresponding to tidal influence (Simmons *et al.* 1993 and Morant 1996). It appears, however, that this is caused by a damming effect of the sea water at high tide rather than sea water entering the mouth (Huizinga 1996). Salinity sampling during a low flow period at the mouth supports this as no evidence of sea water intrusion or mixing with the fresh river water was found (Carter 1996, BCLME 2007). These findings are supported by the lack of estuarine benthic fauna, marine and estuarine plankton and marine fish species (Carter and Bickerton 1996, Morant and Carter 1996 , BCLME 2007). Several authors provide data supporting the definition for river mouth rather than estuary (Carter and Bickerton 1996, Morant and Carter 1996, BCLME 2007) and the physical characteristics fit the classification for a river mouth as proposed by Whitfield (2001).

3.2.2 Is It A Wetland?

Namibia is an extremely arid country so wetlands are ecologically isolated occurring in many unusual forms (Bethune 1998, Barnard and Curtis 1998, Breen 1991). These ecologically important isolated and distinctive wetlands are becoming threatened due to the country's growing demand for water (Barnard and Curtis 1998). Biologically wetlands are crucial to the survival of numerous fauna and flora both within and adjacent to the wetland. Wetland functions can be based on biodiversity, species density, habitat and nutrient production (Reimold 1994).

To achieve consistency in defining wetlands the Namibian Wetlands Working Group of the Biodiversity Task Force has adopted the Ramsar Convention on Wetlands definition of wetlands (Bethune 1998):

> "Areas of marsh… or water, whether natural or artificial, permanent or temporary (ephemeral), with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar 1987).

The KRM is categorized as a coastal wetland and regarded as being ecologically important as a transition zone, occurrence of marine turtles and for migrant shore birds (Barnard and Curtis 1998). With a diversity of 119 bird species the KRM is the richest wetland for diversity and third for abundance (more than 12,000 birds) in Namibia. (Simmons *et al.* 1993, Anderson *et al.* 2001, Paterson *et al.* submitted) The Orange River is considered as the third richest wetland in Namibia for both abundance and species richness (Simmons *et al.* 1993) and is ranked fifth in Southern Africa in terms of bird abundance (21514), species richness (48), conservation value and conservation status (Turpie 1995). There is no Southern African ranking for the KRM.

3.2.3 Definition of the Kunene River Mouth

For the purpose of this study the findings of Carter and Bickerton (1996), Morant and Carter (1996) and BCLME (2007) suggesting that the KRM is classified as a "River Mouth" are followed.

In accordance with Namibian classification (Bethune 1998, Barnard and Curtis 1998) the "Wetland" categorization for the KRM is suggested as a simultaneous classification.

Both classifications are suggested because the lack of any legal definition of a river mouth or estuary in the Water Resources Management Act, 2004 (Government of the Republic of Namibia 2004) or any other legislation may cause ambiguity when regulatory measures are considered. This ambiguity is undesirable and an unambiguous definition of the system is needed (Day 1981, Morant and Quinn 1999)

This study, therefore, considers the KRM as a river mouth forming a coastal wetland.

To maintain the KRM as a freshwater system with intact delta formation a seasonally fluctuating fast flow regime, but with permanent flow of a minimum of 20 m^3s^{-1}, must be maintained (NAMANG 1997). Snaddon and Davies (2003) question this assertion citing lack of data to back this up. There is no recent literature recording a drying up of the Kunene River. According to travel journal the river mouth was almost dry in December 1939 "a mere trickle scarce six inches wide" (Reitz 1943). This may suggest that the Kunene is capable of withstanding massive cyclical variations under natural conditions. There is no data available to indicate what impact anthropogenically caused variations might have on the system.

3.3 Marine Environment

The KRM is on the northern limit of the cold nutrient rich Benguela current. This current is characterized by southerly wind driven upwelling which brings the nutrient rich cold bottom waters to the surface. Discreet wind driven upwelling cells occur throughout the system and are areas of high productivity making them valuable resource nodes for the pelagic fishery. The Kunene upwelling cell occurs off the KRM extending into both Namibian and Angolan waters. The prevailing southwesterly winds cause stress on the ocean surface that drives the upwelling process (Shillington 2003). Adjacent to the KRM is the permanent oceanic surface feature of the Angola-Benguela Front, where the nutrient rich cold Benguela meets the warmer nutrient poor Angola current, which lies in a narrow band of latitude between 14^0 and 16^0 South (Shillington 2003, BCLME 2007). Although nutrient poor the Angola Current has a higher fish diversity than the Benguela. The nutrients carried by the Benguela current supplemented by the nutrient load from the Kunene River provide a rich food supply supporting a diverse ichthyological fauna (BCLME 2007).

3.4 Biodiversity

In 1992 Namibia ratified the International Convention on Biodiversity and is thus obliged to comply with the articles of the convention. The concept of Biodiversity extends beyond the diversity of life, but includes structural aspects as well as the ecological and evolutionary processes (Turpie 2004). Biodiversity can thus be defined as ‘the richness, abundance, and variability of plant and animal species and communities and the ecological processes that link them with one another and with soil, air and water’ (Turpie 2004). Estuaries are dynamic ecosystems showing a high degree of variability even within the same ecological zone (Harrison *et al.* 2000, Wood *et al.* 2004, Turpie 2004). Every estuary has different physiochemical characteristics that provide habitat for plants and animals that determine the structure of the biotic community (Turpie 2004). Although the macro organisms are relatively well known in Southern African estuaries little is known about micro organisms that fit through a net with a mesh size below 0.1 mm. Even though the more obvious fauna and macro organisms are relatively well known, continued monitoring will always add new species to species lists (Turpie 2004).

The KRM is the end of a linear oasis in a hyper arid environment that receives less than 15mm rain per anum (van Zyl 1991, Dean 2000, Skeleton Coast Park Rainfall Data). This linear oasis is unique in the harsh desert environment providing habitat for many species otherwise unable to survive here (Morant 1996b). This unique riverine habitat with associated vegetation and floodplains provides a focus for biodiversity on the hyper arid coastline.

3.4.1 Flora

Two methods of Biome classification have been employed in Namibia. The most widely used is an objectives categorisation approach based on the relationship of vegetation to aridity and rainfall seasonality that divides the country into 4 biomes Irish (1994). Although Irish (1994) considers it is unrealistic to delineate biomes by faunal distribution patterns alone he did use insect distribution data help validate his objective categorisation method (Irish 1994). The second approach is that used by the South African Bird Atlas Project (SABAP) that recognises nine avivegetational zones by relating bird distribution to floristic distribution patterns (Harrison *et al.* 1997, Barnard 1998). The KRM falls within the Desert biome (Irish 1994) or the Namib biome (Harrison *et al.* 1997). For finer detail most botanists refer to Geiss (1971) for his nine vegetation zone categories. Although the study area falls within the northern Namib vegetation type (Geiss 1971), rivers are in fact azonal due to the lush diverse vegetation along riverbanks that is associated with a continuous supply of water (Burke 1998). Flora in the region is sparse and mostly associated with the river channel. Little work has been done on flora at the KRM mouth and no botanical records existed for the area prior to 1994 when 38 species were collected on the south bank of the river (Muller 1994).

A comprehensive vegetation survey covering both north and south banks was done in 1995 mapping broad vegetation types from 1:5,000 scale colour aerial photos and ground truthing the results (Raal and Guerra Marques 1996). Using this method seven plant communities were identified. The vegetation assemblages reflect the influence of the river with *Phragmites australis* and *Sporobolus* grasslands being dominant (Muller 1994, Raal and Guerra Marques 1996). Although some alien species have been recorded in low densities the wetland vegetation is considered natural (Muller 1994, Raal and Guerra Marques 1996). The vegetation communities present at the KRM have regionally low conservation importance they do, however, have a high local and intrinsic importance. These communities provide shelter and food for many mammal, reptile, bird and invertebrate species (Raal and Guerra Marques 1996). The submerged macrophyte beds lining the river banks are important nutrient traps and provide important habitat for fish and the giant fresh water prawn *Macrobrachium vollenhovenii* (Adams and McGwynne 2004). Healthy riparian vegetation plays an important role in minimising river bank erosion and the resulting sediment build up (Turpie 2004, Adams and McGwynne 2004).

3.4.2 Fauna

The faunal composition can be divided into 3 broad groups in the study area i.e.: terrestrial, aquatic and marine. For the purposes of this study marine fauna, while aquatic, is considered separately from riverine fauna because the marine environment is a discreet component to the study area. Birds will be considered terrestrial except for (purely) pelagic species that will fall into the marine category.

3.4.2.1 Riverine Fauna

The river fauna is divided into three broad categories. Each of these categories is wholly dependant on the river for survival.

3.4.2.1.1 Invertebrates

While the macro vertebrate faunal component of the KRM has been fairly well described (e.g. Simmons *et al.* 1993, van Zyl 1991, Griffin 1994, Carter and Bickerton 1996, Morant 1996c, Anderson *et al.* 2001, BCLME 2007) little work has been done on the invertebrate component; only two surveys have been undertaken (Carter and Bickerton 1996, BCLME 2007). Invertebrate surveys were done in November and December 1995 (Carter and Bickerton 1996) during below average flows. Stream flow at Ruacana for November 1995 was 43.23 m^3s^{-1} and 53.44 m^3s^{-1}. The average flow for these months is 64.14 m^3s^{-1} and 107.50 m^3/sec respectively (Department of Water Affairs 2007). A second invertebrate survey was conducted in October 2004 (BCLME 2007) during above average flow. Instream flow at Ruacana was measured 119.40 m^3s^{-1} while the October average is 53.00 m^3s^{-1} (Department of Water Affairs 2007). Ruacana is approximately 310km upstream from the KRM so flow rates are unlikely to be the same in both localities. The flow at the mouth is likely to be lower as there are no rivers feeding the Kunene between Ruacana and the mouth. Tourism developments along the river banks extracting water from the river and evaporation would contribute towards a lower flow at the mouth.

Concentrations of nutrients in the KRM are low. Plankton is either absent or measured in very low concentrations of mainly diatoms and dinoflagellates with densities of between 21 and 959 cells/liter (Carter and Bickerton 1996, BCLME 2007). Data suggest that plankton occurrence within the KRM is associated with salinity (Carter and Bickerton 1006, BCLME 2007). The low nutrient levels recorded in the KRM indicate good water quality (Carter and Bickerton 1996) and suggest a healthy intact ecosystem (Carter and Bickerton 1996). Biotic community structures are integral to assessing water quality as they respond to wide-spread and long term environmental changes (Harrison *et al.* 2000).

The KRM lacks benthic communities (Carter and Bickerton 1996, BCLME 2007). It has been suggested that even during low flow periods of the annual cycle such communities may not establish (BCLME 2007). Data gathered during benthos surveys add a temporal aspect to the snapshot view given by once off water sampling indicating that there have been no benthic communities in the KRM since at least 1985 (Carter and Bickerton 1996). These results suggest that the KRM is a stable, river dominated, freshwater system.

The fresh water prawn, *Macrobrachium volenhovenii*, breeds within the KRM. There is some dispute as to salinity requirements for breeding. Willführnast *et al*. (1993 cited in Carter and Bickerton 1996) suggested that these prawns need saline conditions, and that fresh water is lethal to larva. Prah (1982 cited in Carter and Bickerton 1996), on the other hand, suggests that *M. volenhovenii* can complete its life cycle in fresh water. The KRM is the southern distributional extent of *M. volenhovenii* on the West African coast and is an isolated population. The next closest population is in the Cuanza river some 900 km to the north (Carter and Bickerton 1996). Morphometric data suggest that *M. volenhovenii* at the KRM are a separate race (Kensley 1981 cited in Carter and Bickerton 1996). The flow rates of the Kunene river and the oceanographic regime render it unlikely that there is any interchange with any other *M. volenhovenii* populations ensuring the KRM population remains isolated and complete their lifecycle in fresh water (Carter and Bickerton 1996). This supports the findings of Prah (1982 cited in Carter and Bickerton 1996). The KRM population of *M. volenhovenii* has high conservation and scientific value (Carter and Bickerton 1996).

3.4.2.1.2 Reptiles

Nile soft shelled terrapin, *Trionix triunguis*, inhabit the Nile River and most West and Central African river systems downstream of major barriers (Branch 1998). According to Branch (1998) *T. triunguis* occurs in the Kunene River almost as far east as Ruacana Falls, which marks the southern extent of their range on the West African Coast.. Personal experience suggests that *T. triunguis* do not penetrate further than the first rapids, about 15 km upstream of the mouth as is confirmed in Griffin (2002). Evidence of egg laying activity suggests that these terrapins breed at the KRM (Carter and Bickerton 1996). Density of *T. triunguis* has been conservatively estimated at

3/km of river (Carter and Bickerton 1996). These terrapins readily take bait and are thus susceptible to over exploitation through fishing activities (*pers. obs*).

The Nile crocodile, *Crocodylus niloticus*, is common in the KRM and inhabits the entire river system (Griffin and Channing 1991, Griffin 2002). Individuals of 3 m and larger occur within the KRM and although they appear to be wary of humans they have been known to chase boats (Simmons *et al.* 1993, Carter and Bickerton 1996, *pers. obs.*). The presence of young crocodiles, less than 0.5 m, reported by Carter and Bickerton (1996) supports the suggestion by Griffin and Channing (1991) that Crocodiles breed at the KRM. Crocodiles have not been observed in the sea at the KRM. One record of tracks emerging from the sea at Bosluis Bay (10 km south) and going back to the KRM on suggests that they do not like high salinity or the cooler sea water. Crocodiles have been observed basking on the sand berm at the mouth and also feeding in the mouth lying on the surface with open mouths catching fish entering the river mouth from the sea.

Water or Nile monitors, *Varanus niloticus*, are common at the KRM (Simmons *et al.* 1993, *pers. obs.*) although their presence was not reported by Griffin (1994) or Carter and Bickerton (1996). A wide size and age range of this species has been observed at the KRM suggesting a healthy resident breeding population. *V. niloticus* are known to feed on crocodile and terrapin eggs (Branch 1998) which probably accounts for the disturbed terrapin nest reported by Carter and Bickerton (1996).

3.4.2.1.3 Fish

Diversity of fresh water fish species decreases from Central to Southern Africa. The Kunene River forms the southern distributional limit of several central African species (Hay *et al.* 1997). The Kunene fish fauna comprises at least 12 families, 27 genera and 65 species. Of these at least five are endemic species (Hay *et al.* 1997, BCLME 2007). During a recent fish surveys in the KRM an undescribed *Mugil sp.* was collected (S. Lambeth Scientist with Marine and Coastal Management South Africa December 2006 *pers. com.*).

3.4.2.2 Terrestrial Fauna

3.4.2.2.1 Mammals

The terrestrial fauna is dominated by Gemsbok, *Oryx gazella*, Springbok, *Antidorcas marsupialis*, Black Backed Jackal, *Canis mesomelas*, and Brown Hyaena, *Parahyaena brunnea*. Historically Elephants, *Loxodonta Africana*, used the river as a migration route between the mouth and inland. The last Elephant was seen in 1991. Lions, *Panthera leo*, are sporadic visitors to the area, but there are no recent records of them at the KRM. Small mammals and several rodent species are present at the KRM there is no published data available on species composition or abundance.

3.4.2.2.2 Birds

The avifaunal community at the KRM can be roughly divided into five categories.

1: Resident waders (8 Species)
2: Palearctic Waders (22 Species)
3: Wetland birds (32 Species)
4: Marine birds (19 Species)
5: Non-wetland birds (38 Species)

These five groups have achieved a recorded maximum abundance of 12,000 birds (Ryan *et al.* 1984, Braine 1990, Simmons *et al.* 1993, Anderson *et al.* 2001, Paterson *et al.* submitted, Paterson *in prep.*). With 119 species the KRM is Namibia's richest wetland for bird diversity and third richest for abundance (12,000 birds). A synthesis of bird counts are presented in Appendix 1.

As is typical of fresh water systems in Southern Africa piscivores dominate the avifaunal community (30%) at the KRM (Morant 1996c). The lack of estuarine conditions inhibits the build up of a benthic fauna attractive to waders, thereby significantly influencing the avifaunal composition of the KRM (Morant 1996c). This deficiency of benthos at the KRM probably contributes to the low wader diversity and abundance (Morant 1996c). The most numerous wader is the Little Stint, *Calidris minuta*, (Simmons *et al.* 1993, Morant 1996c, Paterson in prep.) that are largely insectivores specializing in feeding on *Dipteran* larvae (Cramp and Simmons 1982). Another relatively abundant wader is the Sanderling, *Calidris alba*, (Morant 1996c) that feeds in the swash zone on the adjacent sandy beach during outgoing tides and is not dependant on estuarine benthos.

The KRM supports relatively high species diversity, but generally low numbers (Simmons *et al.* 1993). The tidal flats in Baia dos Tigres may support a rich benthic community and is likely more attractive to migrating birds as a refueling stop (Morant 1996c and Simmons *et al.* 2006a). Regionally the high species diversity at the KRM and its unique characteristics in an arid environment indicate that it is an important site.

3.4.2.2.3 Reptiles

There is no comprehensive published data on the reptiles of the KRM. However the following species are known to occur: Southern African Python, *Python natalensis*, Puff Adder, *Bitis arietans*, Side Winder, *B. peringueyi*, Horned Adder, *B. cornuta*. Desert Plated Lizard, *Angolasaurus skoogi*, Shovel Snouted Lizard, *Meroles anchietae*, Reticulated Desert Lizard, *M. reticulates*, and Namib Day Geckos, *Rhotropus spp.* (Skeleton Coast Park Species List).

3.4.2.2.4 Insects

Generally estuaries support interesting insect fauna but their long term survival is dependant on upstream developments (Marais 1994). In desert environments low species densities and diversity are normal, but the linear oasis and "island habitat" created by a river in a desert setting could support greater speciation than found elsewhere (Marais 1994). While little work has been done on insect fauna at the KRM there is at least one endemic species, a mosquito, *Anopholes fontinalis* (Marais 1994).

3.4.2.3 Marine Fauna

3.4.2.3.1 Fish

The marine environment adjacent to the KRM supports a diverse fish fauna. At least 19 species of marine fish have been reported (Hay *et al.* 1997). Of the 19 marine fish that have been reported from the KRM some of these are likely isolated specimens (BCLME 2007). The proximity of the KRM to the Angolan Front puts it at the southern distributional limit of some sub tropical fish that may occur in significant numbers depending on the influence and location of the Angolan Front (BCLME 2007). Marine fish recorded from in the delta are Kob and Garrick that predate the two mullet species occurring in the mouth (BCLME 2007, pers. obs.). Other marine species caught in the surf-zone around the mouth are Dusky Kob, *Argyrosomus coronus*, Garrick, *Lichia amia*, West Coast Steenbras, *Lithognathus aureti*, Blacktail, *Diplodus sargus*, rarely Galjoen, *Dichistius capensis*, Barbel, *Galeichthys feliceps*, Spotted Grunter, *Pomadasys commersoni* and Elf, *Pomatomus saltatrix*. Elsamobranchs (sharks, skates and rays) caught from the shore are Bronze Whaler, *Carcharhinus brachyurus*, Spotted Gullyshark, *Triakis megalopterus,* Broadnose Sevengill Cow Shark, *Notorynchus cepedianus,* Smooth-hound Shark, *Mustelus mustelus,* Common Eagle, Ray *Myliobatis aquila*, Blue Stingray, *Dasyatis chrysonota,* and Biscuit Skate, *Raja straeleni.* Two species of guitarfish (sandshark) also occur in the area namely the Lesser Guitarfish, *Rhinobatos annulatus* and Bluntnose Guitarfish, *R. blochii* (H. Holtzhausen Senior Scientist Ministry of Fisheries, Swakopmund August 2007 *pers. comm.*, BCLME 2007).

3.4.2.3.2 Mammals

Marine mammals that occur within the study area are generally transient. There is no systematic survey work done in this region and most records and sightings are *ad hoc* observations. Data for Angola is unavailable. The Cape Fur Seal, *Arctocephalu pusillus*, is a regular visitor and following population crashes in Southern Namibia there has been a general northward movement of this species to the extent that a new colony has been established on Isla dos Tigres (Simmons *et al.* 2006b).

There are several sight records of various cetaceans such as Heavisides Dolphin, *Cephalorhynchus heavisidii* (JP Roux Senior Scientist Ministry of Fisheries, Luderitz. October 2006 *pers. comm.*), Long Finned Pilot Whale, *Globicephalla melaena*, Bottle Nosed Dolphin, *Tursiops truncates,* (Skeleton Coast Park Species List, *pers. obs*.) and several other unidentified cetacean species. A wide variety of cetacean bones indicate that a diverse cetacean fauna do or did occur in the area. Recent strandings include an undescribed species of beaked whale (M. Griffin Senior Conservation Scientist Ministry of Environment and Tourism October 2004 *pers. comm.*).

Perhaps the most interesting and important observation is that of Atlantic Hump Backed Dolphins, *Sousa teuszii*, north of the KRM (M. Griffin Senior Conservation Scientist Ministry of Environment and Tourism October 2004 *pers. comm.*). This species occurs in small disjunct populations in shallow water making them susceptible to overutilisation. (Leatherwood and Reeves 1983, M. Griffin Senior Conservation Scientist Ministry of Environment and Tourism October 2004 *pers. comm.*).

3.4.2.3.3 Reptiles

The study area is not rich in marine reptile fauna. The most common reptile found in the area is the Green Turtle, *Chelonia mydas*, that appears to favour the warm waters of the KRM. This site is recognized as being important to these turtles both as the southern most distribution on the West African coast and as an important laying up location. There are no confirmed breeding records from the area (Carr and Carr 1991, Griffin and Channing 1991 Carter and Bickerton 1996, Branch 1998, Griffin 2002, Fretey 2001).

3.5 Adaptive Management

Adaptive management (Holling 1978) is a relatively new concept that has only recently begun to gain favour in conservation projects (Salefsky *et al.* 2001). Adaptive management asserts that environmental management is characterized by uncertainty. This uncertainty requires an ongoing experimental process (Figure 2.1) to test the impacts of management strategies on the natural system (Holling 1978, Walters 1986, Jacobson 2003). Adaptive management is an explicitly scientific approach to conservation projects that integrates science with interdisciplinary experience into resource management where assumptions are tested through monitoring (Walters 1997, Rogers 1998, Lee 1999, Salefsky *et al.* 2001). This requires a move away from the traditional paradigm of control in resource management (Holling and Meffe 1996). Adaptive management demands a shift in perspectives to the extent that unexpected outcomes are viewed as learning opportunities and not failures (Lee 1999, Jacobson 2003). “Policies are experiments; learn from them” is how Lee (1993) sums up the approach.

An explicit vision of the goals one is trying to achieve in managing an ecosystem is the essence of the adaptive management process (Walters 1986 cited in Lee 1999). This explicit vision defines the baseline for assumption. Unless the assumptions are measurably challenged, against the vision, learning will not occur thus expanding the understanding of the system (Lee 1999). While adaptive management is a popular management approach (Salefsky *et al.* 2001), it is the idea of adaptive management to gain an insight into the behavior of natural systems that has been more influential than the practical implementation of adaptive management strategies largely due to inadequate institutional support and uncertainty of objectives (Walters 1997, Lee 1999). The adaptive management approach should only be implemented after consensus has been reached on a set of goals by all stakeholders (Rogers 1998, Rogers and Bestbier 1997, Walters 1997, 1999).

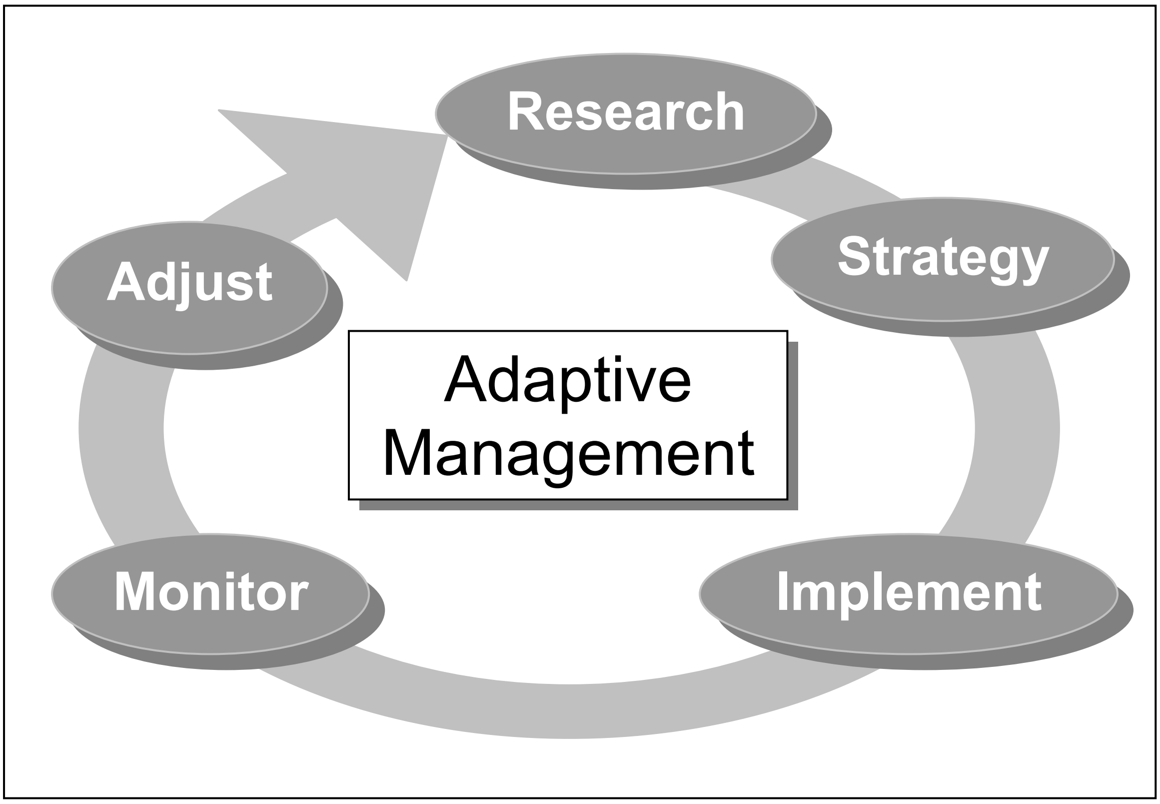


Figure 3.1 The adaptive management cycle (Adapted from Paterson 2004)

3.6 Desired State

Adaptive management is a process that needs explicit objectives and consensus among stakeholders (Rogers 1998, Rogers and Bestbier 1997, Walters 1997, Lee 1999). The Kruger National Park in South Africa has adopted a goal orientated strategic approach in managing river systems to achieve a desired state (Rogers and Bestbier 1997, Rogers and Biggs 1999, Biggs and Rogers 2003). This approach is founded on a "Desired State", the term being a euphemism for operational objectives (Christiansen 1997), which originates from various sources, but essentially indicates a commitment from policy makers and managers as to the condition in which an ecosystem should be maintained (Rogers and Bestbier 1997). The desired state is a concept that has a wide variety of proponents, but essentially indicates a certain level of foresight and commitment from policy makers and managers to managing an area (Rogers and Bestbier 1997). The perception of the desired state concept differs. To some it is the result of scientifically identified endpoints while others consider it a representation of human values (Rogers and Bestbier 1997). For the concept of desired state to contribute to effective management it has to have an accepted operational definition (Costanza 1992 cited in Rogers and Bestbier 1997). The exact definition of a desired state for an area must be the result of a participatory process involving the main stakeholders reaching consensus. This is because the different interests will naturally result in different views of what the desired state is. Once consensus on the Desired State has been reached management intervention is required to achieve and maintain this state (Rogers 1997, Rogers and Bestbier 1997, Walters 1997, Lee 1999).

3.7 Threshold of Probable Concern

Thresholds of Potential Concern (TPCs) are a set of ecological flags to warn managers if and when ecological degradation occurs beyond the desired state. The concept of TPCs was developed as part of an objectives hierarchy management approach for the rivers in the Kruger National Park, South Africa (Rogers and Bestbier 1997). TPCs provide managers at operational level specific spatially and temporally defined indicators on a systems response to change (Rogers and Bestbier 1997, Rogers and Biggs 1999, Biggs and Rogers 2003, Adams and McGwynne 2004).

TPCs are the ecological goals of an objectives hierarchy that guides managers (Rogers and Biggs 1999). These TPCs are the endpoints providing parameters for the indicators that need to be monitored.

3.8 Limits of Acceptable Change

Limits of Acceptable Change (LAC) is a management tool to identify and define limits to the natural environment beyond which change is unacceptable (McCool 1996). This concept was developed in response to the failure of setting visitor carrying capacity in wilderness areas for human recreational use (Stankey and McCool 1990, McCool 1996). The realization that a level of change is inherent in nature based systems and that recreational use always causes changes, forced managers to identify management objectives and set indicators to establish the level of change that would be acceptable (Stankey and McCool 1990, McCool 1996). These indicators are monitored to establish the success of the management practices (McCool 1996, Stankey and McCool 1990). The LAC process can be information driven providing for monitoring key indicators that may be assessed in the context of minimum and maximum standards (Whisman 1998). A LAC based river management plan was adopted by the West Virginia Division of Natural Resources to manage whitewater rafting activities (Whisman 1998). This plan was largely directed at visitor use and no specific river management was implemented (Whisman 1998). At Aonach Mor ski resort in Scotland a LAC approach was used to assess impacts through direct visitor use, eg. path measurements, quantitative litter counts. A LAC was defined for each variable along with a suggested management response (Matouche *et al.* 2005).

The LAC process accepts that there will be some degree of change to the natural environment and thus requires a degree of compromise both from users and managers (McCool 1996, Cole and McCool 1998a) LAC assumes a conflict of interest and requires a compromise to be effective. Without conflict there is no need to apply LAC or, similarly, if one side is unwilling to compromise, then the LAC process will collapse (Cole and McCool 1998a). LACs do require monitoring to assess effectiveness of management strategies and if parameters are exceeded (McCool 1996).

Both TPC and LAC are concepts used to define parameters for variables that help monitor ecological change. The two approaches are essentially similar. The difference, however, lies in the conceptual focus. TPCs are used to measure indicators of bio-physical change, whereas LAC are used to measure and control the degree of visitor utilization and impacts.

3.9 Aesthetics

"Aesthetics is the field of philosophy that studies the way in which humans experience the world through their senses" (Carlson 2002). Mautner (2000) defines aesthetics as "the study of what is immediately pleasing to our visual or auditory perception or to our imagination: the study of the nature of beauty; […]". Aesthetics has usually focused on art, but is by no means confined to art and frequently includes the world at large (Carlson 2002). It is this world at large that constitutes the physical landscape that surrounds us and of which we are an integral part. Our activities have impacted on the non-human ecosystematic landscapes to such an extent that it is almost impossible to find a landscape that does not show responses to these impacts (Eckbo 1975). This has resulted in the need for visual quality landscape evaluation during project planning to protect the scenic quality of landscapes which is becoming a limited resource (Laurie 1975).

Although there are several methodologies for visual quality evaluation of the environment they generally lack input from aesthetic and design specialists (Laurie 1975). Reimold *et al.* (1980) recognize the sensual qualities of aesthetic appreciation of the physical environment that has historically been the subject of art, literature and music. Aldo Leopold (1970) described the aesthetic appreciation process: "Our ability to perceive quality in nature begins, as in art, with the pretty. It expands through successive stages to the beautiful to values as yet uncaptured by language."

While art and aesthetics seem inexplicably linked the terminology applied to art appreciation is accepted as an analytical verbal descriptor, but is not encompassed by landscape aesthetics (Laurie 1975). Combined with the lack of suitable or accepted terminology is that a persons perception of what is aesthetically pleasing is influenced by social, cultural and educational backgrounds (Laurie 1975, Reimold *et al.* 1980, Harrison *et al.* 2000). A pristine natural estuary attracts people through its natural appeal, but paradoxically this very reason for attracting people is threatened through over use (Reimold *et al.* 1980). Human activities impacting on the aesthetic aspects of estuarine quality are important factors in contributing to the perceived state of environmental health of an estuary (Portman and Wood 1985). Activities that alter the appearance of an estuary reduce the natural appeal thereby reducing the value for conservation or recreational uses (Harrison *et al.* 2000). To ensure an estuaries conservation and long-term sustainability good management of the resource is necessary to maintain the quality while providing pleasure to visitors (Reimold *et al.* 1980, Harrison *et al.* 2000).

In Southern Africa an Estuarine Health Index that rates the naturalness of a system has been developed to assign an objective score to the aesthetic state of an estuary (Harrison *et al.* 2000). Criteria contributing to the aesthetics of a system were identified and 14 weighted parameters determined (Harrison *et al.* 2000). According to this system a score tending towards 10 is considered aesthetically intact while a score tending towards 0 is aesthetically degraded (Harrison *et al.* 2000).

3.10 Sense of Place

Sense of place is a human perception of a place influenced by a myriad of emotional and social factors (Williams and Stewart 1998). "Place" is considered a center of meaning and felt value (Sack 1980, Williams and Stewart 1998).Thus an arbitrary space will become "place" once we bestow value on it (Tuan 1977, Sack 1980).

In recent times "place" as a human dimension to natural resource management has gained favour (Kaltenborn and Williams 2002, Williams and Stewart 1998, Yung *et al.* 2003). The "Sense of Place" concept enables resource managers to accommodate the emotional bonds people form with certain spaces (Williams and Stewart 1998). Place can be a set of subconscious values that one associates with an area, but only realise their existence once they are threatened (Williams and Stewart 1998). Challenges that face resources mangers is the different perceptions, understanding and attachments different people have to a place (Sack 1980, Kaltenborn and Williams 2002, Yung *et al.* 2003).

The literature deals with the concept of space becoming more popular in resource management and dealing with the conflicting perceptions that this concept holds

(Sack 1980, Kaltenborn and Williams 2002, Yung *et al.* 2003). It is the value an individual places on a specific space that gives it value (Tuan 1977, Sack 1980 Kaltenborn and Williams 2002, Williams and Stewart 1998, Yung *et al.* 2003).

3.11 Threat Analysis

Risk is defined as the "Probability of a future loss" (Byrd and Cothern 2000, Burgman 2005). Semantics play an important role in defining risk and there is often confusion leading to misunderstanding (Byrd and Cothern 2000). For the purpose of this study the term "threat" will be used to express "the probability of an activity occurring and the extent of the impact it might have". In assessing impacts or threats on an environment an interactive matrix is a simple means of prioritizing important threats (Holling 1978). The field of threat analysis is controversial because opposing groups may distort information with the intention of gaining the upper hand (Byrd and Cothern 2000).

River mouths and estuaries are susceptible to impacts from activities both locally at the estuary or mouth, and in the marine environment or further upstream in the catchment (Turpie 2004). They are focus points for coastal developments (Morant and Quinn 1999) and thus are susceptible to a variety of impacts. Biodiversity loss is considered the major threat to an estuary (Heydorn 1989, Morant and Quinn 1999, Turpie 2004). The studies by Heydom (1989) and Morant and Quinn (1999) respectively, identify six major threats to estuarine biodiversity in South Africa (Table 6.1). Dickens *et al.* (2003) list 11 criteria for assessing wetland habitat integrity. Neither Heydorn (1989) nor Morant and Quinn (1999) list any anthropogenic impacts nor climate change as a threat to estuarine biodiversity (Turpie 2004). Through a root cause analysis Turpie (2004) identifies 14, mostly proximate, causes for biodiversity loss in estuarine systems.

Previous work on estuarine systems in Southern Africa has not considered aesthetic degradation in their threat analyses (Heydorn 1989, Morant and Quinn 1999, Turpie 2004). In their assessment of Southern African estuaries Harrison *et al.* (2000) include an aesthetic health rating. Estuaries, as well as river mouths, do not only offer ecological or economic values, they have a socio-cultural value comprising intangible attributes that contribute to the ‘quality of life’ (Reimold *et al.* 1980). Both local and foreign visitors are attracted to the aesthetic appeal of the open spaces and pristine scenery associated with natural estuaries (Harrison *et al.* 2000). Ironically it is often the case that this high aesthetic appeal attracts high visitor numbers, which in turn impact negatively and thus degrade the aesthetic value (Reimold *et al.* 1980). Development changes the appearance of an estuary, which thereby may lose its value for conservation and tourism (Harrison *et al.* 2000). The KRM is a natural environment with few developments, its aesthetic value is therefore high (Chapter 2 Study Area).

3.12 Stakeholder analysis

The need for broad participatory processes and stakeholder consultation in natural resource management is widely recognized in the literature (e.g. Meppem and Bourke 1999, Venema and van den Breemer 1999, Meppem 2000, Roe *et al.* 2001, Harrison et al. 2001, Lackey 2001, Norton and Steinemann 2001, van der Linde *et al.* 2001, Food and Agricultural Organisation 2003, Murphree 2003, Hay and McKenzie 2005, Misund and Skjoldal 2005, Vierros *et al.* 2006). There is little guidance on how to identify stakeholders and evaluate their interests. Hay and McKenzie (2005) advise that government departments, i.e. bodies with legal obligations, para-statals and civil society need to be included. Vierros *et al.* (2006) present a methodology for analyzing stakeholders in open ocean and deep sea environments that maps interests and activities. An important step in this process is to identify and analyse stakeholders’ uses of the resource (Vierros *et al.* 2006).

Chapter 4: The Current Situation

4.1 Current Management

The KRM has formal conservation status in both Namibia and Angola. In Namibia the area falls within the Skeleton Coast Park (SCP). The Iona National Parks lends it conservation status in Angola. The marine environment has no formal conservation status on either side of the border (Map 1.1 page 3).

Park management activities in Iona appear to be minimal; ad hoc visits are conducted by a conservation officer based in Namibe (E. Afonso Nature Conservator, Iona National Park, Angola. October 2004 *pers. comm.*). Park infrastructure has been destroyed and abandoned (Simmons *et al.* 2006b). An aerial survey was conducted by Namibian MET officials in June 2003 revealing low wildlife densities and no human habitation in the west of the park, but high human and livestock densities in the east and north east of the park where no wildlife was seen (Kolberg and Killian 2003).

Conservation activities in Namibia presently follow a hands off approach with regular monitoring being the main activity. According to the Master Plan for the SCP (Ministry of Environment and Tourism 1993) the area has been designated as a Scientific Reserve/Strict Nature Reserve IUCN Category 1 zone (IUCN 1984). However, the Master Plan has never been fully implemented and subsequent MET policies, Mining and Prospecting in Protected Areas and National Monuments, (Ministry of Environment and Tourism 1999) and other national legislation, Mining and Prospecting Act and the Diamond Act (Government of the Republic of Namibia 1994, 1999) have condoned activities that do not comply with the Master Plan zonation. The SCP Master Plan is currently under review.

The governments of Namibia and Angola have signed and ratified a Memorandum of Understanding (MOU) on creating a transfrontier conservation area linking the SCP and Iona National Park (van der Walt 2003). Familiarization inspections by delegations from both countries have been done to the SCP and Iona NP (Kolberg 2003).

The marine component of the study area (between 16^0 21' S and 17^0 24' S) without any conservation status is subject to fishing boats from both Namibia and Angola fishing in the vicinity of the freshwater plume often deploying nets very close inshore (H. Holtzhausen Senior Scientist, Ministry of Fisheries and Marine Resources, July 2006 *pers. comm.*, *pers. obs.*, BCLME 2007).

4.2 Legal framework

Both Angola and Namibia have a suite of legislation pertaining to the conservation, development and utilization of natural resources, environment, water and the sea. Given that the Kunene River is a shared asset between Namibia and Angola there are several transboundary agreements, protocols or treaties that are pertinent to activities and developments on and utilization of this river. Furthermore there are several international treaties, conventions and protocols pertaining to environmental management which bind both countries. The Convention on Biological Diversity (UNEP 1993) is the most relevant for this study.

The Constitution of the Republic of Namibia makes provisions for environmental protection. Specifically Art. 95, provides for the "maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilisation of living natural resources on a sustainable basis for all Namibians, both present and future" (Government of the Republic of Namibia 1990). Although the constitution as the supreme law guarantees fundamental rights and freedoms it must be noted that this Article does not constitute a right, but rather a directive principle of state policy and is thus not enforceable (Cullinan *et al*. 2005).

On an operational level the Nature Conservation Ordinance (1975) governs all land based conservation activities in Namibia. This legislation, supported by regulations promulgated under Government Notice 240 of 1976, has various amendments but is without substantial revision. The ordinance was drafted under the colonial regime, but has been ratified by the present government and remains in force until the Draft Parks and Wildlife Bill, the Draft Environmental Management and Assessment Bill and the Draft Pollution and Waste Management Bill supplant it. These bills are currently under review, but once they are promulgated will empower MET to more effectively manage and control activities that impact on the KRM whether proximal or distant. However, current legislation is ineffective and cannot deal with many of the problems and issues facing Namibian resource managers today. For example, although there is a policy on prospecting and mining in protected areas (Ministry of Environment and Tourism 1999) this policy cannot be adequately enforced because there is no provision for mining and prospecting in protected areas in Ordinance 4 of 1975 or any amendments thereto. Moreover the Policy on Prospecting and Mining in Protected Areas and National Monuments has not been ratified by parliament so is in itself largely ineffective. Similarly the Environmental Assessment Policy for Sustainable Development and Environmental Conservation (Ministry of Environment and Tourism 1995), though approved by parliament, is unenforceable without the promulgation of the Draft Environmental Management and Assessment Bill to give it statutory effect (Cullinan *et al*. 2005).

The Water Resources Management Act, Act No. 24 of 2004, (Government of the Republic of Namibia 2004) will enable better management of the Kunene River and enforce environmental releases and ecological reserves to maintain a functioning system in the river. This legislation is the jurisdiction of the Ministry of Agriculture, Water and Rural Development and more specifically the Department of Water Affairs. In conjunction with the draft bills proposed by MET there is potential for effective management of the Kunene River.

At present, however, management and protection of the KRM is hampered by an ineffective and outdated legal framework. In contrast many forms of natural resource utilization that pose a potential threat to the KRM are backed up by recent legislation, such as the Aquaculture Act (Government of the Republic of Namibia 2002). This act lends legal muscle to the Policy towards the Responsible Development of Aquaculture (Ministry of Fisheries and Marine Resources 2001a) and provides the basis for Namibia's Aquaculture Strategic Action Plan (Ministry of Fisheries and Marine Resources 2001b). While this Act provides mechanisms for maintaining water quality in areas zoned for aquaculture (Cullinan *et al*. 2005) which could assist conservation of the KRM, aquaculture has been identified as a major threat to estuarine systems (Morant and Quinn 1999, Turpie 2004). Similarly the Marine resources are controlled, managed and utilized within the Namibian Exclusive Economic Zone (EEZ) under the Marine Resource Act in conjunction with the Regulations Relating to The Exploitation of Marine Resources (Government of the Republic of Namibia 2000, 2001). This act gives jurisdiction over all marine resources and makes provision for demarcating utilization exclusion zones and the proclamation of Marine Protected Areas (MPAs). The provisions of this legislation are under the jurisdiction of the Ministry of Fisheries and Marine Resources and do not fall within the ambit of MET.

Mining and prospecting are controlled and regulated by the Ministry of Mines and Energy (MME) through the Minerals and Prospecting Act of 1992 (Government of the Republic of Namibia 1992). This legislation defines the various prospecting and mining activities and does provide for environmental safeguards. MME officials are entrusted with enforcing the provisions of this act.

The prospecting for, recovery, storage, transporting, working and sale of diamonds fall under the jurisdiction of the Ministry of Mines and Energy and the Office of the Diamond Commissioner through the Diamond Act, No 13 of 1999 (Government of the Republic of Namibia 1999). This legislation provides for the declaration of restricted diamond areas and empowers diamond EPL holders and miners to enforce provisions of this act. Furthermore this act gives the Namibian Police (NAMPOL), MFMR inspectors and labour inspectors certain rights of entry to restricted diamond areas. This act does not, however, mention protected area's, nor make any provision for MET officials to enter restricted diamond areas. This omission causes conflict of interest, particularly in the case of restricted diamond areas being declared within protected areas.

4.3. International and National Projects supporting management of the KRM

4.3.1 Benguela Current Large Marine Ecosystem Programme and the Benguela Environment Fisheries Interaction & Training Programme

The Benguela Large Marine Ecosystem (BCLME) Programme and the Benguela Environment Fisheries Interaction & Training Programme (BENEFIT) are closely linked and are concentrated on a regional co-operative programme of managing and conducting research on the Benguela Current involving Angola, Namibia and South Africa (BCLME 2007). The BCLME project is a baseline study of species and biodiversity in estuarine habitats that carried out surveys on all rivers from the Congo in the north to the Diep on the South West Cape coast (BCLME 2007).

4.3.2 Namibian Coastal Zone Management Project

The Namibian Coastal Zone Management (NACOMA) project aims at integrating management programmes to achieve biodiversity conservation within the coastal zone. This project is funded by the World Bank through the Global Environmental Fund (GEF). The project started in 2006 and is expected to run for five years. This project works with MET, Regional Councils and other applicable line ministries (NACOMA 2007a,)

4.3 Strengthening the Protected Areas in Namibia Project

The Strengthening the Protected Areas in Namibia (SPAN) project is a World Bank funded initiative implemented by MET. The project aims to develop biodiversity conservation capacity within the current system of Namibian protected areas. The project is focusing on selected demonstration sites of which the SCP is one through a new corridor park linking the SCP with Etosha. This MET partnered project started in 2005 and has a five year life span (http://www.span.org.na)

4.4. Current and Planned Activities

While the KRM lies in relative isolated solitude there are several ongoing and planned activities that could potentially affect the KRM and surrounding areas. To more fully understand the factors that could influence the area either positively or negatively they are briefly outlined below.

4.4.1 Military and Police

The Angolan government maintains a small military detachment at the KRM of about six members, who are based at Foz do Cunene (Map 2.1 page 12). This detachment has a low profile. However natural resources are harvested, some of which are vulnerable species, e.g the Green Turtle. There is thus a threat of over exploitation as these activities are not monitored or regulated (E. Afonso Nature Conservator, Iona National Park, Angola. October 2004 *pers. comm*.).

Currently there is no permanent Namibian police or military presence at the KRM. It was suggested in 1996 to establish a police presence at the KRM. Since 1996 several police bases have been established in remote and isolated areas elsewhere in the region, e.g. at Möwe Bay, Skeleton Coast Park and at Orupembe. In the light of this development and considering the fact that the KRM straddles an international border, the establishment of a police unit in the study area is not unlikely. However, reliable information to support or dismiss these plans could not be obtained.

The establishment of a high security prison at the KRM has been suggested at high political level. There has been no further activity in regard to realizing this suggestion so it is considered unlikely that a prison will be built in the short term.

4.4.2 Mining

An extensive investigation of marine gravels to assess diamond occurrence was conducted between 1943 and 1947 from Swakopmund to the Kunene Mouth (Schneider and Miller 1992). The northernmost occurrence of diamonds has been recorded in the vicinity of the mouth of the Sechumib River (Bancroft 1955, Heath and Linning 1963 cited in Schneider and Miller 1992), which is approximately 180 km south of the KRM. From about 1984 until independence in 1990 a moratorium was placed on mining and prospecting in parks. The policy on prospecting and mining in protected areas and national monuments (Ministry of Environemnet and Tourism 1999) opened the way for a renewal of mining and prospecting in parks. In line with this policy an exclusive prospecting license (EPL) was granted for the KRM in 2000. Operations only started on this EPL early in 2002. Since then sporadic prospecting has taken place. Prospecting initially concentrated on fluvial gravels, first on the exposed terraces, and then in the river channel. None of these target areas were productive (T. Korns, then operator for NNDC at the Kunene diamond EPL. June 2002 *pers. comm.,* G. Rogers, then operator for NNDC at the Kunene diamond EPL, February 2004 *pers. comm.*). This EPL is still valid and the company has upgraded operations, infrastructure and equipment and is now operating in an area about seven kilometers south of the river (Map 2.1 page 12).

An EPL is valid for three years and may be renewed a maximum of two times, each renewal requiring a 25% reduction in the size of the EPL (Government of the Republic of Namibia 1992). The Minerals Act does, however, grant powers to the minister to renew an EPL more often and waive the stipulated reduction in size (Government of the Republic of Namibia 1992). It is normal procedure and in fact expected that a company either relinquishes an EPL or expands operations and upgrades the EPL to a mining licence. A mining licence can be valid for up to 25 years (Government of the Republic of Namibia 1992). The EPL at the KRM has had three renewals and the holders of the EPL have expressed interest in upgrading to a Mining Licence. As the target mineral are diamonds the area does and will come under the direct jurisdiction of the Diamond Commissioner and be subject to provisions of the Diamond Act for anything up to 25 years or the duration of the mine (Government of the Republic of Namibia 1999). The area will then become a declared diamond area with restricted access. Any tourism development plans will then be impossible. The possibility that the KRM might become a diamond mining area poses a serious direct threat to the area.

At Swartboois Drift, 260 km upstream (Map 1.1 page 3) from the KRM, a deposit of blue sodalite is mined on the Namibian side in close proximity of the river. This operation currently has no known effect on the KRM.

No data are available on past mining activities at the KRM in Angola. However, the presence of old mining equipment at Foz do Cunene and extensive trenches and gravel heaps indicate that large scale diamond prospecting was carried out there prior to 1975. Currently there are no known mining or prospecting activities on the Angolan bank of the Kunene River between the mouth and Ruacana.

Political instability and civil war have severely hindered mining and prospecting activities in Angola. It is therefore unlikely that there is any significant activity in the

Kunene River catchment at present. No information is available on planned mining activities in Angola.

4.4.2 Tourism

The KRM is remote and difficult to reach. Although it is a sought after destination few people visit the area. Tourism to the KRM from within the SCP is presently non existent. Further south there is a range of different tourism activities in the SCP confined to designated and zoned areas. However, between the eastern boundary of the SCP and Ruacana there are several tourist camps/lodges on the Namibian river bank. Some of these lodges offer river based activities in the form of rafting and canoeing and sunset cruises for clients. One operator offers commercial rafting and canoeing trips between Ruacana and Epupa. Tourism operations range from exclusive fly-in safaris to community run camp sites open to self drive safaris or organized commercial tours and self drive visitors.

Tourism on the Angolan side is increasing (Simmons et al. 2006a, Simmons et al. 2006b, BCLME 2007).The KRM falls within a tourist concession that focuses chiefly on fishing. Tourist camps have been established at Tombua (Flamingo Bay) 164 km north of the KRM. A building at Foz do Cunene is used for tourism activities (Simmons *et al.* 2006b). In addition to these activities conducted by the concessionaire self drive tourism is increasing at the KRM (*pers. obs.*).

4.4.4 Dams

There are currently six impoundments on the Kunene all upstream from Ruacana (de Moor *et al.* 2000). It is unlikely that the dams in Angola will affect water level fluctuations below Ruacana but biological consequences for the entire system could be considerable (de Moor *et al.* 2000). Should all six Angolan impoundments become fully operational the impacts on the flow regime may constitute a serious threat (Simmons *et al.* 1993, de Moor *et al.* 2000). The necessity of the Gove Dam to regulate river flow for the proposed hydro electric dam in the Baynes Mountains in Namibia (NAMANG 1997, NIGC 2005) seem to suggest that impoundments above Ruacana could influence river flow in Namibia.

A major hydro-electric scheme has been proposed for the Kunene in the region of Epupa Falls. This project has considered several sites, but the choice has been reduced to two alternatives: a site just below Epupa Falls and a site in the Baynes Mountains (NAMANG 1997). Environmentally the Baynes site is more favourable, but technical and economic considerations favour the Epupa site (NAMANG 1997). Disagreements between Angola and Namibia regarding the best site and possibly financial constraints have resulted in the project being shelved since 1996. However new technologies and recent consensus between Namibia and Angola have revitalized the project focusing on the Baynes site (Dentlinger 2005).

4.4.5 The Cape Fria Harbour project

This project proposes the construction of a deep water harbour at either Cape Fria or Angra Fria, which are situated 160 and 130 km south of the KRM respectively. In addition a town to service the harbour will be necessary as well as the compatible industry. The initial human population expected to be 5,000. The area is presently without infrastructure. A 240 km railway line and surfaced road link to Opuwo are part of the project. Water will be supplied via pipeline from the Kunene River either from the KRM or Ruacana (Ministry of Works Transport and Communication 2007).

Although the harbour will not be situated directly at the KRM this project has the potential to severely affect the area. Infrastructure will be put into an area that has previously been inaccessible. Water consumption cannot be estimated until the scale of the development is finalized. But water abstraction required for the harbour development combined with flow modification caused by hydro electric schemes may further reduce water flow at the KRM, particularly during low flow periods.

4.4.6 Aquaculture

There have been applications to investigate the KRM for potential aquaculture projects. The fresh water prawn, *M. vollenhovenii*, has commercial potential (Morant and Carter 1996) and thus a potentially exploitable species. Aquaculture has been recognized as a major threat to estuarine biodiversity (Morant and Quinn 1999, Turpie 2004).

Chapter 5: Stakeholders

5.1 Introduction

The KRM is a geographically isolated site straddling the international border between Namibia and Angola. The protection afforded by being situated within a protected area and the lack of infrastructure facilitating access in Namibia makes it difficult to visit the KRM. Notwithstanding this isolation a number of activities are taking place or have been proposed that may potentially impact on or affect the KRM (Chapter 4). A River mouth is the end user of water and other catchment processes and will thus be affected by human activities and other developments in the basin (Whitfield 1998, Turpie 2004).

Large scale development projects are being planned in north-western Namibia such as the Cape Fria harbour (Map 1.1 page 3). Although not necessarily within the Kunene catchment this project would require large volumes of fresh water to be extracted from the Kunene River (Ministry of Works Transport and Communication 2006). Other economic sectors are interested in the KRM with potentially conflicting interests such as mining and tourism. Prospecting for diamonds is currently underway at the KRM and there is an active sodalite mining operation at Swartboois Drift (Map 1.1 page 3). Tourism operators are utilizing the river upstream of the KRM at several locations between the Hartmanns valley and Ruacana Falls. These projects represent several levels of exclusivity from self drive visitors to guided tours and upmarket lodges. Activities include rafting, boating and fishing. Several campsites and lodges have been built along the river bank to cater for these activities. The Namibian tourism industry has expressed interest in the KRM and several proposals and applications for tourism development at the KRM have been submitted to MET. In Angola the KRM is part of a tourism concession and self drive visitors also visit the area in increasing numbers.

Namibia has no major impoundments on the Kunene, but there are six in Angola (de Moor *et al.* 2000) with Gove, Matala, Callueque and the Ruacana Weir being the most important (Map 1.1 page 3). There is a hydro electric power station in Namibia the water for which is regulated from the Angolan Ruacana Weir. Namibia has aspirations to build a further hydro electric scheme and dam in the vicinity of the Baynes Mountains.

Interest has been expressed in aquaculture at various sites on the Kunene from the mouth to Ruacana.

The Kunene Regional Council, in whose political constituency the KRM falls, has long been denied access to the coast and the council is now expressing a desire for the opening up of the coastal zone for development and access to the KRM (D. Murorua, Govenor Kunene Region, February 2007 *pers. comm.*, NACOMA 2007).

As a developing country Namibia is promoting a diverse development portfolio. The ministry of Mines and Energy (MME) is facilitating prospecting and mining. The Ministry of Fisheries and Marine Resources (MFMR) promotes aquaculture. MET is developing policy to promote and develop the tourism potential of protected areas. Nampower, the Namibian power utility, is managing Ruacana and pushing for a new hydro electric scheme. Namwater has the mandate to monitor water extraction and also supply water to urban and communal settlements through a pipeline from Ruacana and a canal from Callueque. The National Planning Commission in collaboration with the Ministry of Works Transport and Communication (MWTC) is planning a town and harbour development at Cape Fria. At the same time Namibia has recognized the need for marine protected areas as well as creating transboundary conservation areas.

These interests are all centred on, in close proximity to or are reliant on the Kunene River or KRM in some way thereby having an impact on the KRM. All these interests create a climate of conflicting activities that without proper management could become unsustainable. The sustainable utilisation of natural resources is enshrined in the Namibian Constitution in Art. 95 (Government of the Republic of Namibia 1990). An essential element of the sustainable management of natural resources is the participation of stakeholders (Roe *et al.* 2001, van der Linde *et al.* 2001). It is increasingly being recognized that the adoption of management practices needs to involve all relevant stakeholders in order to secure buy in and support. Sustainable management is thus largely about negotiations between stakeholders (Roe *et al.* 2001). Consequently any future management of the KRM needs to consider its stakeholders. A stakeholder analysis for the KRM to identify who the key players are for future consultations and possible co-management has been carried out adapting the methodology suggested by Vieros *et al.* (2006).

5.2 Method

A list of those groups and institutions who have or may have an interest in or whose activities may impact on the KRM has been compiled. These are considered as potential stakeholders. No data is available for private enterprise activities in Angola. Equally, due to lack of detailed information on Angola, official bodies with jurisdiction over the KRM or other government activities that might influence the mouth through upper catchment projects are aggregated and referred to as “Angolan Government”. For Namibia, the various government bodies MET, MFMR, Nampol etc. are individually considered. The regional council and the Namibian Police have not previously been considered as stakeholders. The Kunene regional council is included as it plays an integral part of the NACOMA coastal zone management project. In the event that a police unit is established at the KRM, the Namibian Police would become a resident and therefore important stakeholder.

A matrix was constructed listing current and potential activities and interests on the X axis. The Y axis has the list of institutions or bodies identified as stakeholders. Each stakeholder was given a score against an activity in which that stakeholder has an interest. The scores for each stakeholder are added up. Ranking for stakeholder importance was based on the total score (Table 5.1).

5.3 Results

The 16 potential stakeholders can be categorized into five groups: National government institutions, regional government, the NGO sector, the private sector and neighbouring communities. The National government institutions form the strongest category comprising ten stakeholders. Of these MET, the Angolan government, MFMR and Namwater have by far the largest number of interests overall. In the private sector the company holding the EPL at the KRM stands out as having the strongest interest. The tourism sector, the regional council and the neighbouring conservancy emerge from this analysis as having a relatively low interest in the area.

There are currently six institutions with legal jurisdiction over the KRM and the river four of which have a mandate to manage different biotic and environmental aspects of the KRM. Eight groups are currently active in the area, three of which are utilizing biological resources, two are concerned with the management of these resources and two groups could potentially become involved in resource harvesting. One group is actively mining mineral resources and two groups are managing this activity. Two of the eight active groups, i.e. BCLME and NACOMA, have a purely research and advisory role of limited duration. Three stakeholders, i.e. MET, the Government of Angola, MMFR and the Angolan Tourism Industry are permanently resident in the area.

5.4 Discussion

The matrix is based on the assumption that the number of activities an organization is involved in reflects the strength of their interest. This analyses singles out MET, the Angolan Government, MFMR, Namwater and NNDC as the parties with the strongest interest in the area. NNDC, the company holding the EPL at the KRM are currently conducting prospecting activities at the KRM. In terms of the number of activities they score relatively low. However, they are resident in the study area and their activities have a potentially high impact on the area (Chapter 6). They should thus be considered an important stakeholder. The presence of mineral exploitation activities also makes MME an important stakeholder because they are the statutory body controlling these activities. With the proximity to an international border security and movement across the border becomes an issue. This is the jurisdiction of Nampol and the Ministry of Home Affairs and Immigration and although these two groups score low on the analyses they should not be overlooked as once development activities are underway they may establish a physical presence for which no contingency has, as yet, been planned. Although the KRM falls within the Kunene Region political constituency the Kunene Regional Council have not been involved in any management decisions of the area, has no access to the area and has received no benefits to date. The Regional Council have expressed a desire to gain access to the coast for development projects that will be beneficial to the region (D. Murorua, Govenor Kunene Region, February 2007 *pers. comm.*, NACOMA 2007).

The relatively low score of the Namibian Tourism sector is due to the fact that this industry is currently excluded from the KRM. It has to be considered however, that controlled tourism is a low threat activity (Chapter 6). MET policy promotes joint venture initiatives and benefit sharing between the tourism sector and park neighbours. Such benefit sharing between neighbouring conservancies and tourism operations located in protected areas is currently in place in several of Namibia's parks, notably SCP (Wilderness Safaris and Purros conservancy) Both the tourism sector as income generator and the neighbouring conservancy as beneficiaries are therefore important stakeholders.

The great number of government institutions contrasts with the low involvement of the NGO and private sector. This contrast is an indicator that Namibian natural resource management policy, at least as far as protected areas are concerned, is still largely state controlled and authoritarian.

5.5 Conclusion

This analysis highlights the main stakeholders who need to be involved in the process of adopting a management strategy for the KRM. In the Government Sector these are MET, the Angolan Government, MFMR, Namwater, MME and the Regional Council In the private sector NNDC and the Namibian tourism industry.

Conservancies and neighbouring communities need to be considered as the main beneficiaries of income generating development projects. The Namibian Police and the Ministry of Home Affairs and Immigration are relevant stakeholders should they decide to establish a physical presence in the area. Considering that the KRM is a transboundary area, any transboundary management practices need to be developed in consultation with the Ministry of Home Affairs and Immigration.

Table 5.1 Stakeholder Matrix. This matrix indicates the various stakeholders according to sector (Y axis) and stakeholding (X axis)

		Legal jurisdiction	Current Activities	Biological Resource utilisation	Advisory	Water utilisation	Management	Research	Residency	Mineral Resource utilisation	Political Constituency	Security	Transfronteir Conservation	Tourism Development (Concessions)	Partnerships Benefit sharing	Dams	Harbour Developments	Agricultural Projects	Border control	Score	%
National Government																					
1	MET	1	1	1	1		1	1	1	1		1	1	1	1	1	1	1		15	83
2	Angola Gov.	1	1	1		1	1		1	1		1	1	1		1				11	61
3	MFMR	1	1	1	1	1	1	1		1						1	1	1		11	61
5	NAMWATER	1	1		1	1	1	1								1	1	1		9	50
11	Police	1										1	1	1					1	5	28
10	MME	1			1			1		1										4	22
16	Home Affairs and Immigration												1	1					1	3	17
13	Nat. Plan. Comm															1	1			2	11
12	Nampower															1	1			2	11
16	MAWRD															1		1		2	11
15	Military											1								1	6
Regional Government																					
14	Regional Council										1					1	1	1		4	22
NGO																					
7	NACOMA Project		1		1			1												3	17
8	BCLME Programme		1		1			1												3	17
Private Sector																					
4	NNDC/Mine		1	1		1			1	1										5	28
9	Angolan Tourism Industry		1	1					1					1						4	22
6	Namibian Tourism Industry			1										1	1					3	17
Neighbours																					
16	Neighbouring conservancy			1										1	1			1		4	22
	Total	6	8	6	6	4	4	6	4	5	1	4	4	6	2	8	6	5	2	87	
	Namibian civil society through Constitution.																				
	International community through applicable conventions and Nam Constitution.																				

Chapter 6: Threat Analysis

6.1 Introduction

In this study aesthetic degradation as outlined in Harrison *et al.* (2000) and biodiversity loss are considered as the main threats to the KRM. Aesthetic degradation is generally a by-product of threats to or proximate causes of biodiversity loss, e.g. through buildings, tracks and runways etc. But aesthetic degradation itself does not necessarily cause biodiversity loss so for the purpose of this analysis aesthetic degradation and biodiversity loss are considered on separate matrices.

Although the KRM is an isolated location, it is prone to threats both local, at the mouth itself, and to remote activities in the catchment basin. Some of these activities are in the proposal or in the planning phase but others are currently underway. Each activity has a level of threat or impact on the KRM. A better understanding of these impacts and threats will be helpful to future management of the area. Being a river mouth as opposed to an estuary the study area has a fresh water regime with a much more limited biotic community. The biotic communities at the KRM are, however, important and have a high aesthetic appeal with contributing to a high sense of place value (Chapter 2). The KRM, is one of the few river mouths in Southern Africa and one of only two permanent coastal river discharges in Namibia thus making it a regionally unique habitat. These are considerations that need to be taken into account when applying a risk threat analysis.

6.2. Method

Two main risks to the KRM were identified 1) biodiversity loss and 2) aesthetic degradation. These risks were assessed for a five year period. Various activities, both current and future, were identified that could potentially cause impacts on the biodiversity of the KRM during this period.

A total of 11 threat categories are used in this study, which are mainly drawn from previous work (Table 5.1).

Table 6.1 Categories used to describe threats to biodiversity

Heydorn (1989); Morant and Quinn (1999)	Turpie (2004)	This study
Residential and industrial development including bridges, road and rail construction across estuaries	Habitat alteration	Habitat alteration
Fixing of mouths	Change of Mouth dynamics	
	Biotic resource use and over-exploitation	Biotic resource use and over-exploitation
Sedimentation due to soil erosion	Sedimentation	Sedimentation
Reduction in freshwater flow	System variability	Change of flow regime
	Alien species	Alien species introduction
Pollution	Chemical/organic pollution	Pollution water
	Solid pollution	Pollution terrestrial
	Salinity	Salinity
	Turbidity	Water quality
	Change nutrient status	
	Oxygen depletion	
	Temperature change	
		Water extraction
	Recreational disturbance	Disturbance by human activity
Mariculture (only Morant and Quinn 1999)		

The literature lists up to 15 possible impacts that are specific to river channels and surrounding floodplains (Heydorn 1989, Morant and Quinn 1999, Turpie 2004). For the purposes of this study "water quality" includes chemical changes, turbidity and organic pollution, although Turpie (2004) lists these as separate proximate causes. Salinity is considered separately because the KRM is a fresh water system. An increase in salinity is thus a significant threat. Threats through river flow are changes in mouth dynamics and loss of system variability (Turpie 2004). In this study "change in flow regime" encompasses seasonal fluctuations, mouth closure and reduced inflow of fresh water. Water extraction refers to extraction at the mouth itself. Pollution has been divided into two categories (1) "terrestrial" and (2) "water". The objective of this approach is simplicity and practicability for use by managers in the field rather than an emphasis on scientific analyses requiring laboratory facilities.

Potential threats to the aesthetic value of the area were selected using Harrison *et al.* (2000) as a guideline.

Some 15 activities were listed against 11 risks or aesthetic parameters resulting in a maximum Activity Impact Score (AIS) of 55 (Table 6.2). A probability rating (PR) was used to describe the likelihood of an activity taking place within the next five years. A five point scale (1 to 5) was used for the descriptors (Negligible, Low, Medium, High and Current). A risk score (RS) was calculated by multiplying the Activity Impact Score with the probability rating to obtain a risk level (RL) of Negligible, Low, Medium, High or Very High (Table 6.2). Thus the risk level is calculated using the following simple formula RS = AIS * PR. These scores were evaluated as negligible risk being 0 to 15% and low risk 16 to 30% of the Activity Impact Score. Medium risk is 31 to 60% of the Activity Impact Score. High and very high risk is 61 to 85% and 86 to 100% of the Activity Impact Score respectively.

Table 6.2 Risk scores showing corresponding risk level and the % range used in the calculation

Risk Score (RS)	**Risk Level (RL)**	**% Range to define RL**
1 - 8	Negligible	0 – 15
9 - 17	Low	16 – 30
18 - 33	Medium	31 – 60
34 – 47	High	61 – 85
48 - 55	Very High	86 - 100

6.3. Results

The parameters identifying the threats to biodiversity and aesthetic health were plotted against a list of activities to identify threats on two separate matrices (Tables

6.3 and 6.4). Threats to water quality were aggregated into pollution to simplify scoring. Future work may include a more detailed analysis. Baseline data are available on the hydrology of the KRM from previous studies (Morant 1996a, BENEFIT 2007) against which future analyses can be compared. The resulting matrices (Tables 6.3 and 6.4) rank various activities according to their Activity Impact Score and probability rating giving a risk score and risk level. By doing this, activities that have a potentially high threat with a low probability will be considered low risk, e.g. the construction of a prison at the KRM has a high impact potential (AIS 8), but scores a 1 on the probability rating obtaining a risk score of 8 and is thus considered a negligible risk level to biodiversity. A prison at the KRM has been mooted because of the extreme isolation of the area, but no definite plans are known to exist for this project. On an aesthetic rating a prison has a relatively high Activity Impact Score (5 out of 11) but the low probability rating makes it an overall negligible aesthetic risk.

Activities with a low impact and high probability have a low or negligible risk level. For instance, on-site controlled tourism has negligible impact (AIS 2) with a high probability factor (PR 4) gaining a low risk score (RS 8). Sensitive tourism development is a desired activity that will create benefit sharing opportunities in the broader region. Currently there are no tourism activities in Namibia at the KRM and it remains a MET priority to develop the tourism and economic potential of protected areas (M. Lindeque, then Permanent Secretary, Ministry of Environment and Tourism, February 2007 *Pers. comm.*). There are currently tourism activities taking place on the Angolan side of the river that are largely uncontrolled and are considered a medium risk level. Uncontrolled Tourism has a higher impact than sensitively developed tourism, but with management strategies aimed at minimizing impacts it becomes a development opportunity with acceptable risk levels.

Appropriate tourism might be a desirable low risk activity at the KRM, but it might lead to the Namibian government becoming concerned with tourist activity in a remote border area and to create a permanent police presence at the KRM to monitor these activities. A police presence would entail a high risk to biodiversity and a medium aesthetic risk but it is currently considered to have low probability so has an overall low risk level.

There is currently a military detachment stationed permanently on the Angolan bank which has a high risk level in terms of biodiversity and a moderate risk to aesthetic value. It seems unlikely that Namibia will station a military detachment there.

6.4. Discussion

These matrices are intended as tools to identify areas where management intervention is necessary by highlighting certain activities with high impacts that have a very high risk level. These activities are undesirable and would require intensive management intervention or total exclusion. Mining is identified as the highest risk to both biodiversity and aesthetics. Mining is not only is a high impact activity, but it is currently being conducted at the KRM.

Several of the activities mentioned have potentially high impacts, have a low probability of occurring. It would be prudent to keep these activities in mind when developing management strategies so that they may be accommodated and their impacts minimized and mitigated as far as possible if they should occur.

Sensitive development planning and appropriate management strategies would minimize threats to both the aesthetic environment and the biodiversity. Such developments would promote appropriate (low impact) activities with low risk levels. For instance, placing structures and other infrastructure in out of sight areas and through building methods that blend in to the physical environment aesthetic degradation can be minimized. Recreation activities must be restricted to those with minimal impacts e.g. no motor boats and water skiing. Natural resource harvesting should be limited and strict zoning is required to identify permissible areas and levels for this activity.

High impact activities like mining, development of a police base or aquaculture should be discouraged. If such activities are to be permitted they should be restricted to specific zones and severely contained to minimize their impact on more appropriate tourism activities. A detailed cost benefit analysis needs to be done to ascertain the most appropriate development.

These simplified matrices to assess risk levels to biodiversity and aesthetics provide a two dimensional picture that helps a manager gain an immediate understanding of the risks that any one activity might pose to the KRM. Detailed scientific studies would still be required to pinpoint precise areas and levels of threat, particularly in the marine and fresh water environments. These matrices presented here are intended as a practical tool for quick assessment.

The cumulative effects of more than one activity with the commensurate threats have not been considered. These threats to both biodiversity and aesthetics would significantly increase with additional activities.

Table 6.3 Threats and risks to biodiversity

	Threats/Risks	1	2	3	4	5	6	7	8	9	10	11				
Activities		Alien species introduction	Salinity	Habitat loss	Biotic resource use over-exploitation	Pollution water	Water extraction	Pollution terrestrial	Disturbance	Sedimentation	Change of flow regime	Water quality	Activity Impact Score (AIS)	Probability rating (PR)	Risk (AIS * PR) score	Risk level (RL)
1	Mining	1	1	1	1	1	1	1	1	1		1	10	5	50	VH
2	Military Presence Angola	1	1	1	1	1	1	1	1				8	5	40	H
3	Dams Off Site	1	1	1		1	1			1	1	1	8	4	32	M
4	Uncontrolled Tourism Angola		1	1	1	1		1	1				6	5	30	M
5	Aquaculture at KRM	1	1	1	1		1	1	1	1		1	9	2	18	M
6	Agriculture Off Site	1	1	1		1	1			1	1	1	8	2	16	L
7	Industry Off Site	1	1	1		1	1			1	1	1	8	2	16	L
8	Tourism Off Site	1				1				1			3	5	15	L
9	Police Station	1	1	1	1	1	1	1	1				8	2	16	L
10	Border Post	1	1	1	1	1	1	1	1				8	2	16	L
11	Harbour Off Site		1				1				1	1	4	2	8	N
12	Aquaculture upstream	1				1	1					1	4	2	8	N
13	Military Detachment Namibia	1	1	1	1	1	1	1	1				8	1	8	N
14	Prison Namibia	1	1	1	1	1	1	1	1				8	1	8	N
15	Controlled Tourism				1				1				2	4	8	N

Table 6.4 Threats and risks to aesthetic value

		1	2	3	4	5	6	7	8	9	10	11				
		Floodplain land use	Buildings and structures	Floodplain /estuary surrounds	Litter and rubble	Human use	Algal growth/aquatic nuisance plants	Turbidity	Odour	Airstrips	Noise	Invasive and exotic vegetation	Activity Impact Score (AIS)	Probability rating	Risk (AIS * PR) score	Risk level (RL)
1	Mining	1	1	1	1	1				1	1	1	8	5	40	H
2	Military Presence Angola			1	1	1						1	4	5	20	M
3	Uncontrolled Tourism Angola			1	1	1					1		4	5	20	M
4	Aquaculture on site	1	1	1	1	1	1		1			1	8	2	16	L
5	Controlled Tourism		1	1		1							3	4	12	L
6	Police Station		1	1	1	1						1	5	2	10	L
7	Border Post		1	1	1	1						1	5	2	10	L
8	Dams Off Site			1				1					2	4	8	N
9	Agriculture Off Site						1	1				1	3	2	6	N
10	Industry Off Site						1	1				1	3	2	6	N
11	Aquaculture off site						1	1				1	3	2	6	N
12	Military Detachment Namibia		1	1	1	1						1	5	1	5	N
13	Prison Namibia		1	1	1	1						1	5	1	5	N
14	Tourism Off Site												0	5	0	
15	Harbour Off Site												0	2	0	

Chapter 7: Proposals for a Desired State, Thresholds and Limits

7.1 Introduction

Notwithstanding the remoteness and isolation of the KRM the analyses of current and potential stakeholders (chapter 4) and associated risks (Chapter 5) indicate that there are various anthropogenic activities, both proximal and distal, that threaten the KRM. The threat analysis and stakeholder analysis both highlight tourism as a development opportunity compatible with the character of the KRM. The KRM offers a unique opportunity to develop a tourism product that is sensitive to the high aesthetic state and sense of place value. As mentioned earlier, the KRM is a sought after destination for many because it has not been open to visitors. There is a sense of exclusiveness attached to the area. In addition to this special sense of place the area offers many attractions such as its unique biodiversity and its fame as a fishing area. However, even tourism development bears the inherent danger of destroying the very aspects of an area that form its attraction (Reimold *et al.* 1980). Thus sensitive planning and effective management are needed to maintain those aspects while allowing human use of an area. A prerequisite for planning and management is the definition of a "Desired State" of the area.

It is beyond the scope of this work to arrive at an exact definition of the "Desired State" for the KRM. Rather, this section provides guidance by suggesting some key aspects for consideration when defining the "Desired State" for the KRM. Suggestions are made as to how the Limits of Acceptable Change (LAC) and Thresholds of Potential Concern (TPC) concepts can be integrated as tools in an adaptive management process for the KRM

When defining the desired state for the KRM three important aspects need to be considered:

1. the high aesthetic value and sense of place associated with the KRM
2. the biophysical components of the area
3. the need for development

While development is desired at the KRM it must be recognized that any development will impact on both the biophysical and aesthetic aspects of the area. This study suggests that the LAC system is appropriate to guide development and direct human activities whereas the TPC system as outlined by Rogers and Bestbier (1997) should be used to monitor biophysical changes in the river. Both systems are essentially the same in that they define thresholds or limits that are monitored (Chaper 3). When these parameters are exceeded, they warn of undesirable change; such change may require direct management action. Both LACs and TPCs fit into an adaptive management approach where constant monitoring feeds back into a management cycle.

7.2 The sense of place

The KRM has a high aesthetic appeal through its natural, unmodified appearance. This aesthetic integrity promotes the sense of place value of the KRM. The sense of place is a subjective state that is enhanced by the natural, unspoiled character and isolation of the KRM. The perennial river forms a green swathe cutting through the harsh barren Namib Desert. The northward movement of dunes is cut off by the Kunene as the sand that continuously tumbles into the river is washed out to sea. The fresh river water forms a linear oasis bisecting this harsh environment supporting a wide range of animals that would otherwise not be able to survive here. The windswept coastal plains back dropped by towering dunes create a timeless atmosphere where nature is in charge.

The exclusionist management practices of the past have turned the KRM into an almost mythical place among many Namibians. It has become a sought after destination which in turn has created a distinct place value on this area. The remoteness of the KRM to Namibian infrastructure has made traveling there an adventure. This expedition feeling adds to the area's special character.

The pristine appearance of the dunes, the undisturbed sand surfaces, the minimal signs of human presence, few tracks and undisturbed surfaces of the wind swept gravel plains create a sense of remoteness and timelessness. The few signs of past human activity that can be observed, speak of history and past endeavor adding to the sense of timelessness. The river winding its way through towering dunes and harsh barren plains creates spectacular vistas and provides the life supporting water in the harsh desert climate thus creating a contrast that adds to the attraction of the area.

In order to maintain the KRM special sense of place it is thus essential to maintain its character of naturalness, isolation and timeless remoteness.

At the KRM the assumption for setting LACs is that the area would be left in as natural a state as possible and human activity would be controlled to minimize the impact on its aesthetic integrity. Indeed, in the present Skeleton Coast Park management plan this area has been zoned as an IUCN Category One Strict Scientific Reserve (Ministry of Environment and Tourism 1993). Any activity at the KRM contradicts this plan therefore requiring compromise from MET. The present situation and current activities at the KRM show that this exclusionary approach to managing this area has failed and a more integrated consultative and adaptive approach to management is needed.

Limits of acceptable change refer to degree to which a change in the environment, both physical and aesthetic, is acceptable while still maintaining the Desired State. Specific management objectives for protection are identified based on the recognition that natural systems are subject to change. This recognition begs the question of how much change is acceptable for management. (McCool 1996). Once this limit has been reached an appropriate management action must be implemented to either return to a previous state or maintain the current level.

Several authors have referred to aesthetic values as important for estuaries and that they contribute towards the sense of place (Reimold *et al.* 1980, Portman and Wood 1985 and Harrison *et al.* 2000) and an aesthetic health index was developed to asses the aesthetic health of an estuary (Harrison *et al.* 2000). In setting a limit on aesthetics a minimum value on the Aesthetic Health Index developed by Harrison *et al.* (2000) is suggested as a guideline to represent the range from perfect (highest possible score to acceptable (defined minimum limit). All developments at the KRM should be looked at with this score in mind and through consultation with stakeholders developments should be adapted to comply.

The river forms an important part of the estuarine health index. Thus activities in the catchment and upstream must be assessed as to the effect they might have on the river at the KRM. Limits should be set on water inflow into the system and water quality. The KRM is a permanently open freshwater dominated river system. Therefore, increased salinity or siltation causing mouth closure would be major impacts. Activities that may cause salinity in the KRM to reach a level where the current resident freshwater aquatic fauna and flora cannot survive, or activities that increase siltation and may thus lead to mouth closure should be strongly discouraged. If mitigation and or adaptation of the project cannot guarantee a minimum inflow to maintain salinity, then no compromise is possible and the project should not be allowed to continue.

An important cause of visual pollution is off road driving. In some areas tracks made by vehicles remain visible for many years and thus detract from the aesthetic beauty of the area. Vehicle movement must be confined to defined tracks or to areas that are quickly and naturally rehabilitated e.g. on the beach below the low water mark and on wind blown sand or dunes. A limited amount of tracks forming a defined network would be an acceptable maximum limit for vehicle movement.

Noise is another factor that would reduce the aesthetic health. Powerboats are a cause of disturbance on estuaries (Turpie 2004) as well as a disturbance factor to biodiversity. Motorbikes and quad bikes are popular recreational vehicles, but are noisy and contribute to track pollution. However, it is possible to set limits by defining which types of vehicles are allowed at the KRM and restricting the number of vehicles at any one time.

Infrastructure development must consider the character of remoteness and isolation. Access by vehicle should be limited to traveling on the beach below the high tide mark or on the high beach track. The development of a road may destroy the sense of place for the KRM.

Waste and rubbish disposal sites are further threats to the aesthetic value of the KRM. Waste is an unavoidable side effect of development for which no acceptable limit can be set other than removal from the KRM for disposal in a registered waste disposal unit. Likewise on-site waste management must be such that all waste materials are contained and out of sight. Regular waste removal must be enforced.

Man-made structures will also affect the visual appeal of the KRM. For certain activities, however, structures are necessary. Specifications for building that conform to pre-determined limits must be drawn up. These specifications would determine which type of structure, building method and materials are allowed. For example, will permanent structures be permitted, or should all structures be temporary? The visibility must be considered as well as the relation to the river. Siting of structures is important to ensure that buildings blend with the surroundings and are erected in unobtrusive localities.

Alien vegetation is another factor that influences area aesthetics. The introduction of Exotic plants, vegetables, fruit trees or other domestic crops or alien vegetation should not be allowed. If the desired state implies maintenance of the natural characteristics of the KRM, no compromise is possible. Invader species from the river catchment must be monitored and thresholds must be set on their numbers, species and density. New species should be eradicated before they take hold and become uncontrollable.

7.3 Biophysical components

Ultimately it is the biophysical environment and its dependant biodiversity that bears the impacts of development. It is hoped that by setting limits of change on various components the impacts on the biodiversity will be minimized thereby maintaining the status quo. The underlying assumption is that by protecting habitats we can protect the biodiversity dependant on them (Bean and Wilcove 1997, Harding *et al.* 2001).

The main bio-physical components of the study area form nine distinct habitats. Any development of the area requires a management regime that maintains these habitats in their current state. These areas all have distinct spatial boundaries. As a quick practical management guide these areas could all be mapped and their area calculated. While it would be desirable to maintain these areas as pristine, a certain level of change might be acceptable to accommodate approved development and recreation activities. A degree, expressed as percentage of spatial change may be a useful primary TPC. Specialist input is necessary to identify representative and practical biotic indicators and set the TPCs accordingly. The approach adopted in the Kruger Park in South Africa could be followed (Rogers and Bestbier 1997).

Detailed monitoring of the biophysical environment and associated biotic and abiotic communities in accordance with a monitoring plan would refine the TPCs for the indicators through an adaptive management process (Chapter 8).

The habitats are:

1. The river
2. Floodplain mudflats
3. Riverine vegetation
4. Gravel Plains
5. Vegetated dunes and dune hummocks
6. Dune field
7. Littoral zone
8. Intertidal zone
9. Marine environment

7.3.1 The River

The focal point of biodiversity in the area is the river which is a freshwater dominated system with little or no saline influence. Annual floods cause seasonal rise and fall of the river level inundating the mudflats of the floodplain. Regular flow control at Ruacana where sluices are opened sporadically cause pulses of increased flow that result in minor water level fluctuations. Ruacana has been operational since 1970 so it would seem that the system has adapted to these fluctuations. Biotic communities in the river are typical of freshwater habitats and are sensitive to salinity fluctuations. A salinity change would affect the biotic communities. To maintain the current freshwater, an increase of salinity levels should be avoided. Thus a minimum inflow of water, i.e. an ecological reserve, is necessary. As yet such a reserve has not been determined, but requires an expert survey following a prescribed protocol (Taljaard *et al.* 2003). Current flow rates of greater than $20 m^3 s^{-1}$ as suggested by NAMANG (1997) should be maintained until an expert study determines an accurate minimum flow must be commissioned as there is no data to support the NAMANG recommendation (Snaddon and Davies 2003).

The mouth must remain open to the sea at all times. Siltation and mouth closure are not acceptable; again river flow is critical here. The sand bars and mouth structure between the dunes and the sea consists of dune sand (Greenwood 1999). A sufficient flow rate must be maintained to prevent this dune sand from silting the river. Again, expert studies must be undertaken to determine the required minimum flow for this.

In South Africa monitoring protocols have been established to calculate and set ecological reserves for river inflow. Guidelines for monitoring TPCs have been suggested for Kruger National Park (Rogers and Bestbier 1997, Taljaard *et al.* 2003, Adams and McGwynne 2004). There is little leeway for compromise on water quality.

7.3.2 Floodplain and Mudflats

This is an area predominantly on the south bank of the river that is seasonally inundated with floodwater. These mudflats channel within these flats form the major habitat and feeding area for migrant birds. After flooding a large lagoon forms south of the mouth that is connected to the main stream and as river levels drop this lagoon disappears and only some water filled channels remain. A backup of freshwater during high tides causes inundations of these channels maintaining a habitat for waders. Bird abundance and diversity may be useful indicators for the status of this habitat. During flooding the lagoon is used by several species of waterfowl.

7.3.3 Riverine Vegetation

The Kunene west of the dunes has a relatively small plant community, both in size and diversity. This community is dominated by reed (*Phragmites australis*) beds. This fringe of vegetation is important in stabilizing the river bank and catches and prevents wind blown sand from overwhelming the mouth. The majority of birds at the Kunene are wetland species. Several bird species are dependant on the vegetation for cover, food and breeding. The reeds provide ideal cover for several skulking wetland birds. A wide variety of reptiles also find refuge in these reed beds. Large herbivores in the area feed on these plant communities.

The three zones described above are all essentially riverine, but considering the specific requirements of a freshwater system they are classified separately. While these habitats are not unique to a freshwater regime the biotic communities would differ markedly in an estuarine system.

7.3.4 Gravel Plains

The gravel plains stretch from the littoral zone to the base of the dunes and from the river to Bosluis Bay. These plains are made up of alluvial gravels and paleo-beaches with marine gravels. In several areas these gravel plains give way to scoured sheets of granite. Vegetated dunes and hummock dunes cover some of this zone. Several species of desert adapted reptile are specific to these plains and it provides breeding areas for some birds such as the Damara Tern, *Sterna balanaerum*.

7.3.5 Vegetated Dunes and Hummock Dunes

This habitat is formed by wind blown sand forming small dunes around bushes, as the bush grows so the sand volume increases until a dune is formed that is permanently anchored by the bush. The chief plant forming these dunes is *Salsola sp.* that is tolerant of high salinity. This bush is nutritious and is eaten by both Gemsbok and Springbok. These dunes also provide shelter and food for reptiles, birds and small mammals. Both Brown Hyaena and the Black-backed Jackal use them as shelter for lying up or while eating food scavenged on the beach. The smaller hummock dunes form a long intermittent chain parallel to the coast on the east of the littoral zone which is an important north/south migration corridor along a coast that offers little or no other cover.

7.3.6 Dune Field

The dunes of the Namib Desert are iconic. The dune slipfaces tumbling into the permanent river that washes the sand out to sea in a continual process are a unique feature of the KRM. These dunes support a wide range of fauna from the desert specialist Tenebrionid beetles, many of which are endemic, the White Lady spiders, *Leucorchestris* and *Carparachne spp.*, to the large Northern Namib endemic Desert Plated Lizard, *Angolasaurus skoogi*, and the Namib endemic Side-winder, *Bitis peringueyi*.

7.3.7 Littoral Zone

The beach zone above the high-water mark is a relatively undisturbed area with a lot of flotsam that provides habitat for many species. This area is dominated by driftwood and beds of sea shells deposited here during periods of higher sea level or high tides. This detritus shelters many animals including several species of scorpion, spider and lizard. The White-fronted Plover, *Charadrius marginatus*, nests in this zone. Ghost Crabs, *Ocypode spp*., dig their burrows on the high beach above the tidal line and also forage in this area.

7.3.8 Intertidal Zone

Between the Kunene and Bosluis Bay the intertidal zone is an exposed coastline dominated by sandy beaches. The few exposed rock outcrops host some intertidal species e.g. Brown Mussel, *Perna perna*, and Limpits, *Patella spp*. The ubiquitous Ghost Crab, *Ocypode spp*., is common along the coast foraging in the intertidal zone for various crustacean species or carrion. The swash zone provides feeding areas for Sanderlings, *Calidris alba*, the second most abundant migrant wader at the KRM.

7.3.9 Marine Environment

The marine environment is dominated by the cold, nutrient rich Benguela current moving up from the south and the warm Angola current coming down from the north. These two currents meet forming the Angola front which is an ecotone between the high biodiversity of the nutrient poor warm water coming from the north and the less diverse, but nutrient rich cold water (BCLME 2007). This front undergoes seasonal movements governed by the prevailing south-westerly winds (BCLME 2007). The Kunene River is a source of nutrients that erupt into the sea providing further feeding opportunities for fish and birds.

The Green Turtle, *Chelonia mydas*, favours the mouth area and the fresh and less saline water plume formed by the river. This is the furthest south this species venture on the west coast of Africa (Branch 1998, Carr and Carr 1991). Thus far, no explanation has been offered as to why these reptiles congregate at the KRM.

Line fish surveys carried out in Namibia at the KRM have shown a decline of the Dusky Kob, *Argyrosomus coronus*, in both size and abundance as well as several other species (BCLME 2007).

7.4 Conclusion

Any development project at the KRM must consider the defined desired state for the area. A precise definition of this state requires a collaborative effort by all stakeholders. However such a definition needs to consider a number of key aspects. A development plan and management strategy for the KRM need to guide development activities in such a way that the aesthetic value and sense of place of the area are maintained. Further, all biophysical components must be maintained to function in as natural a way as possible, maintaining their present levels of ecological functioning.

Chapter 8: Proposed Adaptive Management Process for the KRM

The following steps are suggested for setting up and implementing management, development and monitoring plans for the KRM. The management must be adaptive as accurate knowledge of the area is scarce so management strategies and policies need to be implemented from which lessons are learned and changes implemented. While the following 7 steps are not an adaptive cycle *per se*, the annual management oversight, step 7, will identify where modification of the strategy is necessary. This will then lead into an adaptive cycle where experience gained motivates changes or stability in the processes (Figure 8.1).

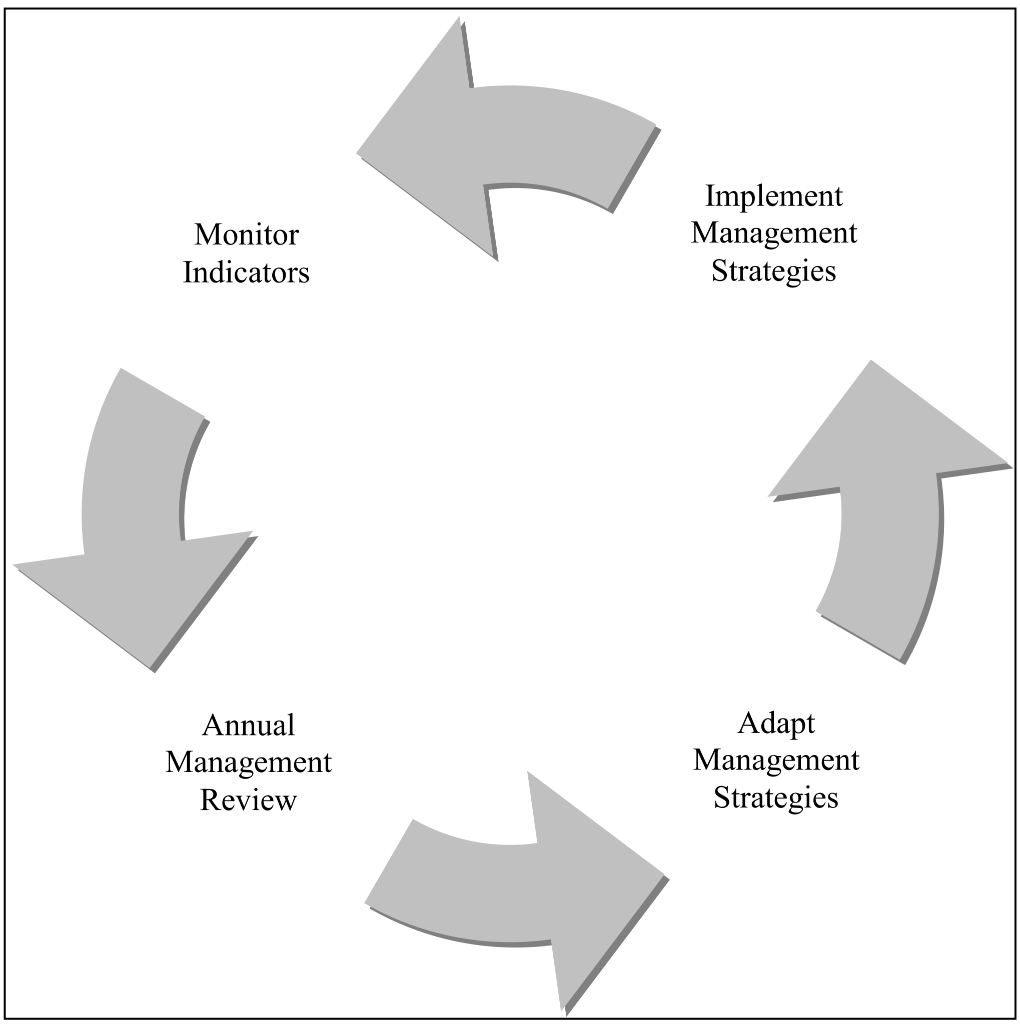


Figure 8.1 The adaptive management cycle suggested for the KRM

Step 1: Define the Desired State.

The Desired State are the goals and objectives for the area that are set and should be reached or maintained through active management and monitoring of the KRM.

This should be a collaborative process through a series of workshops with stakeholders.

- MET as the primary steward of area should define a preliminary Desired State.
- The preliminary Desired State is presented to the stakeholders.
- Consultative process to refine and agree on an acceptable Desired State.

Step 2: Identify Indicators and set Thresholds of Potential Concern and Limits of Acceptable Change

The consensus on a Desired State by stakeholders leads to a set of indicators to guide monitoring. TPCs and LAC provide the parameters for these indicators. Collaboration between key stakeholders, managers and scientists is necessary to identify Indicators, TPCs and LACs for biophysical, human and development aspects.

Step 3: Draft a Management Plan

The draft management plan must be acceptable to all stakeholders. The following process was developed for the Sperrgebiet Park to give stakeholders ownership of and involving them in the process (Ministry of Environment and Tourism 2007). This process has been suggested as a way forward for all coastal parks in Namibia (NACOMA 2007b).

Process

- First draft developed with input from area managers and key stakeholders.
- First draft reviewed by area managers and key stakeholders.
- Revised or unchanged (2^{nd}) draft is presented to all stakeholders.
- Third draft is discussed at MET head office level in a technical committee with key stakeholders.
- A fourth draft is reviewed by a senior MET management committee with the Permanent Secretary.

- Final revisions are made and the Permanent Secretary presents document to the minister for approval and ratification by parliament.

The management plan

To make the plan a useful working document it should fulfill certain criteria, some of which are suggested below.

- The plan should focus on priorities, be strategic and goal oriented in line with the desired state.
- There must be an annual management oversight to review achievements and shortcomings, draw up budgets and adapted annual work plans based on performance and goals.
- It is impossible to plan for all contingencies so the plan must be based on principles that are in effect mini policies for management of various aspects. Once the basic principles are set decisions made against them will be in line with policy.
- The plan must work in conjunction with relevant legislation and regulations with supporting relevant literature to the area. This would include policy documents as appendices on specific aspects of the area e.g. the policy on infrastructure or waste management.
- The plan should include guidelines for concise and standardized reporting specifying temporal frequency to facilitate performance appraisals.
- The plan must accommodate two levels of oversight; a strategic forum with key technical and management staff and a consultative forum for the wider body of stakeholders that can continue to give input during the annual management overview which might affect the Desired State.
- Apart from the annual adaptive review and management process there should be a five year cycle of review and redrafting as required.

Step 4: Draft a development plan

There is potentially a conflict of interests between environmental conservation and development, specifically at the KRM this could be between conservation, tourism and mining. Mining, particularly diamond mining is not compatible with either tourism or conservation at the KRM. On the other hand tourism can also impact negatively on conservation goals. The KRM is a sensitive area with a high place value and diverse and unique biodiversity. Indiscriminate and/or inappropriate development activities will have a negative impact on this value. The development plan must, therefore, take cognizance of the high place value and biodiversity of the area. This plan must follow the same process and produce a similar product as the management plan. This plan can either be integrated with the management plan or can be drafted in conjunction with it.

Step 5: Draft a monitoring plan

The management plan is based on setting and achieving defined goals. Thus a detailed and coordinated monitoring programme is required to check that management strategies are effective. A monitoring protocol to set ecological reserve for river flow has been developed in South Africa (Taljaard *et al.* 2003) which could be used to design a monitoring protocol for the river. Further protocols need to be designed for the terrestrial, marine and human components. Monitoring activities should concentrate on the defined indicators, TCPs and LACs.

- The objectives of monitoring should be clearly defined.
- A spatial and temporal scale of monitoring indicators must be designed by expert, technical and strategic staff of key stakeholders.
- A data storage and retrieval system should be designed to facilitate analysis and achievements.
- A standardised concise reporting format should be designed to facilitate feedback into the system, dissemination and analysis of data.

Step 6: Implementation of plans

Once all plans are agreed upon and have been finalized they must be implemented. Managers should follow the annual work plans and budgets to achieve objectives. There must be an ongoing, monthly reporting on activities against programmes.

Key points

- Operational staff must implement the provisions of the plans on the ground.
- Consultative process with stakeholders on a predetermined schedule.
- A standardised concise reporting format should be designed to facilitate feedback into the system, dissemination and analysis of data.

Step 7: Annual management review.

To achieve a truly adaptive and dynamic management regime regular annual review should be done that make provision for changes in all aspects of the management cycle. Adaptive management is based on the assumption that all the necessary information will never be available. Therefore the management strategy, once implemented, needs to be re-evaluated. This is achieved through monitoring the indicators to see if they remain within the predefined parameters. If these indicators signal a need for change, the management strategies have to be modified accordingly. The annual management oversight provides a forum where the data from monitoring and the reporting process are reviewed. This may require that the basic assumptions regarding the Desired State, the monitoring protocols, the indicators, TPCs and LACs need to be re-visited. The original goals and objectives may change through changes in stakeholder expectations and perceptions, societal pressure, national development projects, climate change and other unforeseen reasons.

In the first year all work plans, timetables and budgets are drawn up. At the end of the first cycle a review process takes place, the annual management oversight. Basic assumptions, management and monitoring strategies are reviewed and adapted as and where necessary. These changes are then reflected in the strategies, progammes and work plans for the next annual cycle.

The following key points need to be considered during the annual management oversight

- Review and analyse data and reports. Performance appraisal against objectives and assess success of management, development and monitoring strategies (Figure 8.2).
- Draft work plans, programmes and budgets for next period with adaptations as and where appropriate.
- Communicate and publish data, results and findings.

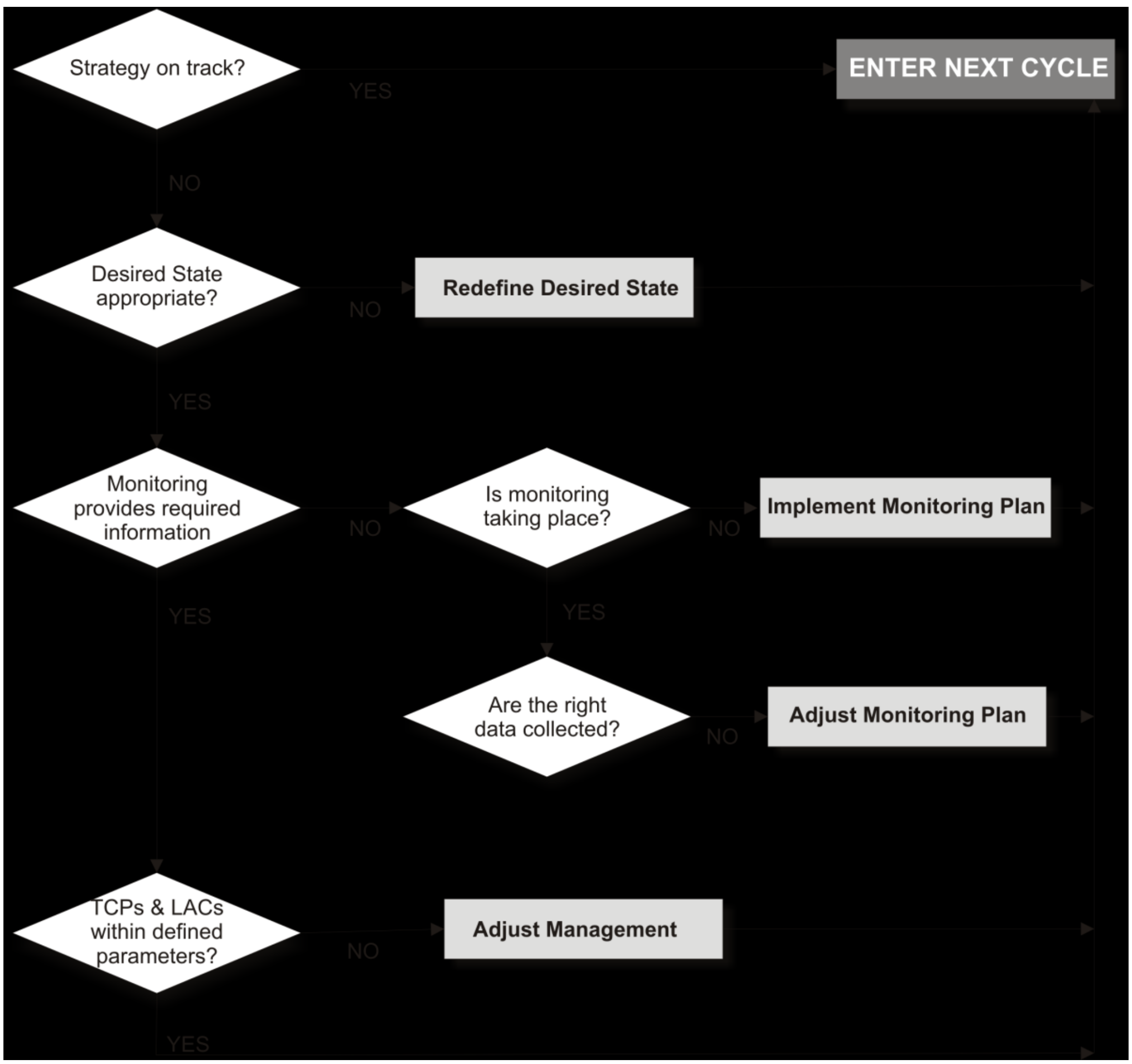


Figure 8.2 The review process to establish if management strategies are on track and where adaptive intervention is required

Step 8: Iteration of management process

After the annual management oversight and review the changes are incorporated into the process and implemented in the next cycle.

Chapter 9: Conclusion

The KRM has important biodiversity making it a bioregionally important site with high conservation value (Simmons *et al.* 1993, Morant and Carter 1996, de Moor *et al.* 2000, Snaddon and Davies 2003, Simmons *et al*. 2006a, Simmons *et al.* 2006b, BCLME 2007). Beside its importance as a biodiversity hotspot the KRM is a relatively unspoiled and natural environment with high aesthetic appeal. The biophysical environment and the aesthetic appeal of the KRM are vulnerable to threats from activities upriver in the catchment basin and also activities at the mouth itself (Simmons *et al.* 1993, de Moor *et al.* 2000, Snaddon and Davies 2003, Simmons *et al.* 2006a, Simmons *et al.* 2006b, BCLME 2007). As the KRM is situated in an arid environment any changes in the flow regime may cause biodiversity and habitat loss. The Orange River mouth is situated in a similarly arid environment. This is a Ramsar site that has been placed on the Montreux Record due to habitat destruction caused by upstream flow restrictions and local mining and development activities. An expensive management programme to maintain a functioning system had to be implemented to mitigate these impacts (CSIR 2001, van Niekerk and Huizinga 2004)

Currently there is no adequate environmental legislative framework in Namibia, without which, effective management of the area is unfeasible (Ministry of Environment and Tourism 1993, Cullinan *et al.* 2005). Eighteen stakeholders with eighteen different interests, both current and proposed, impose on the KRM (Chapter 5). These stakeholders are responsible for 15 activities that may directly affect 11 aspects of the biophysical environment and another 11 aspects of the aesthetic appeal of the KRM (Chapter 6). These threats have different degrees of probability and severity. In particular, there are two activities on either end of the scale that stand out, tourism and mining. Diamond mining and prospecting have significant impacts and pose the highest threat to both the biophysical environment and the aesthetic value of the KRM. On the other hand, tourism is an activity that, if properly developed, is an environmentally compatible activity, with low impact and minimal threat. However, there is currently no tourism development in the study area. Diamond mining and tourism are mutually exclusive (Government of the Republic of Namibia 1999). Thus, diamond mining is not only the most threatening development, but it may also foreclose other more appropriate development potentials for the area, such as ecotourism.

To counteract the degradation of the KRM through inappropriate activities a focused management regime is necessary. This study provides the necessary research base from which a management strategy may follow. In particular, a suite of conservation goals for consideration in developing a strategic adaptive management and development plan are proposed. The suggested framework could guide and facilitate the process of developing these plans.

Considering that the area is at present threatened by high impact development activities which are difficult to mitigate in the currently weak legislative framework, coherent, strategic and adaptive management and development plans are urgently needed.

The KRM cannot be considered in isolation. The area represents an integral component of the Kunene River catchment basin. The KRM forms the interface that links the river and the ocean systems. The fresh water, shelter and nutrients provided by the KRM create an important and crucial habitat for much of the biodiversity on the otherwise barren coastal strip. This contrast between the lushness of the river course and the harsh and arid surrounding landscape contributes to the areas natural beauty creating a high sense of place value. These factors contribute to the importance of the KRM and conservation management and development of the area must take cognizance of this.

While the KRM is an integral part of several different systems it is also a shared resource between Angola and Namibia, both countries thus sharing the responsibility for its conservation. The river influences the marine environment significantly to the north of the river mouth, which calls for a co-ordinated conservation effort (Simmons *et al.* 2006a, Simmons *et al.* 2006b, BCLME 2007). Land based activities at the KRM on either bank could affect planning and development potential on the other bank. Inappropriate developemnt on either side could compromise both the conservation and aesthetic value of the area. The governments of Angola and Namibia have signed a Memorandum of Understanding (MoU) towards consolidating Iona National Park in Angola and Skeleton Coast National Park in Namibia into a transfrontier park (van der Walt 2003). The conservation importance of Baia dos Tigres and Isla dos Tigres and the surrounding marine environment in Angola has been recognized and these areas should also receive formal conservation status (Simmons *et al.* 2006a, Simmons *et al.* 2006b, BCLME 2007) through a Transfrontier Marine Protected Area (TMPA). Although there are currently no Marine Protected Areas (MPA) in Namibia, the Ministry of Fisheries and Marine Resources is in the process of proclaiming the first MPA in the South of the country. This progress increases the likelihood that a TMPA offshore from the KRM may be considered in the near future. In the light of these considerations it appears that the need for an explicit and appropriate management strategy for the KRM cannot be stressed enough.

References

Adams, J. McGwynne L. 2004. Vol. II: E. A monitoring protocol for South African estuaries. In: Breen, C., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., Wood, A. Lamberth, S., Boyd, A. and Morant, P. (eds.). 2004. *Eastern Cape Estuaries Management Programme Vol I and II*. Water Research Commission Report 1246/1/04.

Allanson, B., Baird, D. and Heydorn, A. 1999. Chapter 13. Perspectives. In: Allanson, B. and Baird, D. (eds.). 1999. *Estuaries of South Africa.* Cambridge University Press, Cambridge. Pages 321–327.

Anderson, M. D., Anderson, S. L., Anderson, T. A., Bader, U., Heinrich, D., Hofmeyer, J., Kolberg, C., Kolberg, H., Komen, J., Paterson, B., Paterson, J., Sinclair, K., Sinclair, D., van Zyl, D. and van Zyl, H. 2001. Notes on the birds and other animals recorded at the Cunene River mouth from 6-8 January 2001. *Bird Numbers* 10 (1): 52-56.

Baird, D. 1999. Chapter 11. Estuaries as ecosystems: a functional and comparative analysis. In: Allanson, B. and Baird, D. (eds.). 1999. *Estuaries of South Africa.* Cambridge University Press, Cambridge. Pages 269–288.

Bancroft, J. A. 1955. Report on prospecting for diamonds on the Kaokoveld coast. In: Rabie, L. 1955. *Diamond Prospecting – Kaokoveld*. Ministry of Mines and Energy Geological Survey Namibia. Economic Geology Series open file report EG.

Barnard, P. (ed.). 1998. *Biological Diversity in Namibia: a Country Study.* Namibian National Biodiversity Task Force, Windhoek.

Barnard, P. and Curtis, B. 1998. Sites of special ecological importance. In: Barnard, P. (ed.) 1998. *Biological Diversity in Namibia: a Country Study.* Namibian National Biodiversity Task Force, Windhoek. Pages 74-75.

BCLME. 2007. *Benguela Current Large Marine Ecosystem Programme*. http://www. bclme. org/. Last visited October 2007.

Bean, M.J. and Wilcove, D.S. 1997. The private land problem. *Conservation Biology* 11: 1-2.

Bell, R. 1983 (a). Deciding what to do and how to do it: planning, selecting and implementing field management options. In Ferrar, A. A. (ed.). 1983. *Guidelines for the management of large mammals in African conservation areas.* South African national scientific programmes report No. 69. May 1983.

Bell, R. H. V. 1983 (b). Decision-making in wildlife management with reference to problems of overpopulation. In: Owen-Smith, N. R. (ed.). 1983. *Management of large mammals in African conservation areas.* Haum educational publishers. Pretoria.

Bender, K. Braby, R. And Korrubel, J. 1999. *Coastal Profile of the Erongo Region*. Ministry of Environment and Tourism internal report.

BENEFIT. 2007. *Benguela Environment Fisheries Interaction & Training Programme* http://www. bclme. org/. Last visited October 2007.

Bethune, S. 1998. Wetland habitats. In: Barnard, P. (ed.). 1998. *Biological diversity in Namibia: a country study.* Namibian National Biodiversity Task Force. Windhoek. Pages 60-66.

Biggs, H. C. and Rogers, K. H. 2003. An adaptive system to link science, monitoring, and management in practice., in du Toit, J. T., Rogers, K. H. and Biggs, H. C. (eds). 2003.

The Kruger Experience: Ecology & Management of Savanna Heterogeneity. Island Press, Washington, DC. Pages 59-80

Braine, S. 1990. Records of birds of the Cunene River estuary. *Lanioturdus* 25: 38 – 44.

Branch, B. 1998, *Field Guide to Snakes and Other Reptiles of Southern Africa.* Struik, Cape Town..

Breen, C. M. 1991. Are intermittently flooded wetlands of arid environments important conservation sites? *Madoqua* 17: 2. 62–65.

Breen, C. M. and McKenzie, M. (eds.). 2001. *Managing Estuaries in South Africa: An Introduction.* Institute of Natural Resources, Pietermaritzburg.

Breen, C. M., Harrison, T. and Quinn, N. 2001. Chapter 6. Assessing the State of an Estuary. In: Breen, C. M. and McKenzie, M. (eds.). 2001. *Managing Estuaries in South Africa: An Introduction.* Institute of Natural Resources, Pietermaritzburg.

Breen, C., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., Wood, A. Lamberth, S., Boyd, A. and Morant, P. (eds.). 2004. *Eastern Cape Estuaries Management Programme Vol I and II*. Water Research Commission Report 1246/1/04.

Burgman, M. 2005. *Risks and Decisions for Conservation and Environmental Management*. Cambridge Univesity Press.

Burke, A. 1998. Vegetation zones. In: Barnard, P. (ed.). 1998. *Biological Diversity in Namibia: a Country Study.* Namibian National Biodiversity Task Force. Windhoek. page 26.

Byrd, D. M. and Cothern, C. R. 2000. *Introduction to Risk Analysis: a Systematic Approach to Science-based Decision Making*. Government Institutions. Rockville, Maryland. 433 pages.

Carlson, A. 2002. Environmental aesthetics. In Craig, E. (ed.), *Routledge Encyclopedia of Philosophy*. Routledge. London. Available at: http://www.rep.routledge.com/article/M047SECT1. Last visited November 2005.

Carr, T. and Carr, N. 1991. Surveys of the Sea Turtles of Angola. *Biological Conservation* 58: 19-29.

Carter, R. A. 1996. Chapter 3. Physical and Chemical Characteristics. *In*: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Carter, R. and Bickerton, I. B. 1996. Chapter 5. Aquatic Fauna. In: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Christiansen, N. L. 1997 Managining for Heterogeneity and Complexity in Dynamic Landscapes. In: Pickett, S.T.A., Ostfeld, R.S., Shachak, M. and Likens, G.E. (Editors) *Enhancing the Ecological Basis of Conservation: Heterogeneity, Ecosystem Function and Biodiversity.* Chapman and Hall, New York. Pages 67-186.

Coetzee, J. C., Adams, J. B. and Bate, G. C. 1997. *A botanical importance rating of selected Cape estuaries.* Water SA 23 (1) 81-93.

Cole, D. N. and McCool, S. F. 1998a. Limits of acceptable change and natural resource planning: when is LAC useful, when is it not? In: McCool, S. F., Cole, D. (comps.). 1998. *Proceedings—Limits of Acceptable Change and related planning processes: progress and future directions*; 1997 May 20–22, Missoula, MT. Gen. Tech.

Costanza, R. 1992. Cited in : Rogers, K. H., and R. Bestbier. 1997. *Development of a Protocol for the Definition of a Desired State of Riverine Systems in South Africa*. Department of Environmental Affairs and Tourism, Pretoria, South Africa.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P. and van den Belt, M. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.

Cramp, S. and Simmons, K. E. L. (eds.). 1982). *The Birds of the Western Palearctic*. Vol 111. Oxford University Press.

CSIR .1992. Cited in: Morant, P. D. and Quinn, N. W. 1999. Chapter 12. Influence of Man and Management on South African Estuaries. In: Allanson, B. and Baird, D. 1999 (eds.) *Estuaries of South Africa.* Cambridge University Press, Cambridge. Pages 289-320.

CSIR 2001. Orange River mouth. Conservation and Development Plan: Intuitional Support Study. *CSIR Contract report ENV-S-C 2001-075.*

Cullinan, C., Munkejord, S. and Currie, H. 2005 *Institutional study regarding the establishment of a regional organization to promote integrated management and sustainable use of the BCLME.* The United Nations office for Projects Services (UNOPS) and the BCLME Programme.

Day, J. H. 1981.The Nature, Origin and Classification of Estuaries. In: Day, J.H. (ed.). 1981. *Estuarine Ecology with Particular Reference to Southern Africa.* A. A. Balkema, Cape Town. 411 pages.

Dean, W. R. J. 2000. *The Birds of Angola an Annotated Checklist.* British Ornithologists' Union. 431 pages.

de Moor, F. C., Barber-James, H. M., Harrison, A. D. and Lugo-Ortiz, C. R. 2000. The macroinvertebrates of the Cunene River from the Ruacana Falls to the river mouth and assessment of the conservation status of the river. *African Journal of Aquatic Sciences* 25: 105-122.

Dentlinger, L. 2005. Namibia, Angola eye reviving Kunene hydropower plans. *The Namibian.* Wednesday, August 17.

Department of Water Affairs. 2007. Unpublished Kunene River flow data at Ruacana. Mininitry of Agriculture, Water and Rural Development. Department of Water Affairs.

Dickens, C., Kotze, D., Mashigo, S., Mackay, H. and Graham, M. 2003. *Guidelines for Integrating the Protection, Conservation and Management of Wetlands into Catchment Management Planning.* WRC Report No. TT 220/03. Water Reseach Commission Pretoria.

Eckbo, G. 1975. Qualitative Values in the Landscape. In: Zube, E. H., Brush, R. O. and Fabos, J. G. (eds.). 1975. *Landscape Assessment: Values, Perceptions, and Resources.* Dowden, Hutchinson and Ross, Inc. Stroudsburg, Pennsylvania. 367 pages.

Food and Agricultural Organisation. 2003. Fisheries management. 2. The ecosystem approach to fisheries. Food and Agricultural Organisation of the United Nations, Technical Guidelines for Responsible Fisheries No. 4, Rome, Italy.

Fretey, J.2001. *Biogeography and conservation of marine turtles of the Atlantic coast of Africa / Biogéografie et conservation des tortues marines de la côte Atlantique de L'Afrique.* CMS Technical Series Publication No. 6, UNEP/CMS Secretariat, Bonn, Germany. 429 pages.

Geiss, W. 1971. A preliminary vegetation map of South West Africa. *Dinteria.* 4: 5-114.

Government of the Republic of Namibia. 1990. *The Constitution of the Republic of Namibia.* Government of the Republic of Namibia.

Government of the Republic of Namibia. 1992. *Minerals (Prospecting and Mining) Act, 1992 (Act 33 of 1992)*. Government of the Republic of Namibia.

Government of the Republic of Namibia 1999. *Diamond Act, 1999 (Act 13 of 1999).* Government of the Republic of Namibia.

Government of the Republic of Namibia. 2000. *Marine Resource Act, 2000 (Act 27 of 2000).* Government of the Republic of Namibia.

Government of the Republic of Namibia. 2001. *Regulations relating to the Exploitation of Marine Resources.* Government of the Republic of Namibia.

Government of the Republic of Namibia. 2002. *Aquaculture Act, 2002 (Act 18 of 2002)*. Government of the Republic of Namibia.

Government of the Republic of Namibia. 2004. *Water Resources Management Act, 2004 (Act 24 of 2004)*. Government of the Republic of Namibia.

Greenwood, B. 1999. The Cunene/Kunene river delta complex:sediment sources and dynamics.In: Smith, N. D. and Rogers, J. (Eds). 1999. *Fluvial Sedimentology VI Special Publication of the International Association of Sedimentologists, No. 28.* Blackwell Science.

Griffin, M. 1994 Report on the Reptiles of the Kunene Mouth. In: Tyldesley, P. (Comp) *Report on an Integrated Scientific Data Collecting Expedition to the Mouth of the Kunene River 19/04/94 – 23/04/94.* NNF report.

Griffin, M. 2002. Annotated Checklist and Provisional Conservation Status of Namibian Reptiles. Technical Reports of Scientific Services No 1, Ministry of Environment and Tourism, Windhoek 168 pages.

Griffin, M. and Channing, A. 1991. Wetland-associated reptiles and amphibians of Namibia – a national review. *Madoqua* 17: 221-225.

Harding, E.K., Crone, E.E., Elderd, B.D., Koekstra, J.M., McKerrow, A.J., Perrine, J.D., Regetz, J., Rissler, L.J., Stanley, A.G., Walters, E.L., NCEAS Habiata Conservation Working Group. 2001. The scientific foundation of habitat conservation plans: a quantitive assessment. *Conservation Biology* 15: 488-500.

Harrison, C.M.,Burgess, J. and Clark, J. 1998. Discounted knowledges: farmers' and residents' understandings of nature conservation goals and policies. *Journal of Environmental Management* 54: 305–320.

Harrison, J. A., Allan, D. G., Underhill, L. G., Herremens, M., Tree, A. J., Parker, V. and Brown, C. J. (eds.), 1997. *The Atlas of Southern African Birds.* BirdLife South Africa, Johannesburg.

Harrison, T. D., Cooper, J. A. G. and Ramm, A. E. L. 2000. *State of South African Estuaries: Geomorphology, Ichthyofauna, Water Quality and Aesthetics.* State of the Environment Series Report No: 2. Department of Environmental Affairs and Tourism. Pretoria.

Hay, C. J., Van Zyl, B. J., van der Bank, F. H., Ferreira, J. T. and G. J. Steyn. 1997. A survey of the fishes of the Cunene River, Namibia. *Madoqua* 19 (2): 129-141.

Hay, D. and Mackenzie, M. (Comps.) 2005. *Managing Estuaries in South Africa: a Step by Step Guide.* WRC Report No. TT 243/04. Water Reseach Commission Pretoria.

Heydorn, A. E. F. 1989. Chapter 18: The Conservation status of Southern African estuaries. In: Huntley, B. J. (ed.) *Biotic Diversity in Southern Africa: Concepts and Conservation.* Oxford University Press. Cape Town. 380 pages.

Holtzhausen, H. 2003. *Fish of the Kunene River mouth*. BCLME Orange-Kunene estuaries workshop. 21-23 October 2003, Swakopmund, Namibia.

Holling, C. S. 1978 (ed.). *Adaptive Environmental Assessment and Management.* John Wiley and Sons. Chichester.

Holling, C. S. and Meffe, G. K. 1996. Command and control and the pathology of natural resource management. *Conservation Biology*. 10(2): 328-337.

Huizinga, P. 1996. Chapter 1. Physical Dynamics of the Kunene River Mouth. *In*: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Irish, J. 1994. Biomes of Namibia, as determined by objective categorization. *Navorsing van die Nasionale Museum, Bloemfontein* 10 (13): 550-592.

Kaltenborn, B. P. and Williams, D. R. 2002. The meaning of place: attachments to Femundsmarka national park, Norway, among tourists and locals. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography.* 56: 189-198.

Kensley, B. 1981. Cited in: Carter, R. and Bickerton, I. B. 1996. Chapter 5. Aquatic Fauna. *In*: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Kolberg, H. and Simmons, R. E. 1998. Wetlands . In: Barnard, P. (ed.). 1998. *Biological Diversity in Namibia: a Country Study.* Namibian National Biodiversity Task Force. Windhoek. Pages 47-48.

Kolberg, H. and Killian, W. 2003. *Report on an Aerial Survey of Iona National Park, Angola, 6 to 14 June 2003.* Directorate of Scientific Services, Ministry of Environment and Tourism Report No. 7.

Lackey, R. T. 2001 Values, Policy, and Ecosystem Health. *Bioscience* 51: 437-443

Laurie, I. C. 1975. Aesthetic Factors in Visual Evaluation. In: Zube, E. H., Brush, R. O. and Fabos, J. G. 1975 (eds.). *Landscape Assessment: Values, Perceptions, and Resources.* Dowden, Hutchinson and Ross, Inc. Stroudsburg, Pennsylvania. 367 pages.

Leatherwood, S. and Reeves, R. R. 1983.The *Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books. San Fransisco. 302 pages.

Lee, K. N. 1993. *Compass and Gyroscope: Integrating Science and Politics for the Environment.* Island Press Washington D. C. Pp 238.

Lee, K. N. 1999. Appraising adaptive management. *Conservation Ecology* 3 (2): 3. http://www.consecol.org/vol3/iss2/art3/. Last visited October 2005

Leopold, A. 1970. *A Sand County Almanac with Essays on Conservation from Round River.* Ballantine Books, New York.

Marais, E. 1994. Report on the Insect Fauna of the Kunene Mouth. In: Tyldesley, P. (Comp) *Report on an Integrated Scientific Data Collecting Expedition to the Mouth of the Kunene River 19/04/94 – 23/04/94.* NNF report.

Matouch, S., Forster, J., Jones, P. S., Mitchell, R., Rebane, M., Rose, P., Scheidegger, C., Soier, D. and Stoll-Kleeman, S. 2005. *Anoch Mor: Uplands Thematic Working Group*

Report. The Uplands Thematic Working Group. http://www.nbu.ac.uk/bioforum/ uplands%20thematic%working%20group%20report.pdf. Last visited October 2007.

McCool, S. F. 1996. *Limits of acceptable change: a framework for managing national protected areas: experiences from the United States.* Paper presented at the Workshop on Impact Management in Marine Protected Areas. Kuala Lampur, Malaysia 13-14 August 1996.

McKenzie, M. 2001. Chapter 7. Policy and Law. In: Breen, C. M. and McKenzie, M. (eds.). 2001. *Managing Estuaries in South Africa: An Introduction.* Institute of Natural Resources, Pietermaritzburg.

Mautner, T. 2000. *The Penguin Dictionary of Philosophy.* Penguin Books. London.

Meppem, T. 2000. The discursive community: evolving institutional structures for planning sustainability. *Ecological Economics* 34: 47–61.

Meppem, T., Bourke, S. 1999. Different ways of knowing: a communicative turn toward sustainability. *Ecological Economics* 30: 389–404.

Midgely, D. C. 1966. Cunene *River Hydrological Studies*. Report, South West Africa Administration, Department of Water Affairs.

Ministry of Environment and Tourism. 1993. *The Management Plan for the Skeleton Coast National Park.* Unpublished report file No. N 11/2/1/11. Ministry of Environment and Tourism Windhoek.

Ministry of Environment and Tourism. 1999. *Policy for Prospecting and Mining in Protected Areas & National Monuments.* Ministry of Environment and Tourism, Directorate of Environmental Affairs Windhoek.

Ministry of Fisheries and Marine Resources. 2001a. *Policy Towards the Responsible Development of Aquaculture.* Government of the Republic of Namibia.

Ministry of Fisheries and Marine Resources. 2001b. *Namibia's Aquaculture Strategic Action Plan.* Government of the Republic of Namibia.

Ministry of Environment and Tourism 2007 *Draft management Plan for the Sperrgebiet.* Government of the Republic of Namibia.

Ministry of Works Transport and Communication. 2006. *A Pre-feasability Study of a Future Port Facility in Namibia in the Vicinity of Cape Fria – Angra Fria.* Government of the Republic of Namibia. Unpublished report.

Misund, O.A., Skjoldal, H.R. 2005. Implementing the ecosystem approach: experiences from the North Sea, ICES, and the Institute of Marine Research, Norway. *Marine Ecology Progress Series* 300: 241–296.

Molloy, F. and Reinikainen, T. 2003. Introduction. In: Molloy, F. and Reinikainen, T. (eds.) 2003. *Namibia's Marine Environment.* Directorate of Environmental Affairs of the Ministry of Environment and Tourism, Namibia. Windhoek. 162 pages.

Morant, P. D. (ed.) 1996a. Environmental Study of the Kunene River Mouth. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Morant, P. D. 1996b. Chapter 1 Introduction. In: Morant, P. D. 1996 (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Morant, P. D. 1996c. Chapter 6 Avifauna of the Kunene River Mouth. In: Morant, P. D. 1996 (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Morant, P. D. and Carter 1996. Chapter 7. Discussion and Conclusions. In: Morant, P. D. 1996 (ed.). *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Morant, P. D. and Quinn, N. W. 1999. Chapter 12. Influence of Man and Management on South African Estuaries. In: Allanson, B. and Baird, D. 1999 (eds.). *Estuaries of South Africa.* Cambridge University Press, Cambridge. Page 289-320.

Muller, M. 1994. Report on the flora of the Kunene mouth: a Contribution to the Flora of the Northern Namib. In: Tyldesley, P. (Comp) *Report on an Integrated Scientific Data Collecting Expedition to the Mouth of the Kunene River 19/04/94 – 23/04/94.* NNF report.

Murphree, M.W. 2003. Devolving power: what, to whom and how? In: Preliminary proceedings of the fifth World Parks Conference, September 2003, Durban, South Africa. http://www.iucn.org/themes/wcpa/wpc2003/english/proceedings.htm. Last visited July 2005.

NACOMA 2007a. Namibian *Coastal Zone Management Project.* http://www.met.gov.na/programmes/nacoma/nacoma.htm. Last visited October 2007.

NACOMA 2007b. Improving conservation management effectiveness for the coastal parks workshop 18 June 2007. NACOMA.

Naiman, R. J. 1998. Chapter 5. Biotic Stream Classification. In: Naiman, R. J. and Bilby, R. E. 1998 (eds.). *River Ecology and Management: Lessons from the Pacific Coastal Region.* Springer. New York. 705 pages.

NAMANG. 1997. *Lower Cunene hydropower scheme feasibility study. Final feasibility report. Technical feasibility and environmental assessment Epupa and Baynes projects* *for decision making*. The Permanent Joint Technical Commission of Angola and Namibia on the Cunene River Basin.

National Planning Commission Namibia. 2002. *Namibia vision 2030*. http://www.npc.gov.na/. Last visited August 2004.

Namibia Nature Foundation. 1994. *Report on an Integrated Scientific Data Collecting Expedition to the Mouth of the Kunene River 19/04/94 – 23/04/94*. NNF report.

South West Africa Administration. Nature Conservation Ordinanace, 1975 (Ord. 4 of 1975). Legislative Assembly for the Territory of South West Africa.

Nel, J., Maree, G., Roux, D., Moolman, J., Kleynhans, N., Silberbauer, M. & Driver, A. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 2: River Component.* CSIR Report Number ENV-S-I-2004-063. Stellenbosch: Council for Scientific and Industrial Research. Available at URL: www.sanbi.org.

NIGC 2005. http://www.nigc.org/eia/angola.asp. Last visited October 2007

Norton, B. G. and Steinemann, A. C. 2001. Environmental Values and Adaptive Management. *Environmental Values* 10: 473–506

Paterson, B. 2004. Hypermedia as a knowledge management tool in wildlife management. *Game and Wildlife Science*. 21: 757-765

Paterson, J., Boorman, M., Glendinning, J., Komen, L., Komen, T. and Paterson, B. In prep. Vagrants, range extensions and interesting bird records for Skeleton Coast Park Namibia and southern Angola.

Penrith, M. 1982. Cited in: Van Zyl, B. J. 1991. *Wetlands of the Cunene River.* Madoqua. 17 (2): 125-128.

Portman, J. E. and Wood, P. C. 1985. The UK National Estuarine Classification System and its Application. In Wilson, J. G. & Halcrow, W. (eds) *Estuarine Management and Quality Assessment*. New York, Plenum Press, pages 173-186.

Prah, S. K. 1982. Cited in: Carter, R. and Bickerton, I. B. 1996. Chapter 5. Aquatic Fauna. *In*: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Raal, P. A. and Guerra Marques, A. L. 1996. Chapter 4. Wetland Vegetation of the Lowermost Reaches of the Kunene River. *In*: Morant, P. D. 1996 (ed.). *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Ramsar. 1987. Convention on wetlands of international importance especially as waterfowl habitat. The Ramsar Convention on Wetlands. http://www.ramsar.org/ key_conv_e.htm. Last visited October 2007.

Reimold, R. J. 1994. Chapter 4. Wetlands Functions and Values. In: Kent, D. M. (ed.) 1994. *Applied Wetlands Science and Technology.* Lewis Publishers. Boca Raton. Florida. 436 pages

Reimold, R. J., Phillips, J. H. and Hardisky, M. A. 1980. Socio-cultural Values of Wetlands. In: Kennedy, V. S. (ed.). 1980. *Estuarine Perspectives.* Academic Press. New York. 533 pages.

Reitz, D. 1943. *No Outspan*. Faber and Faber. London. 288 Pages.

Republic of south Africa. 1998. *National water act: act no. 36 of 1998.* Pretoria, South Africa

Roe, D., Mayers, J., Grieg-Gran, M., Kothari, A., Fabricius, C., Hughes, R. 2000. *Evaluating eden: Exploring the myths and realities of community-based wildlife management: Series overview.* Evaluating Eden series no 8. A publication of the Biodiversity and Livelihoods Group (BLG). http://www.iied.org/blg/pubs/eden.html. Last visited July 2005.

Rogers, K. 1998. Managing science/management partnerships: a challenge of adaptive management. *Conservation Ecology* 2 (2): 1. http://www.consecol.org/vol2/iss2/resp1/. Last visited October 2005.

Rogers, K. H. and R. Bestbier. 1997. *Development of a Protocol for the Definition of a Desired State of Riverine Systems in South Africa*. Department of Environmental Affairs and Tourism. Pretoria South Africa.

Rogers, K. and Biggs, H. 1999. *Integrating indicators, endpoints and value systems in strategic management of the rivers of the Kruger National Park.* Freshwater Biology 41: 439-451.

Ryan, P. G., Cooper, J. and Stutterheim, C. J. 1984. Waders (Charadrii) and other coastal birds of the Skeleton Coast, South West Africa. *Madoqua* 14: 71-78.

Sack, R. D. 1980. *Conceptions of Space in Social Thought: a Geographic Perspective.* Macmillan. London.

Salefsky, N. Margoulis,R. and Redford, K. 2001. *Adaptive management a tool for conservation practitioners.* Biodiversity Support Programme, Washington DC.

Schneider, G. I. C. and Miller, R. McG. 1992. *Diamonds*. Ministry of Mines and Energy Geological Survey Namibia. Economic Geology Series open file report.

Shigwedha, A. 2005. World Bank sponsors coastal conservation. *The Namibian,* Tuesday, October 18, 2005.

Shillington, F. 2003. Oceanography. In: Molloy, F. and Reinikainen, T. (eds.). 2003. *Namibia's Marine Environment.* Directorate of Environmental Affairs of the Ministry of Environment and Tourism, Namibia. Windhoek. 162 pages.

Simmons, R. E., Braby, R. and Braby, S. J. 1993. Ecological studies of the Kunene River mouth: avifauna, herpetofauna, water quality, flow rates, geomorphology and implications of the Epupa Dam. *Madoqua* 18 (2): 163-180

Skeleton Coast Park Rainfall Data. Unpublished. Skeleton Coast Park Electronic Database. Möwe Bay, Skeleton Coast Park.

Skeleton Coast Park Species List. Unpublished. Skeleton Coast Park Electronic Database. Moewe Bay, Skeleton Coast Park.

Simmons, R. E., Boix-Hinzen, C., Barnes, K. N., Jarvis, A. M. and Robertson, A. 2001. Namibia. In: Fishpool L., D., C. and Evans, M (eds.). *Important Bird Areas of Africa and its Islands*. Birdlife International, Cambridge, UK.

Simmons, R. E., Sakko, A., Paterson, J. and Nzuzi, A. 2006a. Birds and Conservation Significance of the Namib Desert's least known coastal wetlands: Baia and Ilha dos Tigres, Angola. *African journal of marine science*. 28. (3 & 4): 713-717.

Simmons, R. E., Crawford, R. J., Russo, V., Morant, P., Neto, D. S. and Boyd, A. 2006b. *Conservation aspects of the Cunene River mouth, Baia dos Tigres and Iona National Park.* Unpublished BCLME Workshop Report, April 2006.

Snaddon, K. and Davies, B. 2003. Cunene River, Namibia – Epupa Dam and reservoir options a review of the aquatic ecological aspects of the draft feasibility report.

International Rivers Network. http://www.irn.org/programs/safrica/epupareview/aquaeco.html. Last accessed October 2007.

Stankey, G. H. and McCool, S 1990. Chapter 9 Managing for appropriate wilderness conditions: the carrying capacity issue. In: Hendee, J. C., Stankey, G. H. and Lucas, R. C. 1990. *Wilderness management*. North American Press, Golden Colorado. Pages 215-239.

Taljaard, S., van Niekerk, L., Huizinga, P. and Joubert, W. (Comps.). 2003. Resource Monitoring Procedures for Estuaries for Application in the Ecological Reserve Determination and Implementation Process. CSIR Enviromentech Report CSIR ENV-S-C 2003-059. CSIR Stellenbosch.

Tuan Y-F. 1974. *Topophilia: a Study of Environmental Perception, Attitude and Values.* Prentice Hall Inc. New Jersey.

Turpie, J. K. 1995. Prioritizing South African estuaries for conservation: a practical example using waterbirds. *Biological Conservation* 74: 175-185.

Turpie, J. K. 2004. Vol. II: D. Current status of estuaries, their protection and threats to their biodiversity, proposed goals for conservation and guidelines for a strategy for the protection of estuarine biodiversity. In: Breen, C., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., Wood, A. Lamberth, S., Boyd, A. and Morant, P. (eds.) 2004. *Eastern Cape Estuaries Management Programme Vol I and II*. Water Research Commission Report 1246/1/04.

Turpie, J.K. 2005. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 3: Estuary Component.* Pretoria: South African National Biodiversity Institute.

Turpie, J. K., Adams, J. B., Joubert, A., Harrison, T. D., Colloty, B. M., Maree, R. C., Whitfield, A. K., Wooldridge, T. H., Lamberth, S. J,. Taljaard, S. and. van Niekerk, L. 2002. Assessment of the conservation priority status of South African estuaries for use in management and water allocation. *Water SA* 28 (2): 191-206.

United Nations Environmental Programme. 1992. Convention for Biological Diversity. United Nations General Assembly. New York.

van der Walt, P. 2003. *Ai-Ais/Richtersveld Transfrontier Park*. Peace Parks Foundation. http:/www.peaceparks.org/news.php?pid=72&mid=389. Last visited October 2007.

van der Linde, H., Oglethorpe, J., Sandwith, T., Snelson, D. and Tessema Y. (with contributions from Anada Tiéga and Thomas Price). 2001. *Beyond Boundaries: Transboundary Natural Resource Management in Sub-Saharan Africa.* Washington, D.C., U.S.A.: Biodiversity Support Program.

van Niekerk, L. And Huizinga, P. 2004. *Guidelines for the Mouth Management of the Orange River Estuary.* CSIR Enviromentek. Stellenbosch.

van Zyl, B. J. 1991. Wetlands of the Cunene River. *Madoqua* 17 (2): 125-128.

Venema, B., van den Breemer, H. 1999. Natural Resource Management in Africa: Approaches, Constraints and Opportunities. In: *Towards Negotiated Co-management of Natural Resources in Africa.* Venema, B. and van den Breemer, H. (eds.). 1999. Lit Verlag, Muenster, Hamburg, London. Pages 1-16.

Vierros, M., Douvere, F. and Arico, S. 2006. *Implementing the Ecosystem Approach in Open Ocean and Deep Sea Environments an Analysis of Stakeholders, their Interests and Existing Approaches.* United Nations Univesity, Institute of Advanced Studies. 39 Pages.

Walters, C. 1986. Cited in: Lee 1999. Appraising adaptive management. *Conservation Ecology* 3 (2): 3. http://www.consecol.org/vol3/iss2/art3/. Lastr visited October 2005

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology* 1 (2): 1. http://www.consecol.org/vol1/iss2/art1/. Last visited October 2005.

Warren, G. A. 1998. Recreation Management in the Bob Marshall, Great Bear, and Scapegoat Wildernesses, 1987 to 1997. In: McCool, S. F., Cole, D. (comps.). 1998. *Proceedings—Limits of Acceptable Change and related planning processes: progress and future directions*; 1997 May 20–22; Missoula, MT. Gen. Tech.

Whisman, S. A. 1998. *Limits of Acceptable Change River Management Plan. 1998 Annual Report. A Summary of LAC Indicators for Commercial Rafting Use.* The West Virginia Division of Natural Resources.

Whitfield, A. K. 1992. A characterization of Southern African estuarine systems. *Southern African Journal of Aquatic Science* 18 (1 & 2): 89-103.

Whitfield, A. K. 1998. *Biology and Ecology of Fishes in Southern African Estuaries.* J. L. B. Smith Institute of Icthyology, Grahamstown, South Africa.

Whitfield, A.K. 2001. Chapter 3. Structure and Functioning. In: Breen, C. M. and McKenzie, M. (eds.). 2001. *Managing Estuaries in South Africa: An Introduction.* Institute of Natural Resources, Pietermaritzburg. Pages 10-19.

Willführnast, J., Rosenthal, H., Udo, P. J. And Nast, F. 1993. Cited in: Carter, R. A. 1996. Chapter 3. Physical and chemical characteristics. *In*: Morant, P. D. (ed.) *Environmental Study of the Kunene River Mouth*. CSIR Report EMAS-C96023. CSIR Stellenbosch.

Williams, D. R. and Stewart, S. I. 1998. Sense of place an elusive concept that is finding a home in ecosystem management. *Journal of Forestry* 96 (5): 18-23.

Wood, A., Cowley, P. and Paterson, A. 2004. A Classification System for Eastern Cape Estuaries, with Management Guidelines for the Sustainable use of their Living esources. In: Breen, C., Adams, J., Batchelor, A., Cowley, P., Marneweck, G., McGwynne, L., McKenzie, M., Ngulube, P., Paterson, A., Sihlophe, N., Taljaard, S., Turpie, J., Uys, A., van Niekerk, L., Wood, A. Lamberth, S., Boyd, A. and Morant, P. (eds.). 2004. *Eastern Cape Estuaries Management Programme Vol I and II*. Water Research Commission Report 1246/1/04.

Yung, L., Freimund, W. A. and Belsky, J. M. 2003. *The Politics of Place: Understanding Meaning, Common Ground, and Political Difference on the Rocky Mountain Front.* Forest Science 49. 6: 855-866

Personal Communications

Afonso, E. Nature Conservator, Iona National Park, Angola. BCLME survey at the Kunene River mouth. October 2004.

Griffin, M. Senior Scientist, MET, Namibia. Informal discussions regarding Kunene River in Windhoek. April 2005.

Holtzhausen, H. Senior Scientist, Ministry of Fisheries and Marine Resources. Informal discussion Swakopomund. July 2006.

Nujoma, S. January 2004. President of Namibia. Speech delivered at Angra Fria to inaugurate the Cape Fria harbour project. January 2004.

Tjongarero, S. 2004. Governor Kunene Region 1990-2004. Coastal Zone Management meeting at Terrace Bay. January 2004

Murorua, D. Governor Kunene Region. NACOMA Workshop in Khorixas. February 2007.

Lamberth, S. Senior Scientist, Marine and Coastal Management, South Africa. Informal discussions on Kunene October 2004 survey in Cape Town. December 2006.

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

	Bird species per group	Scientific Name	Ryan *et al.* 1984 November & December 1981	Braine 1990 1982 to 1988	Simmons *et al*. 1993 March & May 1991	Simmons *et al*. 1993 November 1991	SCP unpublished February 1999	SCP unpublished August 2000	Anderson *et al.* 2001 January 2001	SCP unpublished January 2002	SCP unpublished February 2004	Paterson *in prep.* October 2004	Paterson *et al.* 2007 submitted February 2006
	Resident Waders												
1	African Black Oystercatcher	*Haematopus moquini*			1								
2	Whitefronted Plover	*Charadrius marginatus*	60	160	94	150	1		48	15	4	6	23
3	Chestnutbanded Plover	*Charadrius pallidus*	79	40	43	112			9			20	
4	Kittlitz's Plover	*Charadrius pecuarius*	7	6	1		4					2	2
5	Threebanded Plover	*Charadrius tricollaris*	5	30	4	1	4		4				1
6	Avocet	*Recurvirostra avosetta*	2	60	4		3					2	
7	Blackwinged Stilt	*Himantopus himantopus*			1								
8	Blacksmith Lapwing	*Vanellus armatus*	1	2	1								
	Palearctic Waders												
9	Turnstone	*Arenaria interpres*	3	60	60	1			1			1	
10	Ringed Plover	*Charadrius hiaticula*	49	3	70	99	10		70	6		24	18
11	Mongolian Plover	*Charadrius mongolus*		1	1								
12	Greater Sand Plover	*Charadrius leschenaultii*											2
13	Grey Plover	*Pluvialis squatarola*	9	40	5	3							
14	Curlew Sandpiper	*Calidris ferruginea*	158	600	37	1798	390		20	48		5	22
15	Baird's Sandpiper	*Calidris bairdii*							2				
16	Little Stint	*Calidris minuta*	463	300	1577	1708	149		889	266		300	500
17	Knot	*Calidris canutus*	1	60	14	3						15	
18	Sanderling	*Calidris alba*	107	800	196	150	504		244	182	1000	250	59
19	Ruff	*Philomachus pugnax*	27	80	2	2							
20	Terek Sandpiper	*Xenus cinereus*	1										
21	Common Sandpiper	*Actitis hypoleucos*	11	10	4	3	1		6			1	1
22	Common Redshank	*Tringa totanus*											1

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

			Ryan *et al.* 1984	Braine 1990	Simmons *et al*. 1993	Simmons *et al*. 1993	SCP unpublished	SCP unpublished	Anderson *et al.* 2001	SCP unpublished	SCP unpublished	Paterson *in prep.*	Paterson *et al.* 2007 submitted
	Bird species per group	**Scientific Name**	November & December 1981	1982 to 1988	March & May 1991	November 1991	February 1999	August 2000	January 2001	January 2002	February 2004	October 2004	February 2006
	Palearctic Waders												
23	Marsh Sandpiper	*Tringa stagnatilis*		4	1								
24	Wood Sandpiper	*Tringa glareola*							2				
25	Greenshank	*Tringa nebularia*	14	80	1	106	1		8	5	1	1	
26	Bartailed Godwit	*Limosa lapponica*		40	2	2						1	1
27	Curlew	*Numenius arquata*		1	2								
28	Whimbrel	*Numenius phaeopus*	1	3		1							
29	Painted Snipe	*Rostratula benghalensis*		10									
30	European Oystercatcher	*Haematopus ostralegus*			1								
	Sea Birds												
31	Cape Gannet	*Morus capensis*		3	14	3000						20	
32	White-breasted Cormorant	*Phalacrocorax carbo*	149	150	142	42	267	163	240	81	20	12	
33	Cape Cormorant	*Phalacrocorax capensis*	225	300	680	18	22		46	42	140	2	70
34	Crowned Cormorant	*Phalacrocorax coronatus*											16
35	Kelp Gull	*Larus dominicanus*	42		339	61	94	57	21	3	54	300	178
36	Lesser Black-backed Gull	*Larus fuscus*											2
37	Greyheaded Gull	*Larus cirrocephalus*			108	1		38					
38	Franklin's Gull	*Larus pipixicans*			2								
39	Caspian Tern	*Hydroprogne caspia*	1	36	4	8	2	8	74	4	16	2	50
40	Common Tern	*Sterna hirundo/paradisaea*	6	1000	150	150						15	1
41	Arctic Tern	*Sterna paradisaea*										1	
42	Sandwich Tern	*Sterna sandvicensis*	269	100	283	20	55				800	20	
43	Swift Tern	*Sterna bergii*		4	46		4				21		
44	Damara Tern	*Sterna balaenarum*	135	2000	203	360				13	12	6	58

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

	Bird species per group	Scientific Name	Ryan *et al.* 1984	Braine 1990	Simmons *et al*. 1993	Simmons *et al*. 1993	SCP unpublished	SCP unpublished	Anderson *et al.* 2001	SCP unpublished	SCP unpublished	Paterson *in prep.*	Paterson *et al.* 2007 submitted
			November & December 1981	1982 to 1988	March & May 1991	November 1991	February 1999	August 2000	January 2001	January 2002	February 2004	October 2004	February 2006
	Sea Birds												
45	Arctic Skua	*Stercorarius parasiticus*		3		1							
46	Pomarine Skua	*Stercorarius pomarinus*		1		1						1	
47	Subantarctic Skua	*Catharacta antarctica*			1	2						1	
48	Black Tern	*Chlidonias niger*		20	1							2	
49	Royal Tern	*Sterna maxima*		2			13		1		24		14
	Resident and migrant non-wading wetland and non wetland birds												
50	Ostrich	*Struthio camelus*										2	
51	White Pelican	*Pelecanus onocrotalus*	64	86	67	125	144	155	149	67	144	118	86
52	Grey Heron	*Ardea cinerea*	5	5	5	5	5	2	4	6	2	1	1
53	Blackheaded Heron	*Ardea melanocephala*	2	1	1	2				3			
54	Goliath Heron	*Ardea goliath*	1	6	1	1	3	1	4	2	2	1	1
55	Purple Heron	*Ardea purpurea*		1		1							
56	Little Egret	*Egretta garzetta*	25	11	47	35	16	8	9	5	6	8	1
57	Cattle Egret	*Bubulcus ibis*		1									
58	Yellowbilled Egret	*Egretta intermedia*							1				
59	Dwarf Bittern	*Ixobrychus sturmii*							1				
60	Whitebacked Night Heron	*Gorsachius leuconotus*		2									
61	Abdim's Stork	*Ciconia abdimii*		1	1								
62	Black Stork	*Ciconia nigra*			3			1			1		1
63	Reed Cormorant	*Phalacrocorax africanus*	36	44	100	30		4	1			8	4
64	Darter	*Anhinga melanogaster*	3	6	1	1			1				
65	African Spoonbill	*Platalea alba*		2		3	3				2	7	1
66	Greater Flamingo	*Phoenicopterus ruber*	23	40	3	147			42			123	

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

	Bird species per group	Scientific Name	Ryan *et al.* 1984 November & December 1981	Braine 1990 1982 to 1988	Simmons *et al*. 1993 March & May 1991	Simmons *et al*. 1993 November 1991	SCP unpublished February 1999	SCP unpublished August 2000	Anderson *et al.* 2001 January 2001	SCP unpublished January 2002	SCP unpublished February 2004	Paterson *in prep.* October 2004	Paterson *et al.* 2007 submitted February 2006
	Resident and migrant non-wading wetland and non wetl												
67	Lesser Flamingo	*Phoeniconaias minor*	14	300	23							1	
68	Egyptian Goose	*Alopochen aegyptiacus*	37	12	8	8	50	23	77	155		107	18
69	Redbilled Teal	*Anas erythrorhyncha*	4		1	1			5				
70	Cape Teal	*Anas capensis*	12	44	7	1		4				26	
71	Hottentot Teal	*Anas hottentota*	2										
72	Cape Shoveller	*Anas smithii*							1				
73	Black Crake	*Amaurornis flavirostris*	10	p			1		1	3		1	2
74	African Crake	*Crex egregia*							1				
75	Purple Gallinule	*Porphyrio porphyrio*	1						1				
76	Moorhen	*Gallinula chloropus*		4	1	1							
77	Redknobbed Coot	*Fulica cristata*		6	3							15	
78	Water Dikkop	*Burhinus vermiculatus*		2									
79	Whitewinged Tern	*Chlidonias leucopterus*	2	12		6							
80	Pied Kingfisher	*Ceryle rudis*	9	p	3	1	2		5		1	4	
81	Giant Kingfisher	*Ceryle maxima*		4									
82	African Pied Wagtail	*Motacilla aguimp*	3	c								2	
83	Cape Wagtail	*Motacilla capensis*	15	c	10	2			11			2	
84	Yellow Wagtail	*Motacilla flava*							1				
85	Osprey	*Pandion haliaetus*		4	2	2			1	1	1	2	1
86	Black-shouldered Kite	*Elanus caeruleus*											1
87	Yellowbilled Kite	*Milvus migrans parasitus*							1				
88	Rock Kestrel	*Falco rupicolus*										1	
89	Peregrine Falcon	*Falco peregrinus*										1	

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

			Ryan *et al.* 1984	Braine 1990	Simmons *et al*. 1993	Simmons *et al*. 1993	SCP unpublished	SCP unpublished	Anderson *et al.* 2001	SCP unpublished	SCP unpublished	Paterson *in prep.*	Paterson *et al.* 2007 submitted
	Bird species per group	**Scientific Name**	November & December 1981	1982 to 1988	March & May 1991	November 1991	February 1999	August 2000	January 2001	January 2002	February 2004	October 2004	February 2006
	Resident and migrant non-wading wetland and non wetl												
90	Lanner Falcon	*Falco biarmicus*	1		1	1							
91	Steppe Buzzard	*Buteo buteo*				1							
92	Palm Swift	*Cypsiurus parvus*							2				
93	Bradfield's Swift	*Apus bradfieldi*							2				
94	Loanda Swift	*Apus horus fuscobrunneus*											1
95	Barn Swallow	*Hirundo rustica*		p	8	54			39			p	
96	Sand Martin	*Riparia riparia*											p
97	Brown-throated Martin	*Riparia paludicola*											p
98	Common House-Martin	*Delichon urbicum*											p
99	Rock Martin	*Hirundo fuligula*		p	2				1				
100	Banded Martin	*Riparia cincta*			3								
101	Pied Crow	*Corvus albus*		12	15	12			42	3		30	
102	Tractrac Chat	*Cercomela tractrac*		c	2	2			3			2	
103	Mountain Wheatear	*Oenanthe monticola*											
104	African Reed-warbler	*Acrocephalus baeticatus*							4			c	
105	Lesser Swamp-Warbler	*Acrocephalus gracilirostris*											
106	Fantailed Cisticola	*Cisticola juncidis*							14				
107	Black-chested Prinia	*Prinia flavicans*										p	
108	Gray's Lark	*Ammomanopsis grayi*										2	
109	Fiscal Shrike	*Lanius collaris*							2				
110	Wattled Starling	*Creatophora cinerea*			3								
111	Cape Sparrow	*Passer melanurus*										p	
112	House Sparrow	*Passer domesticus*			1								

APPENDIX 1: BIRDS OF THE KUNENE RIVER MOUTH

	Bird species per group	Scientific Name	Ryan *et al.* 1984 November & December 1981	Braine 1990 1982 to 1988	Simmons *et al.* 1993 March & May 1991	Simmons *et al.* 1993 November 1991	SCP unpublished February 1999	SCP unpublished August 2000	Anderson *et al.* 2001 January 2001	SCP unpublished January 2002	SCP unpublished February 2004	Paterson *in prep.* October 2004	Paterson *et al.* 2007 submitted February 2006
	Resident and migrant non-wading wetland and non wetl												
113	Common Waxbill	*Estrilda astrild*		c	100							c	
114	Bluecheeked Bee-eater	*Merops persicus*											
115	Madagascar Bee-eater	*Merops superciliosus*		8		2			14			5	
116	Great Spotted Cuckoo	*Clamator glandarius*			1								
117	African Red-eyed Bulbul	*Pycnonotus nigricans*						45					
118	Masked Weaver	*Ploceus velatus*			p	p	p	p	2			p	p
119	Lesser Masked Weaver	*Ploceus intermedius*											

c Common at the KRM
p Preasent at the KRM

APPENDIX 2: PHOTOGRAPHS OF THE KUNENE RIVER MOUTH

Picture 1: Aerial view of the Kunene River Mouth looking upriver

Picture 2: View from the dunes looking west

Picture 3: View upriver showing dunes being stopped by the river

Picture 4: The river mout on the beach showing the interface of fresh brown and blue saline water

Picture 5: Pelicans on sand bar in river mouth

Picture 6: Mining impacts at the Kunene River Mouth

APPENDIX 2: PHOTOGRAPHS OF THE KUNENE RIVER MOUTH

Picture 7: Scenery en-route to the Kunene River Mouth

Picture 8: Beach driving at Bosluis Bay