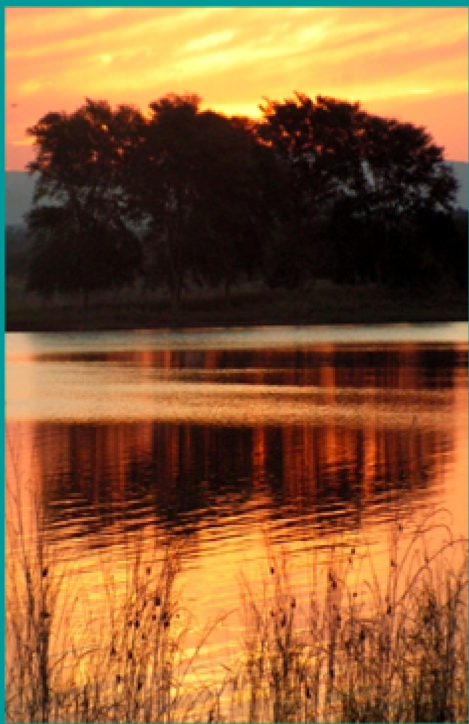
The Maputaland Conservation Planning System and Conservation Assessment



Robert J. Smith and Nigel Leader-Williams

Durrell Institute of Conservation and Ecology

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The Maputaland Conservation Planning System and Conservation Assessment

A report by

Robert J. Smith and Nigel Leader-Williams

Durrell Institute of Conservation and Ecology, University of Kent, United Kingdom

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Suggested citation: Smith, R.J. and Leader-Williams, N. (2006). *The Maputaland Conservation Planning System and Conservation Assessment.* Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, UK.

For further information visit: http://www.mosaic-conservation.org/maputaland/

Cover photographs by Nerissa Chao (left), Louise McRae (centre) and Julian Easton (right)

TABLE OF CONTENTS

List of figures

List of tables

EXECUTIVE SUMMARY

Introduction

- The Maputaland centre of endemism is a region of approximately 17,000km^2 that falls within Mozambique, South Africa and Swaziland. The conservation value of Maputaland is internationally recognised, as it contains high levels of species richness and endemism, and it forms part of the Maputaland-Pondoland-Albany biodiversity hotspot and contains the Greater St Lucia Wetland Park World Heritage Site.

- Most of Maputaland has low agricultural potential and the people of the region have traditionally relied on harvesting its natural resources to maintain their livelihoods, which has helped maintain biodiversity levels. However, recent changes in infrastructure, agricultural techniques and a growing human population have led to an increase in intensive agriculture.

- Poverty levels in Maputaland are generally high and the governments of Mozambique, South Africa and Swaziland all recognise the need for local economic development. Given the local conditions, they have also recognised that this development should be based on eco-tourism and the sustainable use of natural resources, which would build on the existing network of private and communally-owned game reserves and ranches.

- One key part of this development process was the launch in 2000 of the Lubombo Transfrontier Conservation Area (TFCA) initiative. The Lubombo TFCA falls entirely within Maputaland and aims to serve as a vehicle for the conservation and sustainable use of biological and cultural resources, whilst promoting regional peace, co-operation and socio-economic development. Developing the TFCA will involve a range of project partners and donors and these organisations will work together to build capacity, improve infrastructure and establish new conservation initiatives.

- The proposed projects have the potential to increase economic prosperity and conserve regional biodiversity, but it is vital that these developments fit within an overall land-use planning framework. It is generally agreed that such a framework should follow the approach of systematic conservation planning and this report describes how such a system was developed for Maputaland. It also describes the results from the first Maputaland Conservation Assessment (MCA), which used the conservation planning system to identify important areas for conservation within the region.

The Maputaland Conservation Planning System

- The Maputaland Conservation Planning System (CPS) was developed in collaboration with partners from all the three range states of Mozambique, South Africa and Swaziland. It is based on the MARXAN conservation planning software and can be used to identify priority areas that are needed to conserve the region's biodiversity. Systematic conservation planning is a spatially explicit, target-based approach. It uses complementarity-based computer algorithms to identify portfolios of planning units that meet the representation targets for the specified conservation features.

- The Maputaland CPS contained data on 110 conservation features, which consists of 44 landcover types, 20 vertebrate species, 13 invertebrate species, 20 plant species and 13 ecological processes. The landcover features were mapped with a spatial resolution of 25m by digitising Landsat ETM and ASTER satellite imagery. The distributions of the species were mapped by using expert knowledge to develop rule-based models that combined the landcover data with distribution polygons and other spatial data.

- The CPS divides Maputaland into a series of planning units and lists the amount of each conservation feature found within each planning unit. Most of these planning units are 1km^2 hexagons but each of the region's

14 protected areas (PAs) is also represented as a single unit. The CPS also includes data on the risk of each planning unit being converted to subsistence agriculture, as well as data on the potential profitability from game ranching.

The Maputaland Conservation Assessment

- The first MCA was undertaken in 2006 and identifies a potential conservation landscape for Maputaland. Such a landscape would maintain the biodiversity of the region and would consist of the existing PAs, together with new core areas and conservation linkages. The MCA does not specify how these new core areas and linkages should be owned or managed. Instead, it identifies which areas are needed to meet the representation target for all of the desired conservation features.

- Individual targets were set for each conservation feature based on their underlying ecology and conservation status. Previous research from South Africa was used to identify appropriate targets for the landcover types, which helped ensure that these conservation features acted as effective biodiversity surrogates. Most of the species targets were set to ensure that Maputaland contained viable populations of each species, although targets for wide-ranging species were based on conserving a viable metapopulation within Southern Africa.

- The initial data from the MCA showed that the present PA system protects an area of 3,601km^2, so that 21% of Maputaland currently has PA status. These PAs ensure that the representation targets are met for 53 of the 110 conservation features, and that 27% of the landcover type targets and 65% of the species targets are met. The median percentage target met for the remaining features was 44% and this ranged from 0% for 6 features and 99.8% for the Lubombo aquatic South landcover type.

- The first stage of the MCA was to identify the conservation landscape boundaries that would contain: the existing PAs; new core areas; and new conservation linkages. MARXAN was run 200 times to identify 200 near-optimal portfolios of planning units, based on meeting the landcover and species targets whilst minimising the risk of the portfolio being cleared for agriculture. Each planning unit was given an irreplaceability score, measured as the number of times it appeared in the 200 portfolios, and any unit with a score of more than 100 was selected to form the basis of the final conservation landscape. This landscape was then refined to remove any patch of planning units that was less than 10km^2 and add extra planning units to ensure that the ecological process targets were met.

- The second stage of the MCA was to identify where new core areas should be established within the conservation landscape. This involved repeating the MARXAN analysis but the portfolios were restricted so that they only contained planning units that fell within the conservation landscape. Once again, MARXAN identified 200 portfolios and the core area system was based on the best of these portfolios. It was then modified to remove patches of planning units that were less than 10km^2 and add units that were need to meet all of the targets.

- The final conservation landscape consists of the existing 3,601km^2 of PA, 4,940km^2 of new core areas and 1,995km^2 of linkages. Much of the landscape overlaps with the proposed TFCA zones, as well as with existing and proposed privately- and communally-managed PAs. Hence, there is great potential for the MCA to guide the development of these new conservation areas. However, the MCA also shows that some important parts of the conservation landscape fall outside of these proposed areas and so further conservation initiatives will be needed to ensure the long-term persistence of Maputaland's biodiversity.

Future work

- The MCA was designed to include a range of data that would increase its real-world relevance. However, some of these data could not be captured spatially, so we recommend that the next step should be for the relevant stakeholders and implementation agencies to modify the conservation landscape where appropriate and to develop an implementation timetable. These new steps should be informed by the CPS and the agricultural transformation risk map.

- Systematic conservation planning in Maputaland should be an ongoing process and conservation assessments should be regularly repeated based on updated conservation, target, biodiversity and risk data. In addition, we recommend the collection of further biodiversity data, so that future MCAs are based on all of the desired conservation features that were identified by the experts. These MCAs would also benefit from incorporating a wider range of data on the economic value of Maputaland's natural resources and ecosystem services. Finally, we suggest that new conservation planning software should be developed, which would allow the MCA to incorporate data on minimum PA size.

- The Maputaland CPS was hampered by a lack of suitable biodiversity distribution data, despite the large number of naturalists and researchers who collect such data in Maputaland. Therefore, we recommend that the Maputaland range states collaborate to develop a transnational data collection and storage system for collating this information. We also recommend that all researchers should be obliged to store their relevant data in this system and that naturalists should be encouraged to collect and store their data whenever possible. Such a system would dramatically improve the biodiversity distribution datasets for Maputaland and would allow targeted data collection in under-sampled areas.

- The TFCA process provides a framework for mainstreaming the results of the MCA. Therefore, there is a need for further work to ensure that the outputs of the MCA are converted into products that can be used both by the TFCA initiative and the local implementation partners who are directly involved in land-use and land-zoning decisions. In addition, it is important to ensure that the TFCA initiative builds capacity and develops management systems so that the CPS continues to be an integral part of conservation planning in Maputaland.

SUMÁRIO EXECUTIVO

Introdução

- O centro de endemismo de Maputaland está situado numa região de aproximadamente 17,000km^2 que abrange Moçambique, a África do Sul e a Suazilândia. O valor em termos de conservação de Maputaland é internacionalmente reconhecido, devido aos seus altos níveis de riqueza específica e de endemismo, fazendo esta região parte do hotspot de biodiversidade de Maputaland-Pondoland-Albany que contêm o Greater St Lucia Wetland Park World Heritage Site.

- A maior parte da área de Maputaland tem um baixo potencial agrícola. Os habitantes de Maputaland têm tradicionalmente subsistido da recolha dos recursos naturais desta região, contribuindo assim para a manutenção dos seus níveis de biodiversidade. No entanto, mudanças recentes nas infra-estruturas e nas técnicas agrícolas, juntamente com o crescimento das populações humanas, levaram a um aumento da agricultura intensiva.

- Os níveis de pobreza em Maputaland são geralmente elevados e os governos de Moçambique, da África do Sul e da Suazilândia reconhecem a necessidade de um desenvolvimento económico local. Dadas as condições locais, os mesmos governos reconheceram que este desenvolvimento deverá ser baseado no eco-turismo e no uso sustentável dos recursos. Tal desenvolvimento será traçado a partir das já existentes redes de reservas de caça e ranchos, sejam estas propriedades privadas ou propriedades comunitárias.

- Um elemento chave deste processo de desenvolvimento foi o lançamento no ano 2000 da iniciativa da Área de Conservação Transfronteiriça (ACTF) do Lubombo. A ACTF do Lubombo está integralmente situada em Maputaland e tem como objectivo impulsionar a conservação e o uso sustentável dos recursos biológicos e culturais enquanto promove a paz regional, a cooperação e o desenvolvimento socioeconómico. O desenvolvimento da ACTF envolverá uma variedade de parceiros e doadores cujas organizações trabalharão em conjunto para criar competências, melhorar infra-estruturas e estabelecer novas iniciativas para a conservação.

- Os projectos propostos têm o potencial de aumentar a prosperidade económica e conservar a biodiversidade regional. É no entanto vital que estes desenvolvimentos se insiram em estratégias de planeamento do uso da terra. É geralmente aceite que tal estratégia deverá seguir uma abordagem de planeamento sistemático de conservação e este relatório descreve como este sistema foi desenvolvido para Maputaland. São também descritos os resultados da primeira Avaliação da Conservação de Maputaland (ACM), a qual usou um Planeamento Sistemático de Conservação para identificar áreas dentro da região cuja conservação é importante.

Planeamento Sistemático de Conservação de Maputaland

- O Planeamento Sistemático de Conservação (PSC) de Maputaland foi desenvolvido em colaboração com parceiros dos três países abrangidos pela área de Maputaland. É baseado no uso do software de planeamento de conservação, MARXAN, e pode ser utilizado para identificar áreas prioritárias, fundamentais para a conservação da biodiversidade da região. O Planeamento Sistemático de Conservação usa uma abordagem espacialmente explicita que visa o cumprimento de vários objectivos pré-estabelecidos. Utiliza algoritmos de computador, baseados na complementaridade para identificar um portfólio de unidades de planeamento que cumpram os objectivos pré-estabelecidos para várias características a conservar.

- O PSC de Maputaland incluiu dados para 110 características a conservar, entre as quais 44 coberturas de terra, 20 espécies de vertebrados, 13 espécies de invertebrados, 20 espécies de plantas e 13 processos ecológicos. As várias coberturas de terra foram mapeadas com uma resolução espacial de 25m através da digitalização de Landsat ETM e imagens de satélite ASTER. A distribuição das espécies foi mapeada usando o conhecimento de peritos para o desenvolvimento de modelos teóricos que combinaram dados para a cobertura de terra com polígonos de distribuição e outros dados espaciais.

- O PSC divide Maputaland numa série de unidades de planeamento e regista a quantidade de cada característica a conservar encontrada em cada uma das unidades. A maior parte destas unidades de planeamento são hexágonos de 1km^2 sendo cada uma das 14 áreas protegidas (APs) da região também representada como uma unidade. O PSC também inclui dados relativos ao risco de cada unidade de planeamento ser convertida para agricultura de subsistência, assim como o potencial lucro da criação de espécies cinegéticas.

A Avaliação da Conservação de Maputaland

- A primeira ACM foi levada a cabo em 2006 e identifica uma potencial paisagem de conservação para Maputaland. Tal paisagem manteria a biodiversidade da região e consistiria em existentes APs juntamente com novas áreas core e ligações de conservação. A ACM não especifica como estas novas áreas core e ligações devem ser geridas ou apropriadas. Ao invés, identifica quais as áreas que são necessárias para alcançar os objectivos pré-estabelecidos para todas as características de conservação desejadas.

- Objectivos específicos foram criados para cada característica de conservação baseados nos seus princípios ecológicos e estatutos de conservação. Resultados de trabalhos de pesquisa prévia na África do Sul foram usados para identificar objectivos apropriados para os tipos de cobertura de terra. Estes resultados ajudaram a assegurar que estas características de conservação agissem como indicadores reais da biodiversidade. Para muitas das espécies o objectivo foi assegurar que Maputaland contivesse populações viáveis. No entanto para espécies com uma ampla-distribuição o objectivo foi assegurar a conservação de metapopulações viáveis na África Austral.

- Os dados iniciais da ACM mostraram que o presente sistema de APs protege uma área de 3,601km^2, de modo que 21% de Maputaland tem actualmente um estatuto de AP. Estas APs asseguram que os objectivos são alcançados para 53 das 110 características de conservação, constituindo 27% das coberturas de terra e 65% das espécies. A percentagem mediana dos objectivos alcançados para as características remanescentes foi de 44%, tendo variado entre 0% para 6 características e 99.8% para o tipo de cobertura de terra “Aquático de Lubombo Sul”.

- A primeira fase da ACM foi identificar os limites da paisagem de conservação que conteria: APs existentes; novas áreas cores; e novas ligações de conservação. MARXAN foi corrido 200 vezes para identificar 200 portfólios quase-óptimos de unidades de planeamento, para satisfazer os objectivos pré-estabelecidos de tipo de cobertura de terra e espécies enquanto minimizava o risco do portfólio ser transformado para a agricultura. A cada unidade de planeamento foi dado um valor de insubstituíbilidade, correspondendo ao número de vezes que aparecia nos 200 protofólios, sendo que qualquer unidade com um valor maior do que 100 era seleccionada para formar a base da paisagem de conservação final. Esta paisagem foi depois melhorada ao remover qualquer porção de unidades de planeamento que tivesse menos de 10km^2, e adicionando unidades de planeamento extra de modo a assegurar que os processos ecológicos alvos seriam alcançados.

- A segunda fase da ACM foi identificar onde as novas áreas core deveriam ser estabelecidas dentro da paisagem de conservação. Este processo envolveu repetir as análises MARXAN mas os portfólios foram restringidos de maneira a apenas conter unidades de planeamento que se encontrassem dentro da paisagem de conservação. Uma vez mais MARXAN identificou 200 protofólios e o sistema de área core foi baseado no melhor destes protofólios. O protofólio também foi modificado de modo a remover porções de unidades de planeamento que tivessem menos de $10km^2$ e foram adicionadas as unidades necessárias para alcançar todos os objectivos.

- A paisagem de conservação final consiste nos $3,601km^2$ existentes de APs, $4,940km^2$ de novas áreas core e $1,995km^2$ de ligações de conservação. A maior parte da paisagem sobrepõem-se com a proposta ACTF, bem como com as já existentes e as propostas APs geridas por comunidades e privados. Existe claramente um grande potencial para a ACM guiar o desenvolvimento destas novas áreas de conservação. No entanto, a ACM também mostra que algumas partes importantes da paisagem de conservação ocorrem fora destas áreas propostas, e neste sentido futuras iniciativas de conservação serão necessárias para assegurar a manutenção a longo-termo da biodiversidade de Maputaland.

Futuro trabalho

- A ACM foi desenhada para incluir vários dados que aumentariam a sua relevância para o mundo real. No entanto parte destes dados não puderam ser espacialmente capturados, e por esta razão recomendamos que o próximo passo para os diversos intervenientes e agências de implementação relevantes no processo seja modificar a paisagem de conservação onde apropriado e desenvolver um calendário de implementação. Estes novos passos deveriam ser guiados por um PSC e pelo mapa de risco de transformação agrícola.

- O Planeamento Sistemático da Conservação em Maputaland deverá ser um processo contínuo e a avaliação da conservação regularmente repetida baseando-se na actualização de dados sobre conservação, objectivos, biodiversidade e risco. Recomendamos adicionalmente a recolha de mais dados relativos a biodiversidade, para que futuras ACM sejam baseadas nas desejadas características de conservação identificadas pelos especialistas. Estas ACM também beneficiariam da incorporação de uma vasta gama de dados sobre o valor económico dos recursos naturais e serviços dos ecossistemas de Maputaland. Finalmente, sugerimos que um programa de planeamento de conservação seja desenvolvido que permita a ACM incorporar dados sobre a dimensão mínima das APs.

- O PSC de Maputaland foi afectado pela falta de dados apropriados da distribuição da biodiversidade, apesar do grande número de naturalistas e investigadores que recolhem tais dados em Maputaland. Neste sentido recomendamos que os estados integrantes de Maputaland colaborem no desenvolvimento de um sistema transnacional de recolha e armazenamento de dados. Recomendamos também que todos os investigadores sejam obrigados a armazenar seus dados relevantes para este sistema, e que os naturalistas sejam encorajados a recolher e armazenar os seus dados quando possível. Tal sistema iria melhorar dramaticamente os dados relativos à distribuição da biodiversidade para Maputaland e permitir a recolha de dados focalizada em área sub-pesquisadas.

- O processo da ACTF fornece uma base para a integração dos resultados da ACM. Portanto, existe a necessidade de desenvolver mais trabalho de modo a assegurar que os resultados da ACM sejam convertidos em produtos que possam ser duplamente usados pela iniciativa da ACTF e pelos parceiros locais de implementação que estão directamente envolvidos nas decissões de zoneamento e uso da terra. É também importante assegurar que a iniciativa da ACTF capacite e desenvolva sistemas de gestão para que o PSC continue a ser parte integrante do planeamento da conservação em Maputaland.

ACKNOWLEDGEMENTS

The Maputaland Conservation Planning System is the result of a three year project that involved a large number of people working in Mozambique, South Africa, Swaziland and elsewhere. It would be impossible to thank everyone who gave their time and expertise to this project but we would especially like to thank the following people and organisations:

Mozambique

We would like to thank the following people for their support, advice and hospitality and for helping guide the development of the Maputaland CPS: James Culverwell, Afonso Madope, Bruno Nhancale, Cornelio Ntumi and Bartolemeu Soto. We would also like to thank the following for all their advice and help: Gabriel Albano, Salomao Banderia, Carlos Bento, Arlito Cuco, Antonio Hoguane, Iracema Maiópuè, Raimundo Matusse, Sharmila Moiane, Helena Motta, Antonio Reina and Almeida Sitoe. We would also like to thank the National Directorate of Conservation Areas, Universidade Eduardo Mondlane and Fórum para Natureza em Perigo for all of their support.

South Africa

We would like to thank the following people for their support, advice and hospitality and for helping guide the development of the Maputaland CPS: Adrian Armstrong, Joan and Buster Carlston, Pete Goodman, Wayne Matthews, Petros Ngwenya, Shannon and Ian Rushworth. We would also like to thank the following for all their advice and help: Andy Blackmore, Andre Boshoff, Greg Botha, Charles Breen, Gladman Buthelezi, Tony Conway, Richard Cowling, John Craigie, Fred Ellery, Stuart Ferrer, Vusi Gumbe, Katherine Hanekom, Jennifer Jones, Bruce Kelbe, Caiphus Khumalo, Roelie Kloppers, Scotty Kyle, Jenny Longmore, Saskie Lovell, Sue McClintock, Steve McKean, Craig Mulqueeny, Bheka Nxele, Carl Oellerman, Terry Olifant, Bruce Page, Derek Potter, Dianne Scott, Rob Slotow, Heidi Snyman, Debbie Swanepoel, Ricky Taylor, Mandla Tembe, Bongani Thabethe, Pete Thomson, Berndt van Reynsburg, Andrew Venter and Andrew Whitley. We would also like to thank Ezemvelo KwaZulu-Natal Wildlife and the Greater St Lucia Wetland Park Authority for all of their support.

Swaziland

We would like to thank the following people for their support, advice and hospitality and for helping guide the development of the Maputaland CPS: Sikhumbuzo Dlamini, Linda Loffler and Ara Monadjem. We would also like to thank the following for all their advice and help: Rod de Vletter, Mdumiseni Dlamini, Ngwane Dlamini, Ray Gama, Cebisile Magagula, Themb’a Mahlaba, Seth Maphalala and Kim Roques. We would also like to thank the Swaziland National Trust Commission, the Swaziland Environment Agency and the University of Swaziland for all of their support.

Australia

We would like to thank Ian Ball, Hugh Possingham and Matt Watts for producing the MARXAN conservation planning software and for their advice on designing the Maputaland Conservation Assessment.

DICE and the UK

We would like to thank Leonor Almeida, Yolanda Barrios, Matt Linkie, Moses Malekia, Radhika Miraglia, Bruno Nhancale, Guy Parker, Kevin Smith and Als Vowles for helping produce the Maputaland landcover map and the MCA report. We would like to thank Paul Brookes, Nerissa Chao, Julian Easton, Louise McRae, Petros Ngwenya, Bruno Nhancale and Chris Ransom for the work that did as part of their MSc dissertations that fed into the Maputaland conservation planning system. Finally, we would like to thank Christine Eagle, Joan England, Jan Horn, Nicola Kerry-Yoxall, Shelley Malekia, Susan Simpson and Chris Williams at the Department of Anthropology for all their help.

This work was primarily funded by the UK Government’s Darwin Initiative for the Survival of Species and we are very grateful for all their support.

1 AN INTRODUCTION TO CONSERVATION PLANNING IN MAPUTALAND

1.1 General introduction

The world's natural ecosystems are being degraded at a rate unprecedented in human history (Balmford & Bond, 2005). Conservationists advocate a range of interventions to reduce this loss and one of the most commonly adopted approaches is the development of protected areas (PAs). PAs aim to reduce biodiversity loss by controlling human access to prevent over-exploitation, habitat loss and habitat fragmentation. In addition, these PAs help maintain ecological processes and can be used to raise revenue through nature-based tourism.

Nearly 12% of the Earth's land surface now has PA status but many of these PAs are too small to conserve key species and ecological processes, and most PA systems fail to represent important biodiversity elements (Pressey, 1994; Brooks et al., 2004). In addition, PAs can be unpopular with local communities who resent loss of traditional access and user rights. Thus, most PA systems need to be modified to improve their conservation value whilst reducing conflict with local communities and other groups. A number of methods have been used to design these improved PA systems, but it is now generally agreed that the most effective techniques are based on the systematic conservation planning approach (Knight et al., 2007).

This report describes a systematic conservation planning project in the Maputaland centre of endemism, a region of high conservation value in Southern Africa. The project aimed to design a conservation landscape for this region, which would augment and link the present PA system. This work was funded by the British Government through their Darwin Initiative for the Survival of Species. This chapter provides a brief introduction to systematic conservation planning and then describes Maputaland and the conservation opportunities in the region. Finally, it describes the Maputaland conservation planning project and the aims of this report.

1.2 Systematic conservation planning and assessments

Systematic conservation planning is an approach to designing PA systems and other conservation networks. One of the key strengths of this approach is that it avoids being overly prescriptive (Pressey et al., 2003), but systematic conservation planning projects generally involve the following steps:

1) Identifying and involving key stakeholders
2) Identifying broad goals for conservation planning
3) Gathering and evaluating data
4) Formulating targets for conservation features
5) Reviewing target achievement in existing conservation areas
6) Selecting additional conservation areas
7) Implementing conservation action in selected areas
8) Maintaining and monitoring established conservation areas

Systematic conservation planning has also been defined as a long-term process that combines a conservation assessment with a process for collaboratively developing an implementation strategy with relevant stakeholders (Knight et al., 2006a). A conservation assessment is a short-term activity for identifying spatially-explicit priority areas for conservation action and this report focuses on a conservation assessment for Maputaland.

1.2.1 Conservation assessment characteristics

Conservation assessments generally involve defining the planning region boundaries and then dividing this region into a series of planning units. The aim of the assessment is to identify a *portfolio* of these planning units that, if conserved, would achieve the conservation goals of the planning process. There is no specific method for conducting a conservation assessment, as they need to be tailored to local conditions (Knight et al., 2006b), but they all share the following four characteristics:

A. Spatially explicit

Conservation assessments identify priority areas and so are based on spatial data. This means that any relevant information that cannot be converted into a spatial format has to be excluded from the assessment process.

B. Representation and persistence

Conservation assessments aim to identify PA systems or other ecological networks that fully represent the planning region's biodiversity and ensure its long-term maintenance (Knight et al., 2007). Mapping all of this biodiversity is beyond the scope of any assessment, so a set of biodiversity surrogates are used instead.

These biodiversity elements, also known as conservation features, are selected based on local conditions and data availability but they typically include broad environmental surrogates, such as habitat or landcover types, as well as key species and ecological processes (Cowling et al., 2004).

C. Target driven

Conservation assessments are based on explicit numerical representation targets, so that the priority areas are designed to conserve the specified amount of each conservation feature. This helps ensure that the conservation planning process is not derailed by implicit or explicit political pressures (Cowling et al., 2003). Each target should be developed to ensure the long-term persistence of its associated conservation feature (Pressey et al., 2003).

D. Complementarity

Conservation assessments recognise that conservation is only one of a number of competing land-uses and that any priority area system should minimise its impacts on other sectors. The most efficient methods for meeting the conservation targets are based on the concept of complementarity. These methods aim to identify the smallest group of areas that, when combined, meet all of the representation targets (Csuti et al., 1997).

1.2.2 Incorporating economic and threat data

Most conservation assessments are based on a large number of planning units and conservation features, so it is best to analyse the data using specially designed software. This has another important advantage, as the software can incorporate a range of other relevant spatial data, thereby increasing the real-world relevance of the assessment. Software packages, such as MARXAN, are designed to minimise the costs of meeting the representation targets (Ball & Possingham, 2000).

Thus, including data on the financial value of the land (Pence et al., 2003), the potential profitability of conservation-friendly land-uses (Easton, 2004), or the opportunity costs of using the land for conservation (Stewart & Possingham, 2005; Richardson et al., 2006), can identify PA systems with more political relevance.

Producing a PA system that meets all of the representation targets is usually a long-term process, with projects often assuming a 20 to 50 year implementation time period. This makes it highly likely that conservation assessments will identify some priority areas that will be transformed before they can be protected (Sarkar et al., 2006).

Conservation planners can address this problem in two ways. First, it is important to continuously update the planning system data and repeat the assessment process at regular intervals (Meir et al., 2004). This will ensure that the assessment identifies priority areas based on the actual distribution of the conservation features. Second, assessments can include data on risk of habitat transformation. These data can be used both to avoid high risk areas wherever possible and prioritise conservation interventions (Wilson et al., 2005).

1.3 Conservation planning in Maputaland

The Maputaland centre of endemism is a region of approximately 17,000km^2 that falls within Mozambique, South Africa and Swaziland. It consists of the most southerly part of the East African Coastal plain and the Lubombo Mountain range (Figure 1-1) and contains a number of unique species and sub-species.

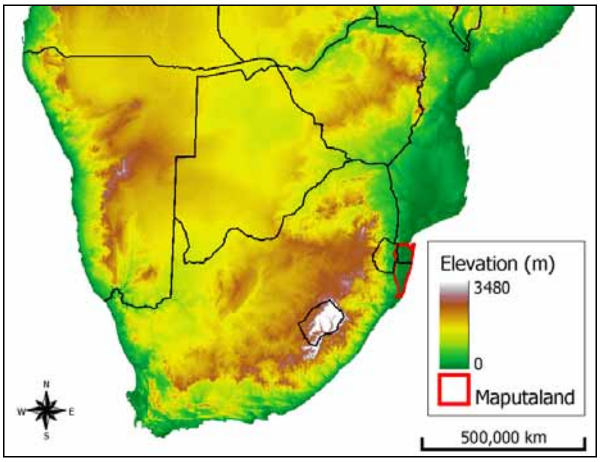

Figure 1-1: An elevation map of Southern Africa showing the location of Maputaland

In this study we demarcated the boundaries of the region as: the Namaacha-Maputo road in the north, the Indian Ocean in the east, the Mtubatuba-St Lucia in the south and the Lubombo Mountain range in the west (Figure 1-2). These boundaries contain the majority of Maputaland's unique biodiversity, although a few of the endemic species have ranges that extend outside (van Wyk & Smith, 2001).

A number of conservation initiatives are currently underway in Maputaland and this section will provide some background to these activities. The first sub-section will briefly describe the biodiversity of the region and the agencies that are responsible for conserving these natural resources. The second and third sub-sections contain information on the relevant conservation opportunities and constraints and the fourth describes the role of the Darwin Initiative project in informing developments in Maputaland.

1.3.1 Biodiversity conservation in Maputaland

The geology and rainfall patterns of Maputaland combine to play a major role in determining biodiversity levels within the region (Smith, 2001). From west to east, rainfall is relatively high in the Lubombo Mountains, low in the central region and then highest with close proximity to the Indian Ocean. The geology shares this pronounced spatial pattern, with rhyolitic soils in the Lubombo Mountains, Cretaceous sediments in the centre of the region and then a large area of coastal sands in the east (Watkeys et al., 1993). In addition, there are a number of river systems that have deposited alluvial soils on top of the underlying geology types. This means that Maputaland can be divided into five ecological zones, which from west to east are the: Lubombo, Cretaceous, Alluvial, Coastal plain and Coastal dune zones (Figure 1-3).

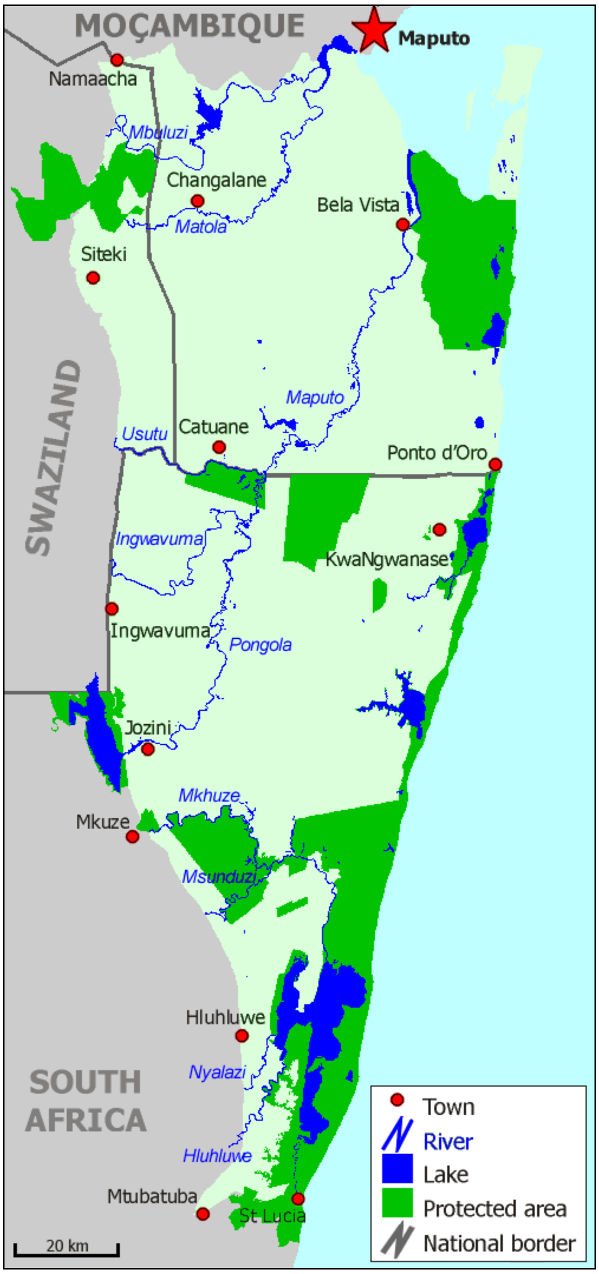

Figure 1-2: A detailed map of Maputaland, showing towns, rivers, lakes and PAs

These ecological zones have relatively distinct boundaries and have a large number of associated species, which ensures the region has high levels of species richness. This species richness is further enhanced by the location of Maputaland at the southernmost part of the East African coastal plain (Figure 1-1), as the region contains species that are typically found in both East and Southern Africa. In addition, Maputaland has high levels of endemism because much of the coastal plain is geologically recent and so many species and sub-species have evolved to fill new niches.

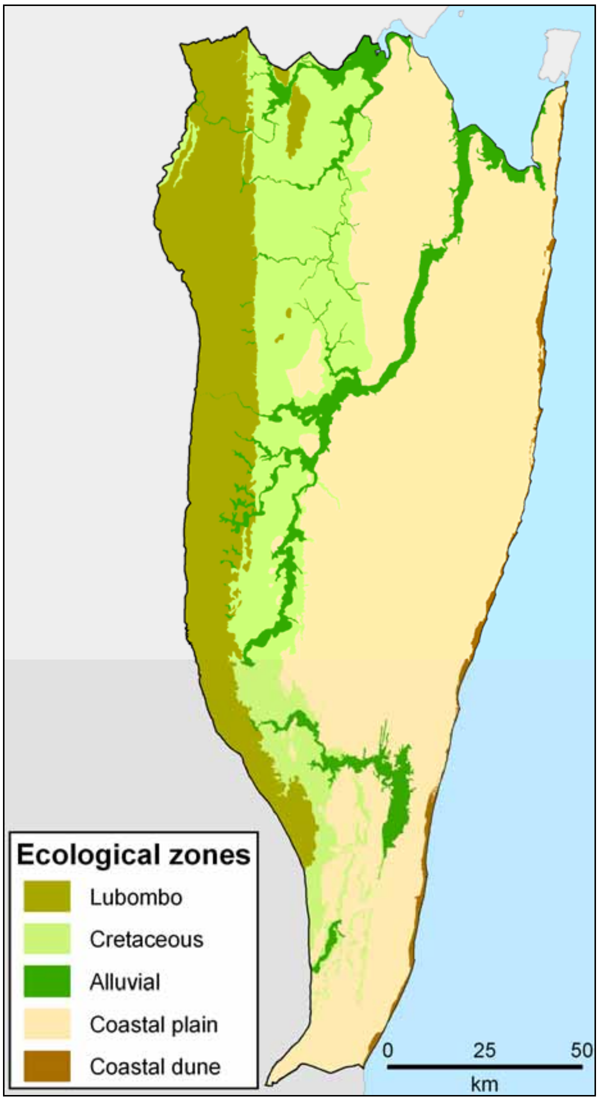

Figure 1-3: The ecological zones of Maputaland

The conservation importance of Maputaland is globally recognised, as it forms part of the Maputaland-Pondoland-Albany biodiversity hotspot (Steenkamp et al., 2004) and the South East African Coast Endemic Bird Area (Stattersfield *et al.,* 1998). It is particularly important for the conservation of plants, with 230 of the 2,500 species having endemic or near-endemic status (van Wyk & Smith, 2001). It also contains the Greater St Lucia Wetland Park World Heritage Site, five RAMSAR sites and nine Important Bird Areas. In addition, the protected areas of Maputaland contain a number of important populations of globally threatened species, such as the black rhinoceros.

Maputaland contains 14 statutory PAs (Figure 1-2) and these are managed by the National Directorate of Conservation Areas (DNAC) in Mozambique, Ezemvelo KwaZulu-Natal Wildlife (EKZNW) and the Greater St Lucia Wetland Park Authority (GSLWPA) in South Africa and the Swaziland National Trust Commission (SNTC) in Swaziland.

1.3.2 Conservation constraints and opportunities in Maputaland

The ecology and climate of Maputaland have played a large role in determining the region's present conservation status. One key factor is that most of the region's soils are nutrient poor, with only the Cretaceous and Alluvial zones containing land that is highly suitable for agriculture. As a result, local people's livelihoods have traditionally depended on harvesting natural resources (de Boer et al., 2002; Tarr et al., 2004). In addition, the low profitability of farming in the region means that it has been relatively ignored by commercial farmers and their political supporters, so much of the land is still communally owned. These factors have led to the following situation:

- Much of Maputaland's important biodiversity remains intact, although large mammals are generally restricted to the PAs, while alien plant species are a serious conservation threat in many areas. In addition, most of the natural habitats on nutrient rich soils in South Africa have been converted to agriculture.

- The PA system is extensive in South Africa but coverage is lower in Mozambique and Swaziland (Figure 1-2). However, most of the PAs are not large enough to contain viable populations or wide-ranging species and do not fully protect important ecological processes.

- Many of the people in the region are extremely poor and this problem has been exacerbated by the impacts of war in Mozambique and the forced removals of people to create PAs. Poverty levels are compounded by a lack of good infrastructure and the high prevalence of HIV-AIDS.

- Changes in infrastructure, agricultural techniques, human population trends and social patterns have led to an increase in the extent of farming, and also increased levels of agricultural intensification. This has serious implications for the conservation of some habitat types, such as sand forest, which are vulnerable to these new threats (Botes et al., 2006).

- The human population increase and changes in infrastructure and prevailing social conditions have also increased examples of over-harvesting. This has had strong impacts on financially valuable species, as well as on species with a low reproductive rate or restricted ranges (Ransom, 2005).

This combination of factors creates significant conservation constraints and opportunities. The main constraint is that Maputaland is home to a large number of very poor people who rely on the land for their livelihoods. Thus, there is a need for job creation in the region through economic development. However, it is generally agreed that conservation-based industries have the potential to be the most profitable form of land-use in the region, so there is a great deal of interest in developing such conservation projects, both because of the globally important biodiversity and the need to reduce local poverty levels.

Most of these projects are based on the sustainable use of natural resources or nature-based tourism. One of the most economically important forms of harvesting is based on game ranching and trophy hunting (Goodman et al, 2002), but a number of plant species are also being used (Tarr et al., 2006). Nature-based tourism is already a major industry in the region (Lindberg et al., 2003) but it has an even greater potential because Maputaland contains a wealth of natural and cultural heritage.

1.3.3 Current conservation initiatives in Maputaland

There are a number of conservation initiatives currently underway in Maputaland, other than those restricted to the state managed PAs. This sub-section will focus on projects that will increase the area of land managed for biodiversity.

A. Private reserves and ranches

Some parts of Maputaland are privately owned and much of this land was traditionally used for growing crops, such as pineapples and sugar cane, or for ranching cattle. Some of this agriculture remains but a number of former farms have been converted to privately-owned game reserves and ranches. This was mostly for economic reasons, as it allowed owners to maximise their profits by combining photographic tourism, trophy hunting and game ranching, but many land-owners are also interested in conserving biodiversity. These new private reserves play a major role in conserving important habitats in the South African section of Maputaland (Lindberg et al., 2003) and there is potential for the private sector to increase its conservation role in Mozambique and Swaziland.

B. Community conservation areas

Most of Maputaland consists of communally-owned land, and the people in these regions have traditionally used their land for low-intensity farming and the extraction of natural resources. The success of privately owned game reserves has encouraged several communities in all three countries to set up similar enterprises, with most focussing both on nature-based tourism and trophy hunting (Chao, 2004; Ngwenya, 2005). The success of these projects depends on building capacity, producing equitable benefit-sharing systems and reducing human-wildlife conflict (Nhancale, 2005). Results to date have been mixed. However, there is great potential for these schemes in Maputaland and a large amount of support from a number of sectors, which suggests that their conservation role will increase in the future.

C. Transfrontier Conservation Areas

Transfrontier Conservation Areas (TFCAs) are relatively large areas that cross the political boundaries between two or more countries, and cover large-scale natural ecosystems that include one or more PA. They act as vehicles for the conservation and sustainable use of biological and cultural resources, whilst promoting regional peace, co-operation and socio-economic development. As part of this, they encourage the involvement of the private sector and local communities in developing new conservation initiatives.

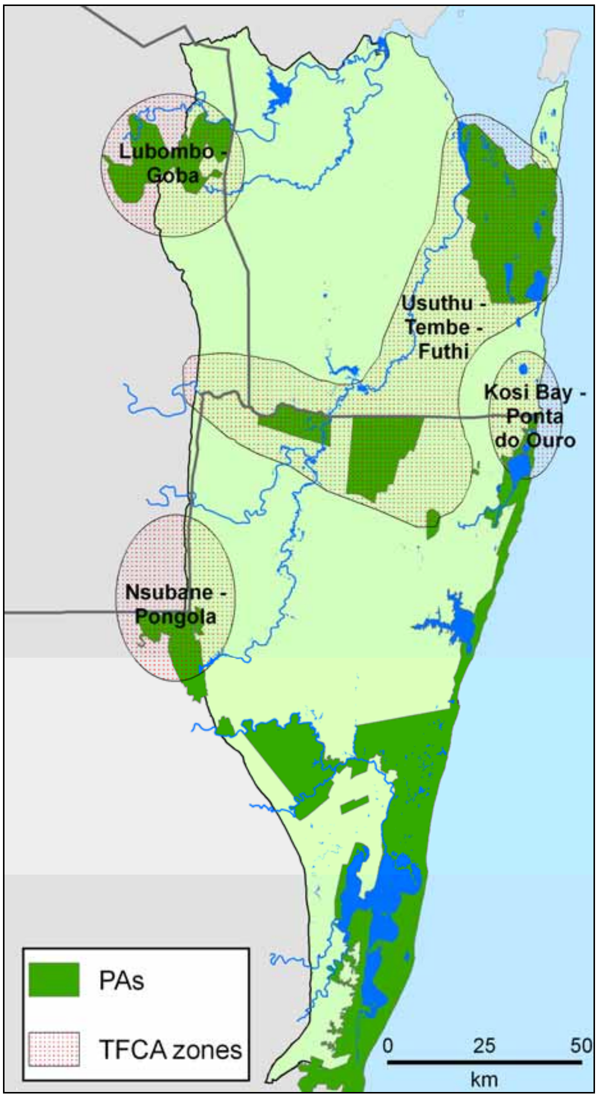

Figure 1-4: Approximate boundaries of the Lubombo TFCA zones

A number of potential TFCAs have been identified in Southern Africa and this includes the Lubombo TFCA, which falls entirely within the Maputaland centre of endemism. This project was launched in 2000 with the signing of a trilateral protocol and it is strongly supported by the Governments of Mozambique, South Africa and Swaziland. A large amount of funding has been made available to build local capacity, establish new conservation areas and improve infrastructure, so that Maputaland fulfils its nature-based tourism and resource harvesting potential. The TFCA is currently focussing on four zones, which are: Usuthu-Tembe-Futi, Nsubane-Pongola, Kosi Bay-Ponta do Ouro TFCA and Lubombo Conservancy-Goba (Figure 1-4).

1.4 The Maputaland systematic conservation planning project

There are a large number of planned conservation initiatives in Maputaland that involve a range of stakeholders, implementation agencies and donors working in the three Maputaland range states. Therefore, it is vital to develop a scientifically defensible conservation planning system that can provide a broad framework for guiding this process. In response the Durrell Institute of Conservation and Ecology (DICE) has worked with its project partners to develop the Maputaland conservation planning system (CPS).

This project was funded by the British Government's Darwin Initiative for the Survival of Species and involved a number of elements, including building conservation planning capacity in Maputaland and developing new software. This report describes one of the most important elements of this project, which was producing the Maputaland CPS and undertaking the first Maputaland Conservation Assessment (MCA). The purpose of this MCA was to identify a conservation landscape, which would include the existing PAs, new core areas and linkages to maintain connectivity.

1.4.1 Report aims

This report consists of four main chapters, together with a reference section and three appendixes, and has the following aims:

i) To describe how the Maputaland CPS was developed, with an emphasis on how the key conservation features were selected and mapped.

ii) To describe the results of the first MCA and explain how these outputs were used to design a conservation landscape for Maputaland.

iii) To discuss the results of the first MCA and make recommendations about how the Maputaland CPS could be improved in the future.

2.1 Introduction

The Maputaland CPS consists of a number of datasets which are described in this chapter. The first section explains how conservation features were selected to act as surrogates for the region's biodiversity. The second section describes how these landcover types, species and ecological processes were mapped and the final section describes how data on conservation opportunities, risk of agricultural transformation and potential game ranching profitability were developed.

2.2 Selecting the conservation features

The list of conservation features was developed during the project through discussions with a range of local experts. This list was then finalised during a workshop in Maputo in February 2006, which was attended by 18 experts from the three Maputaland range states (Figure 2-1). The workshop participants divided into the following 5 working groups; *Mammals*, *Non-Mammal Vertebrates*, *Invertebrates*, *Plants* and *Ecological Processes*. Each group developed a list of features and then presented their results to the workshop for comment. All the participants also commented on the landcover classification system and suggested modifications to the landcover features.

Figure 2-1: Conservation feature workshop participants

2.2.1 Landcover types

The landcover types of Maputaland show strong spatial patterns, and each type is restricted to one of the five main ecological zones (Figure 1-3). A previous project developed a landcover classification scheme for the South African section of Maputaland (Smith, 2001), based on earlier studies of the region's vegetation (Tinley & van Riet, 1981; Matthews et al., 1999; Matthews et al., 2001) and this acted as the basis for the classification scheme adopted for the present project. The South African system originally contained 35 categories, of which 30 were natural types. However, this was modified to merge categories that were difficult to distinguish using the satellite imagery. Thus, *Acacia tortilis* woodland and *Acacia nigrescens* woodland categories were merged into a new category named *Acacia* woodland, while *Acacia grandicornuta* bushland and *Acacia luederitzii* thicket categories were merged into a new category named *Acacia* thicket (Table 2-1; Figure 2-3).

The expert panel then decided that some of the landcover types should be further divided based on their geographic location (Table 2-1). All of the Lubombo zone types were divided into three sub-divisions: the North sub-division lies north of the Usuthu Gorge, the Central division lies between the Pongola Gorge and the Usuthu Gorge, and the South division lies south of the Pongola Gorge (Figure 2-2). The Cretaceous zone was divided into North and South divisions and the Usutu River acts as the dividing boundary. The floodplain grasslands were divided into North and South divisions, and the South division consists of the Mkhuze River system and all systems to the south. Finally, mangroves were divided into North and South divisions, with the South division including areas south of Kosi Bay (Figure 2-2). Thus, 44 landcover types were used as conservation features in the Maputaland CSP.

2.2.2 Species

The distributions of most species in Maputaland are thought to mirror that of their associated landcover types, so protecting each landcover type should automatically conserve most species. However, there are two exceptions to this pattern. First, some species have large ranges and so would not be conserved by protecting small or isolated patches of suitable habitat. Second, some species have a limited distribution within their associated landcover type, and so protecting these types might not be enough to conserve the species. So, these two criteria were used to identify which species should be included in the CPS.

The final Maputaland CPS includes data on 20 vertebrate (Table 2-2), 13 invertebrate (Table 2-3) and 20 plant species (Table 2-4). The majority of the mammal species and several of the bird species were selected because they had large ranges that might not be successfully conserved using landcover conservation features alone. The remaining species were selected because they have a restricted range within their associated landcover type. All of the species were seen as having conservation importance within Maputaland, although not all of them appear in national Red Lists of threatened species.

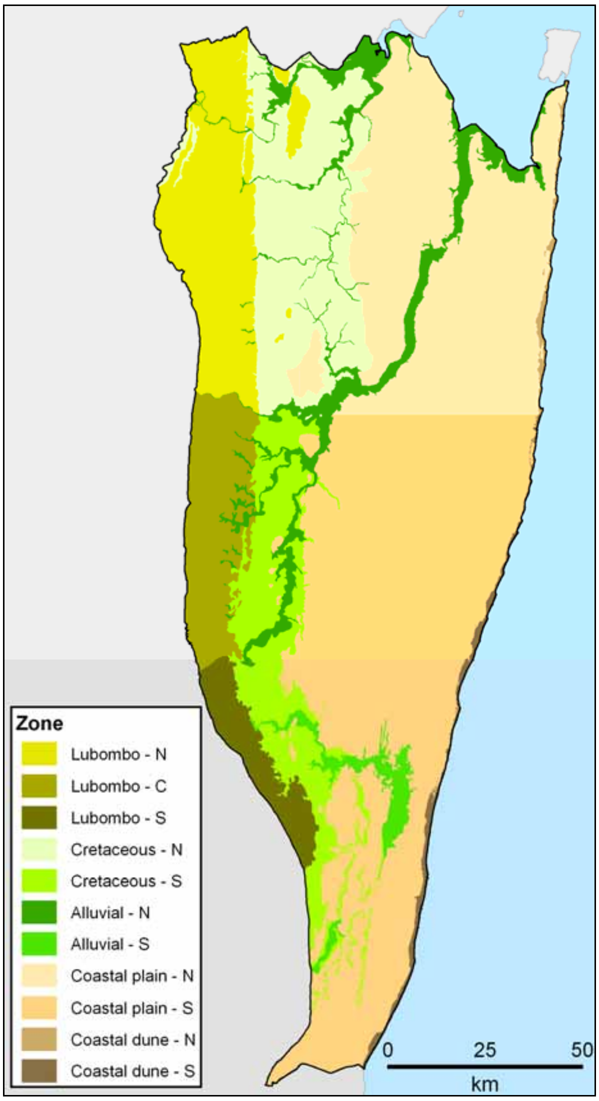

Figure 2-2: Geographic sub-divisions used in the landcover classification scheme

2.2.3 Ecological processes

The long-term conservation of Maputaland's biodiversity depends upon maintaining a number of ecological processes. Some of these processes, such as pollination, act over a fine spatial extent and so are probably represented by conserving any associated landcover types (Pressey et al., 2003). Therefore, the *Ecological Processes* working group focused on identifying features with a larger spatial extent.

A) Processes that maintain connectivity

Most of the selected ecological processes were associated with maintaining connectivity. This is important for ensuring the viability of those species with large ranges or those that form metapopulations, as well as for maintaining seed dispersal and connecting feeding and breeding grounds (Rouget et al., 2006).

Five connectivity based conservation features were identified and these are described below:

1) Maintaining east-west connectivity through the Lubombo Mountains

The Lubombo Mountains act as a natural barrier to east-west propagule movement. Thus, there is a need to maintain connectivity between the Maputaland coastal plain in the east and the tropical and temperate areas to the west of the Lubombo Mountains through river gorges.

2) Maintaining north-south connectivity along the Lubombo Mountains

The Lubombo Mountains provide connectivity between the tropics and sub-tropic zones, so there is a need to maintain this link.

3) Maintaining north-south connectivity along the coastal dune zone

The coastal dune zone provides connectivity between the tropics and sub-tropic zones, so there is a need to maintain this link.

4) Maintaining dry season/wet season corridors

There is a need to maintain east (dry season)/west (wet season) movement of fauna and flora.

B) Other ecological processes

Two other ecological processes that are not related to maintaining connectivity were identified and these are described below:

5) Maintaining fire regimes

Certain plant communities and species are dependent on traditional fire-burning regimes. Thus, it is important to maintain large enough areas to allow the implementation of appropriate fire regimes. The following landcover types are fire maintained and so targets were set to ensure that large patches of each type were represented: Lubombo woodland - North, Lubombo woodland – Central, Lubombo woodland - South, *Acacia* woodland - North, *Acacia* woodland - South, hygrophilous grasslands, woody grassland, *Terminalia* woodland, and, woodland on red sands.

6) Maintaining herbivory

Herbivory by a range of species is also needed to maintain certain plant communities and species. Thus, it is also important to maintain areas that are large enough to support natural grazing/browsing patterns. It was decided that the best way to maintain herbivory in Maputaland was to ensure that elephants were represented in the PA system. Therefore, it was not necessary to add any extra targets for this ecological process as elephants were already included in the CPS as a conservation feature.

2.3 Mapping the conservation features

The conservation features were mapped using the ArcView GIS software and all the data were converted to a raster format with a resolution of 25m (Appendix A). The specific details of the mapping process are described below.

2.3.1 Landcover types

The landcover map has a resolution of 25m and was derived from Landsat ETM and ASTER satellite scenes. The first step in this process was to adapt a landcover map of the South African section of Maputaland, which was derived from two Landsat TM scenes from 1997 and 1995 (Smith et al, 2006). This original map was modified to be consistent with the new landcover classification scheme and then new areas of subsistence agriculture, commercial agriculture and plantations were added by on-screen digitising ASTER scenes from 2001 and 2003. The same process was used to identify where *Eucalyptus* plantations have been cleared in GSLWP (Figure 2-3).

The Mozambique and Swaziland parts of Maputaland were also mapped using on-screen digitising of Landsat ETM scenes from 2000 and ASTER scenes from 2001 and 2003.

2.3.2 Species

The biodiversity of Maputaland is relatively well known but most of the species distribution data cannot be used because they are either recorded at too coarse a spatial scale or are affected by sampling bias (Lombard, 1995; Freitag et al., 1998). Therefore, we decided to base all of our species distribution maps on expert opinion and the Maputaland landcover map. Three methods were used, depending on the species, and these are described below:

i) ***Method based on landcover associations***. This involved using expert opinion to identify which landcover types provided suitable habitat for a particular species. It was then assumed that the distribution of the species mirrored that of its associated landcover types.

ii) ***Method based on landcover associations and distribution rules***. This was based on the landcover associations approach described above, but the modelled distributions were modified to exclude areas of associated landcover types that were not suitable based on other distribution rules. These rules, which were based on expert opinion, were species dependent and used factors such as elevation, slope, habitat patch size and distance to the coastline.

iii) ***Method based on landcover associations and range polygons***. This approach was based on literature reviews and expert opinion to map polygons within which a species was thought to occur. This information was then supplemented with landcover type association data to produce the final distribution map.

This landcover map was developed to represent the habitat types in the region accurately and so forms an important data source. However, it should be noted that these methods may over-estimate the distribution of some of the species in the CPS. This is especially likely for the habitat specialists that were mapped using the first two techniques described above. In addition, it is likely that the third technique under-estimates species' distributions, as the known ranges of these species are based on limited sampling.

2.3.3 Ecological processes

The important corridors were identified as part of the initial stage of the MCA, as they needed to link the core areas, so these were not mapped at the beginning of the process. The remaining ecological processes were based on representing large patches of key landcover types and conserving elephant habitat, and so these were based on the landcover map.

Table 2-1: Landcover types included in the Maputaland conservation planning system

Landcover type	Sub-divisions	Ecological zone
Conservation features		
Lubombo aquatic	North, Central and South	Lubombo
Rock-faces	North, Central and South	Lubombo
Lubombo grassland	North, Central and South	Lubombo
Lubombo woodland	North, Central and South	Lubombo
Lubombo thicket	North, Central and South	Lubombo
Lubombo forest	North, Central and South	Lubombo
Acacia woodland	North and South	Cretaceous
Acacia thicket	North and South	Cretaceous
Floodplain grassland	North and South	Alluvial
Reed beds		Alluvial
Riverine thicket		Alluvial
Riverine forest		Alluvial
Sedge and grass swamp		Coastal plain
Hygrophilous grasslands		Coastal plain
Woody grassland		Coastal plain
Terminalia woodland		Coastal plain
Woodland on red sands		Coastal plain
Sand thicket		Coastal plain
Sand forest		Coastal plain
Inland evergreen forest		Coastal plain
Swamp forest		Coastal plain
Mangroves	North and South	Coastal plain
Beach		Coastal dune
Dune thicket		Coastal dune
Dune forest	North and South	Coastal dune
Open Water		Other
Mud Flats		Other
Salt marsh		Other
Other landcover types		
Towns		
Subsistence agriculture		
Commercial agriculture		
Plantations		

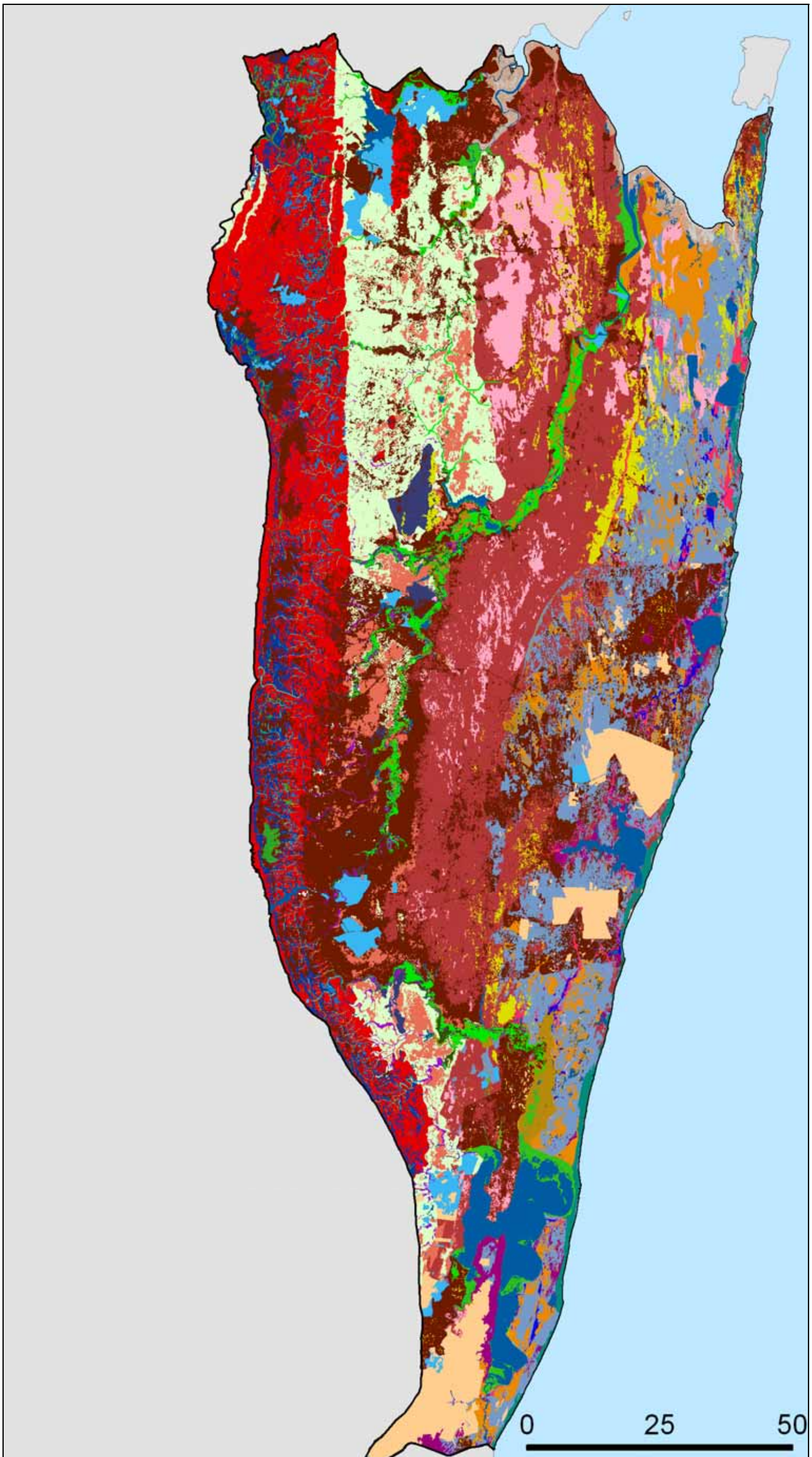

Figure 2-3: The Maputaland landcover map

Table 2-2: Vertebrate species included in the Maputaland CPS

Latin name	English name	Group name
Cercopithecus albogularis samango	Samango monkey	Mammals
Diceros bicornis	Black rhinoceros	Mammals
Loxodonta africana	African elephant	Mammals
Lycaon pictus	African wild dog	Mammals
Ourebia ourebi	Oribi	Mammals
Panthera leo	Lion	Mammals
Caprimulgus natalensis natalensis	Swamp nightjar	Birds
Circaetus fasciolatus	Southern banded snake eagle	Birds
Ephippiorhynchus senegalensis	Saddle-billed stork	Birds
Gyps coprotheres	Cape vulture	Birds
Halcyon senegaloides	Mangrove kingfisher	Birds
Neotis denhami stanleyi	Denham's bustard	Birds
Scotopelia peli	Pel's fishing owl	Birds
Bitis gabonica gabonica	Gaboon viper	Reptiles
Bradypodion setaroi	Setaro's dwarf chameleon	Reptiles
Cordylus warreni warreni	Warren's girdled lizard	Reptiles
Lycophidion pygmaeum	Pygmy wolf snake	Reptiles
Scelotes arenicolus	Zululand dwarf burrowing skink	Reptiles
Scelotes fitzsimonsi	Fitzsimon's dwarf burrowing skink	Reptiles
Scelotes vestigifer	Coastal dwarf burrowing skink	Reptiles

Table 2-3: Invertebrate species included in the Maputaland CPS

Latin name	English name	Group name
Streptocephalus dendrophorus	Fairy shrimp	Crustaceans
Ornipholidotus peucetia penningtoni	Pennington's white mimic	Butterflies
Iolaus lulua	White-spotted sapphire	Butterflies
Agriocnemis ruberrima ruberrima	Orange whisp	Odonates
Gynacantha zuluensis	Zulu darner	Odonates
Lamellothyrea descarpentriesi	St Lucia purple fruit chafer	Fruit chafers
Parepistaurus eburlineatus	Ivory-striped wingless grasshopper	Grasshoppers
Parepistaurus inhaca	Inhaca wingless grasshopper	Grasshoppers
Natalina wesseliana	Maputaland cannibal snail	Snails
Doratogonus major	Major large black millipede	Millipedes
Gnomeskelus petersii	Peter's flat-backed millipede	Millipedes
Spinotarsus ingwavuma	Ingwavuma slender spined millipede	Millipedes
Proandricus hlatikulu	Hlatikulu earthworm	Earthworms

Table 2-4: Plant species included in the Maputaland CPS

Latin name	English name
Brachystelma vahrmeijeri	-
Celtis gomphophylla	False white stinkwood
Celtis mildbraedii	Natal white stinkwood
Crassula maputensis	-
Encephalartos aplanatus	-
Encephalartos ngoyanus	-
Encephalartos umbeluziensis	-
Excoecaria madagascariensis	-

Table 2-4 (continued): Plant species included in the Maputaland CPS

Latin name	English name
Ficus bubu	Swazi fig
Hawortia limifolia sub umbomboensis	-
Helichrysum tongense	-
Nidorella tongensis	-
Ozoroa sp. Nov (suffrotex)	-
Pelargonium tongaense	Tonga pelargonium
Raphia australis	Kosi palm
Rhus kwazuluana	-
Streptocarpus confusus lebomboensis	-
Thesium vahrmeijeri	-
Vanilla roscheri	-
Warburgia salutaris	Pepper-bark tree

2.4 Opportunity and cost data

Conservation assessments should not be based on biodiversity information alone and a range of other data can be included to increase their real-world relevance. One commonly used type of data is land price, as this allows assessments to identify low-cost portfolios (Pence et al., 2003). However, we decided not to use this type of economic data in the Maputaland conservation planning system because much of the region is communally owned. This means that most conservation initiatives will involve local communities deciding to manage their land for biodiversity, making the financial value of individual planning units less relevant to the decision making process.

Instead, we included three other types of data that were more relevant for Maputaland. First, we used the available maps to identify where existing and proposed private and communally-owned game reserves are located. Second, we identified which parts of Maputaland were most at risk of being cleared for agriculture and, third, we modelled potential game ranch profitability for all the landcover types. The methodologies used for producing these spatial datasets are described below.

2.4.1 Conservation opportunity data

There are a number of privately- and communally-owned game reserves and game ranches in Maputaland (Figure 2-6) but some of these are still being developed and not all of them have been gazetted and mapped. In addition, some of these reserves are managed to maximise game productivity and not for biodiversity. Therefore, it was decided not to treat these areas as being equal to the state-run PAs in the MCA. Instead, we used the available GIS data to guide the final assessment so that these reserves were included whenever possible.

2.4.2 Likelihood of agricultural transformation

The likelihood of subsistence agricultural transformation map was produced using results from a previous analysis (Smith, 2001), which found that the spread of subsistence agriculture in the South African section of Maputaland was predicted by distance to existing subsistence agriculture, ecological zone, slope and elevation. Thus, land that was most likely to be transformed tended to be close to existing farmland, on Cretaceous or Alluvial soils and on flat low-lying ground.

We decided to use this South Africa-based model for the whole of Maputaland for two reasons. First and most importantly, landcover change patterns in Mozambique have been strongly affected by the civil war, and some farmland was abandoned and is reverting to woodland and thicket. This means that past patterns in Mozambique are likely to be very different from future patterns and these future changes were felt more likely to resemble those shown in South Africa. Second, Swaziland makes up a relatively small proportion of Maputaland and so it was not thought appropriate to re-analyse the data using information from South Africa and Swaziland.

Thus, the risk of agricultural transformation map was derived from the original model and based on the landcover, ecological zone, elevation, and slope maps (Figure 2-4). Previous work has shown that spatial patterns of plant use in Maputaland are also related to distance from subsistence agriculture (Brookes, 2004; McRae, 2005), so it is likely that risk of agricultural transformation also acts as a surrogate for risk of natural resource over-harvesting.

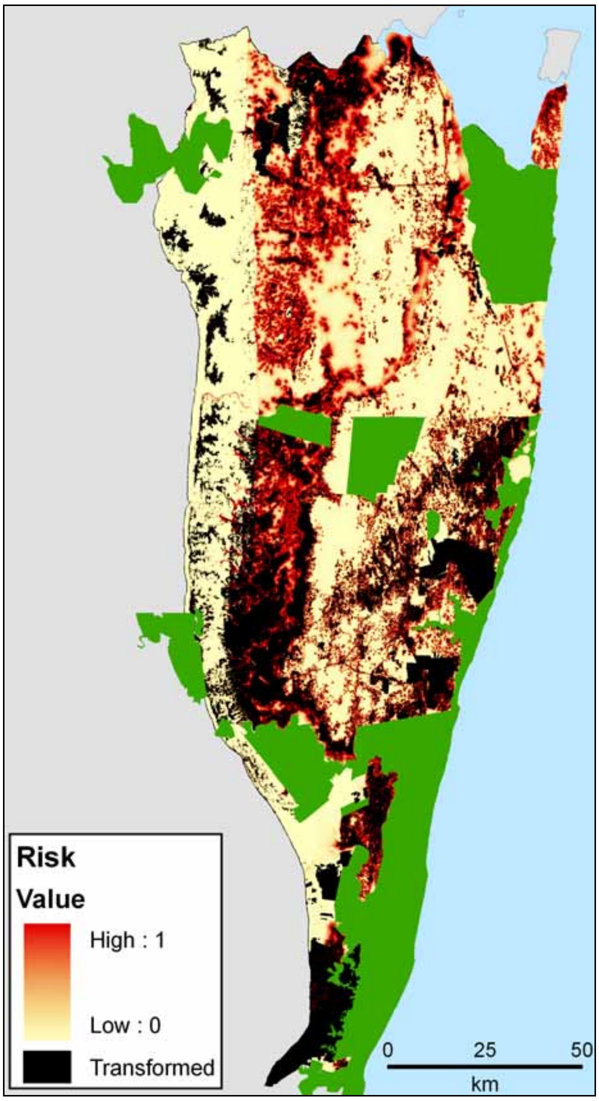

Figure 2-4: Likelihood of agricultural transformation maps

2.4.3 Potential game ranch profitability

The potential trophy hunting profitability map was based on a project that used EKZNW game count data from Mkhuze Game Reserve, Ndumo Game Reserve and Tembe Elephant Park (Easton, 2004). The project focused on 25 native ungulate species that are either found on game ranches in Maputaland or have the potential to be ranched in the future.

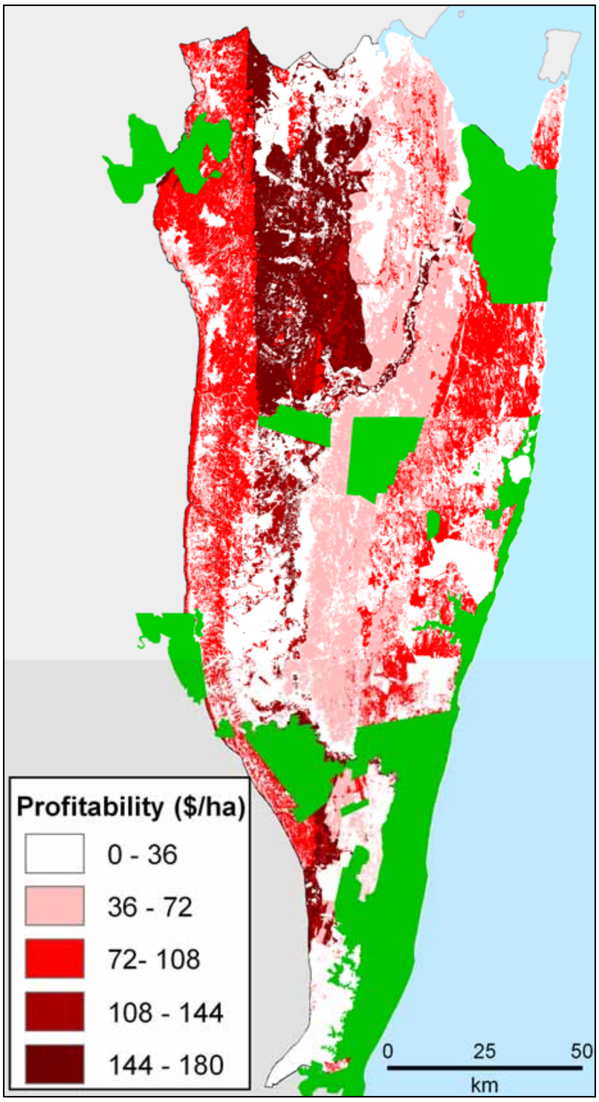

Figure 2-5: Potential annual game ranch profitability map measured in US$/hectare

The data were used to estimate the density of each game species in each of Maputaland's landcover types. These density estimates were then combined with game ranching data from 2004 to estimate potential profitability from trophy hunting and biltong hunting for each landcover type (Figure 2-5).

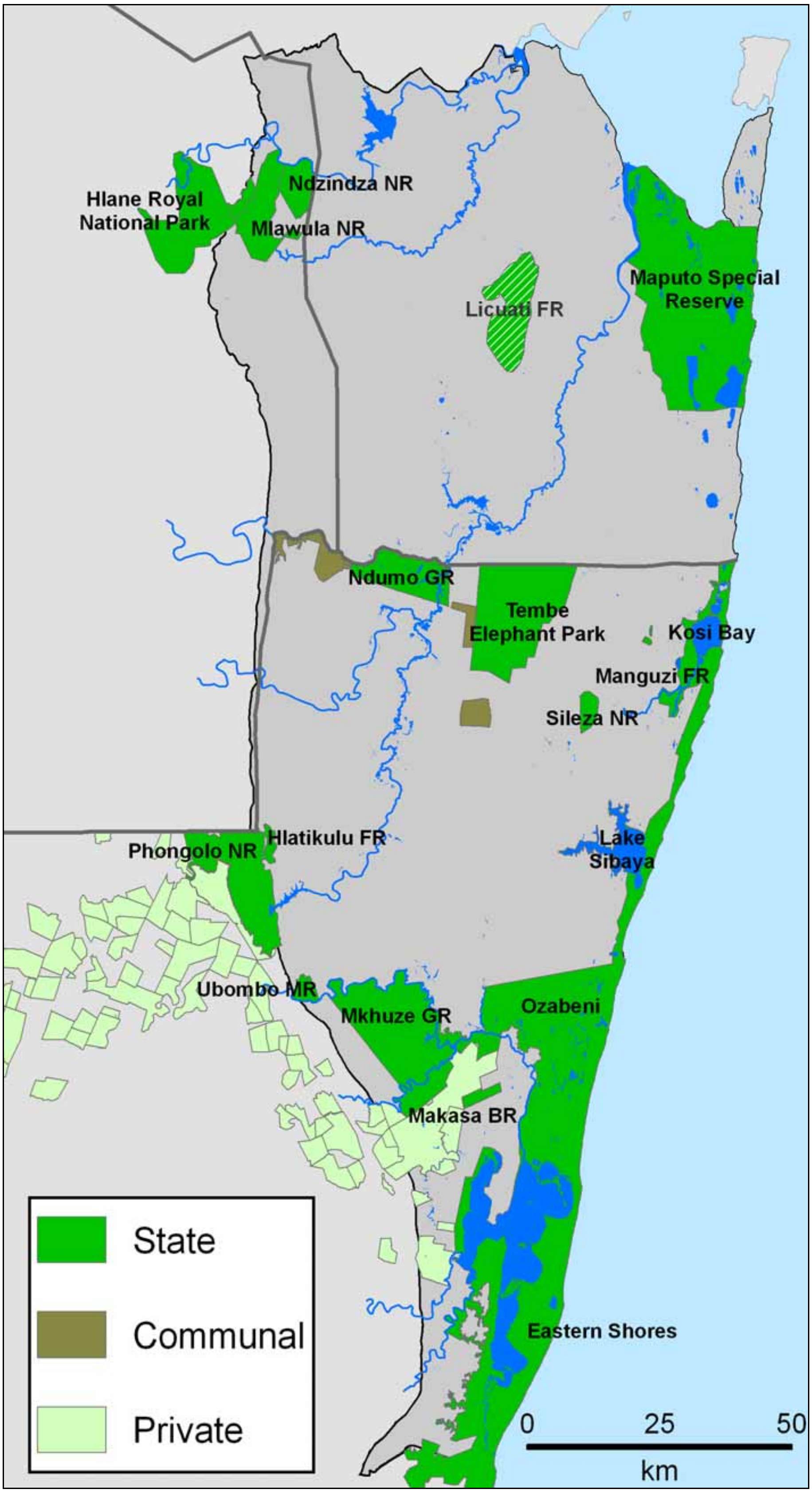

Figure 2-6: The PAs, private and communally managed reserves of Maputaland

(BR = Biosphere Reserve, FR = Forest Reserve, GR = Game Reserve, NR = Nature Reserve). The Licuati Forest Reserve is shown here but was not set as being conserved in the assessment)

3.1 Introduction

The first MCA aims to identity a potential conservation landscape that would ensure the long-term persistence of the region's biodiversity, and this chapter describes how this landscape was developed. The first section details how representation targets were set for each conservation feature. This is followed by an explanation of the assessment process, which involved identifying the planning units that should form the conservation landscape and identifying core conservation areas within this landscape. The final section details the effectiveness of the current PA system and gives the assessment results.

3.2 Setting the representation targets

Systematic conservation planning is a target-driven process and any conservation assessment is strongly affected by these values (Svancara et al., 2005), with more land needed to meet higher targets. In the past, many targets have been based on political expediency, but it is important that each target is set to ensure the long-term persistence of its associated conservation feature. This section describes how these targets were developed for the Maputaland CPS.

3.2.1 Landcover types

The landcover type targets were based on a methodology that uses phytosociological relevé data to produce species-area curves for each habitat type (Desmet & Cowling, 2004). These curves are then used to estimate the area of each habitat type needed to ensure that a specified proportion of the associated plant species are represented.

The South African National Biodiversity Institute (SANBI) has used this methodology to set targets for each vegetation type listed in the national vegetation classification system (Driver et al., 2005), and these results have been modified by EKZNW to produce targets for each vegetation type in KZN (Goodman, 2002). Therefore, we decided to adopt this approach in Maputaland by following these steps:

i) We estimated the original extent of each landcover type, based on the proportion of its associated ecological zone that has been transformed. This was then adjusted based on estimates of its relative likelihood of being transformed, when compared with the other landcover types found in the same ecological zone.

ii) We identified which of the South African vegetation types most closely corresponded with each of the Maputaland landcover types and assigned the associated proportional target that was developed by EZKNW.

iii) We multiplied the estimated extent of each landcover type by the proportional target to give a final area-based target measured in hectares (Appendix B).

3.2.2 Species

We used two methods for producing targets for the different species, depending on data availability and levels of expert knowledge, and these are described below:

i) ***Minimum viable populations***. We decided that Maputaland should contain a viable population of most of the species included in the planning system (Appendix B). If a distribution map included density data then we set the targets as being 1000 adult individuals (Warman et al., 2004). Targets for the remaining species were measured in hectares and these were based on the minimum viable population analyses that were undertaken for the KZN CPS. Some species are represented in both the Maputaland and KZN systems, but most of the Maputaland species targets were based on targets for similar species or taxonomic groups from KZN.

ii) ***Proportion of metapopulation***. Some of the animals species included in the CPS have very large ranges, so that Maputaland only forms a proportion of a metapopulation. For these species we first set the minimum viable metapopulation size based on expert opinion. We then estimated the proportion of the metapopulation that falls within Maputaland and set the target as equalling the same proportion of the metapopulation size.

The initial targets for four of the plant species, *Excoecaria madagascariensis*, *Nidorella tongensis*, *Streptocarpus confusus lebombo* and *Vanilla roscheri*, were higher than the total amount of habitat found in Maputaland. This was because little is known about the individual traits of these species and so their targets were based on data from similar species in KZN. We felt that it was important to include these species in the final conservation assessment, but were reluctant to set such high targets, based on the quality of the underlying data. Therefore, we changed these targets to equal 50% of the total area of habitat for each of the four species (Appendix B).

3.2.3 Ecological processes

The ecological process targets were based on expert review and developed by the relevant working group. Most of the ecological processes ensured connectivity and for these the group set targets based on creating linkages (Appendix B). In addition, the group set area-based targets to ensure the maintenance of natural fire regimes.

3.3 Conservation assessments using MARXAN and CLUZ

The MCA used the computer program MARXAN to help identify suitable conservation portfolios (Ball & Possingham, 2000). This software uses simulated annealing techniques to identify near-optimal conservation portfolios, which meet the representation targets whilst minimising planning unit costs. The software is also designed to choose patches of planning units whenever possible, by including a cost based on the portfolio’s external edge. MARXAN acts to reduce this boundary cost, which helps ensure that the conservation portfolios are more ecologically viable and easier to manage.

The simulated annealing process involves running the software a number of times, as it is based on a selection process that generally identifies different portfolios at the end of each run. MARXAN then identifies the best of the portfolios that is has produced, ie the portfolio that meets all the targets and has the lowest total cost based on summing the planning unit costs and the boundary costs. In addition, it produces the summed solution output, which calculates the number of times each planning unit appeared in the different portfolios produced by the different runs. This summed solution is a type of irreplaceability score (Ferrier et al., 2000), with the most important planning units appearing in the largest number of different runs. MARXAN is a stand-alone computer program, so this assessment also used the CLUZ ArcView extension (Smith, 2004) to import and export the data and refine the initial MARXAN outputs.

This section explains how MARXAN and CLUZ were used to develop the MCA outputs, beginning with a description of how the MARXAN input files were developed from the available PA, biodiversity and risk data. This is followed by a description of how the boundaries of the conservation landscape were defined, and an explanation of how the core areas within the landscape were identified.

3.3.1 Developing the planning unit data

The planning unit system was based on a series of 1km^2 hexagons but it was decided that each PA should also be represented as one planning unit. Therefore, we used ArcView’s Union option to combine the hexagon shapefile with the PA shapefile. The final system consisted of 14 PA planning units, 13,820km^2 hexagon planning units and 1,167 hexagon fragments that bordered the PAs. Thus, in total there were 15,001 planning units in the Maputaland CPS.

It was assumed that all of the PA planning units were conserved and should appear in any conservation portfolio. In addition, planning units were excluded from any possible conservation portfolio if more than 25% of their area consisted of commercial agriculture, if more than 80% of their area consisted of subsistence agriculture, or if more than 80% of their area consisted of commercial or subsistence agriculture (Smith et al., 2006). The status of all other planning units was set as being available and so these units could be selected by MARXAN if required.

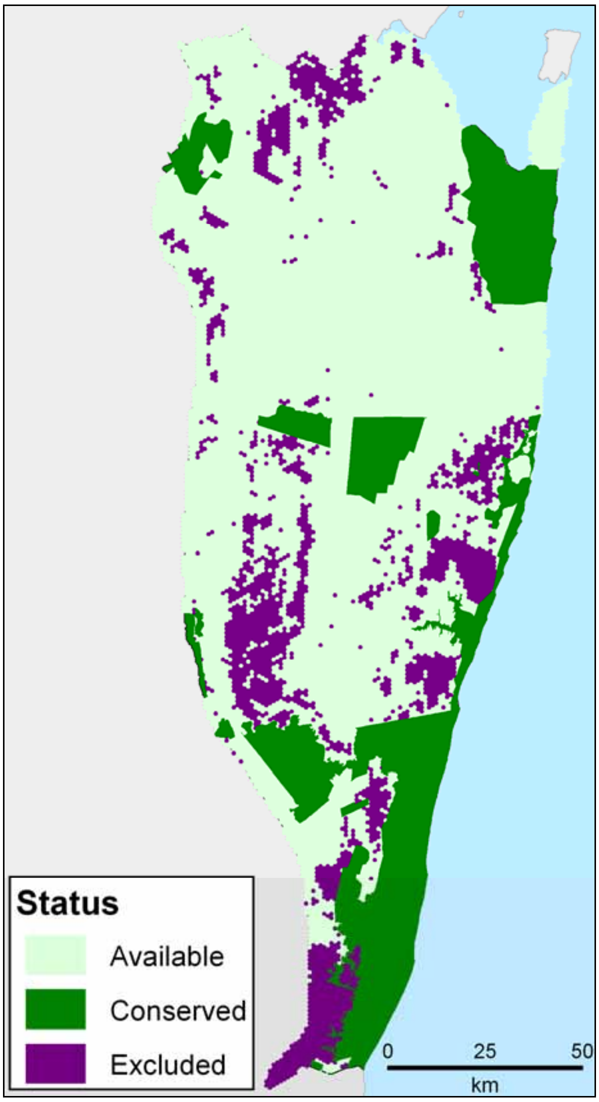

Figure 3-1: Conserved and excluded units

The cost of including a planning unit in a portfolio was based on its risk of being cleared for subsistence agriculture. The final cost was calculated by summing all of the values in the risk map that fell within each planning unit. This was considered a more appropriate measure than mean risk, as it ensured that smaller planning units generally had lower costs and so were not overly penalised for also containing less biodiversity.

3.3.2 Assessment stage 1 – Designing the conservation landscape

The conservation landscape was defined as the part of Maputaland that contains the existing PAs and any new core areas and linkages needed to maintain connectivity and meet the ecological process targets. MARXAN is not able to identify portfolios that meet the ecological process targets, so we first identified planning units that were important for meeting the targets for the landcover types and species. We did this by running MARXAN 200 times, where each run consisted of two million iterations. To increase the likelihood of identifying low-cost portfolios we used a two-step process that followed simulated annealing with iterative improvement. Based on trial and error, we used a boundary length modifier value of 2, as this produced portfolios that were neither highly fragmented nor too extensive to be politically unacceptable.

MARXAN identified 200 near-optimal portfolios and the four best portfolios were displayed. In addition, MARXAN was used to produce irreplaceability scores for each planning unit, based on the number of times that each planning unit appeared in the 200 portfolios. This irreplaceability map was then used to design the conservation landscape by undertaking the following steps:

i) All of the planning units that appeared in at least 100 of the 200 runs of the initial assessment were selected.

ii) Any patches of planning units that were smaller than $10km^2$ were removed from the landscape.

iii) New planning units were added to the portfolio to ensure that all of the connectivity targets were met.

3.3.3 Assessment stage 2 – Identifying the core areas

The core areas were selected to ensure that, when combined with the existing PAs, they met all of the representation targets for the landcover types and species. This involved the following steps:

i) MARXAN was run using the same parameters that were used in the initial assessment but the analysis was restricted so that it could only select planning units found in the conservation landscape.

ii) All of the planning units that appeared in the best portfolio identified by MARXAN as core areas were selected but any patches of planning units that were smaller than $10km^2$ were removed.

iii) Landcover types and species that were under-represented in the new PA system were identified and new core areas were added to meet their targets. This involved adding extra planning units to meet the targets for *Brachystelma vahrmeijeri*, *Streptocarpus confusus lebombo* and the sedge and grass swamp.

3.4 Results

The results section begins with a review of the effectiveness of the current Maputaland PA system. This is followed by results from the first and second stages of the assessment and the final section discusses the potential for making modifications to the conservation landscape.

3.4.1 Current representation levels

Fourteen PAs fall partly or completely within Maputaland (Figure 1-2) and these protect an area of 360,151ha. These PAs ensure that the representation targets are met for 53 of the 110 conservation features (Figure 3-2).

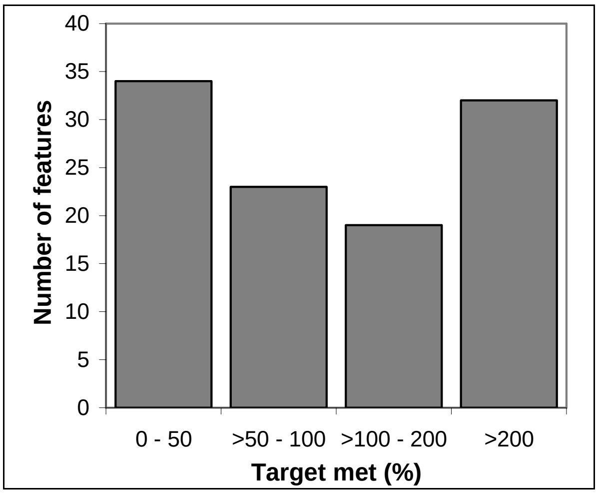

Figure 3-2: Details of PA system target fulfilment

This meant that 27% of the landcover types and 65% of the species targets are met, with the median percentage target met for the remaining features being 44%. This ranged from 0% for 6 features and 99.8% for the Lubombo aquatic South landcover type (Appendix 2).

3.4.2 Assessment stage 1

The initial assessment identified 200 different portfolios and was used to produce an irreplaceability score map, which showed the number of times that each planning unit appeared in the 200 portfolios (Figure 3-3). The results showed that 642 of the planning units were identified as being irreplaceable because they appeared in all of the 200 portfolios. An additional 3,750 planning units appeared in at least 100 of the portfolios, whereas only 119 of the available planning units failed to appear in any of the portfolios.

There were areas of high irreplaceability to the south of Mkhuze Game Reserve, around Lake Sibaya and Sileza Nature Reserve, to the south-west of Maputo Special Reserve, north and south of Ndumo Game Reserve, north of Tembe Elephant Park and around Mlawula Nature Reserve (Figure 2-6, Figure 3-3). However, it should be noted that irreplaceability is a measure of whether the planning unit could be swapped for other planning units without affecting the number of targets that are met by a portfolio. Thus, many planning units with low or medium irreplaceability scores are also needed to meet the representation targets (Figure 3-4).

The combined cost of each of the portfolios was calculated as the total planning unit costs plus the total boundary length costs, and these ranged between 5,978,151 and 6,983,510 for the 200 portfolios. The four best portfolios had total portfolio costs of between 5,978,151 and 6,187,720 and all four portfolios selected the same regions to the south of Mkhuze Game Reserve, to the south-west of Maputo Special Reserve and north of Ndumo Game Reserve and Tembe Elephant Park (Figure 3-4).

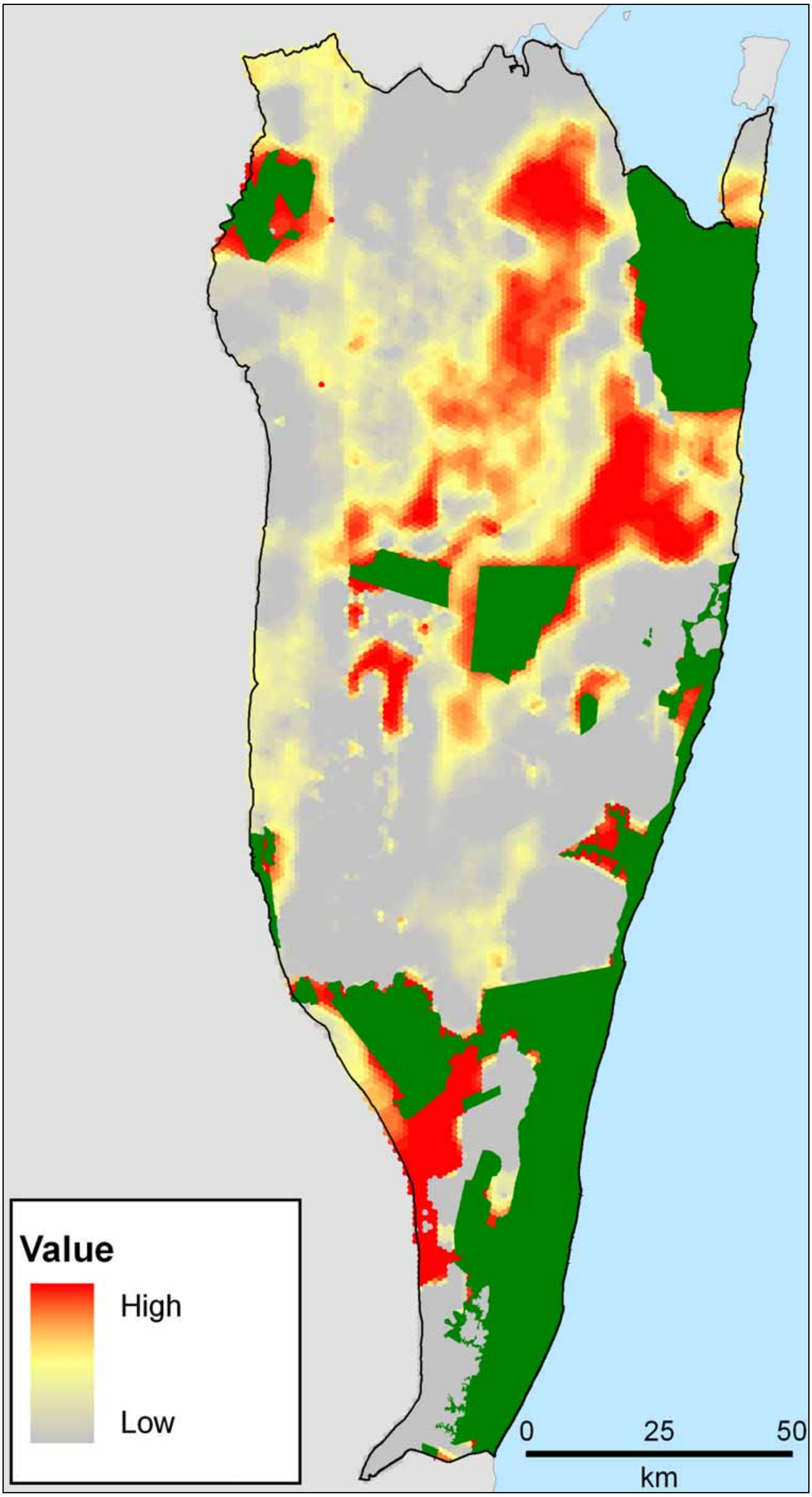

Figure 3-3: Irreplaceability scores based on meeting targets for the landcover types and species

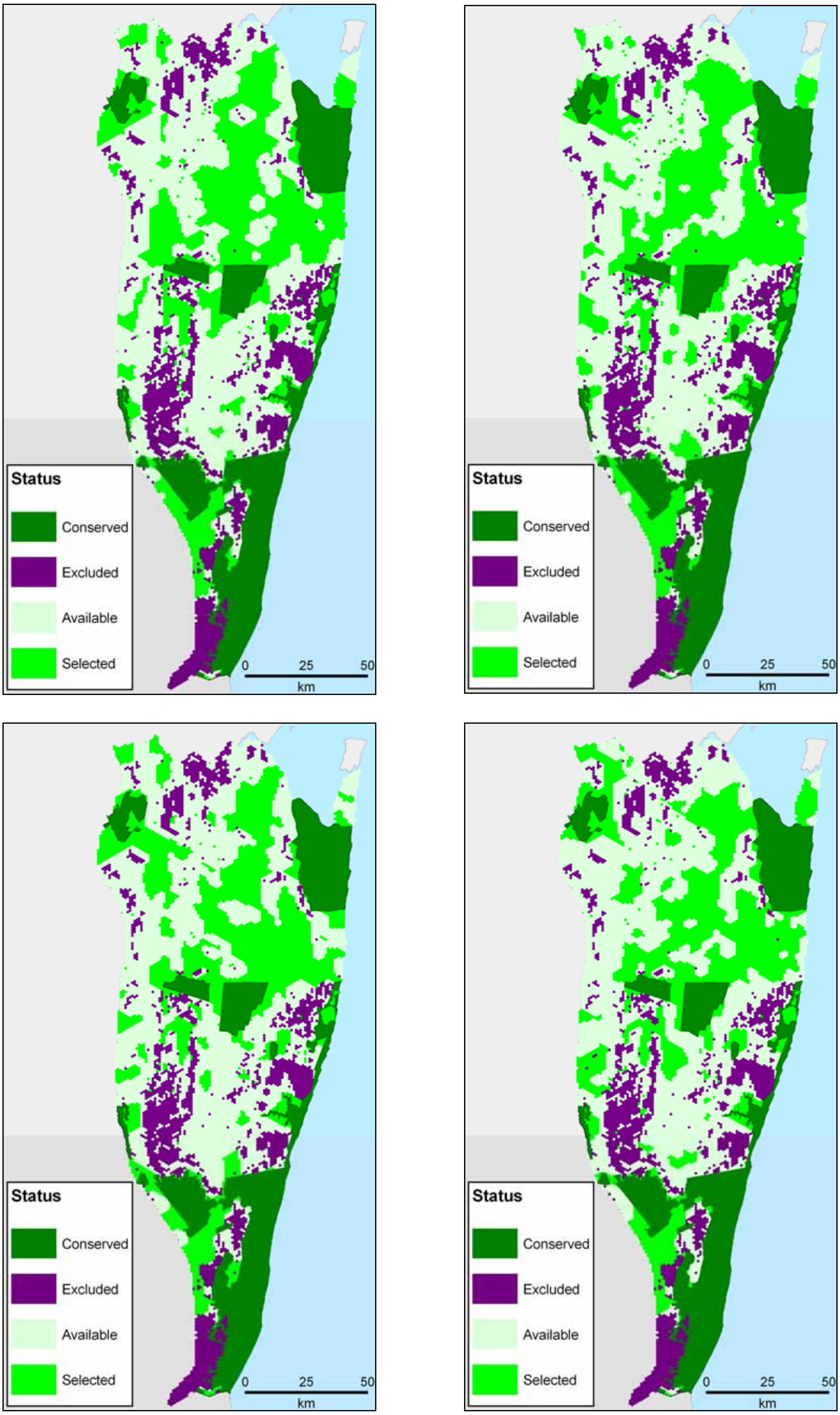

Figure 3-4: The four best portfolios identified by MARXAN (selected units shown in bright green)

The proposed conservation landscape consists of 7,319 planning units and covers an area of 10,536km^2, of which 6,935km^2 falls outside the existing PA system (Figure 3-5). A large proportion of the landscape falls within Mozambique, although there are also significant new areas in the north of Swaziland.

3.4.3 Assessment stage 2

The MARXAN analysis selected a number of new core areas within the conservation landscape and most of these add to or join existing PAs (Figure 3-6). These have a total area of 4,940km^2 and conserving them would ensure that all of the landcover and species representation targets are met. The final assessment also identified a number of linkages that are needed to meet the ecological process targets and cover a total area of 1,995km^2.

Comparing the final results from the MCA with the irreplaceability scores from the first stage of the assessment shows that much of the conservation landscape is irreplaceable (Figure 3-7). However, the landscape also contains some areas with lower irreplaceability scores and these could be swapped for other planning units that contain similar amounts of each landcover type and species. This is especially the case for the Cretaceous zone in Mozambique and some of the landscape linkages.

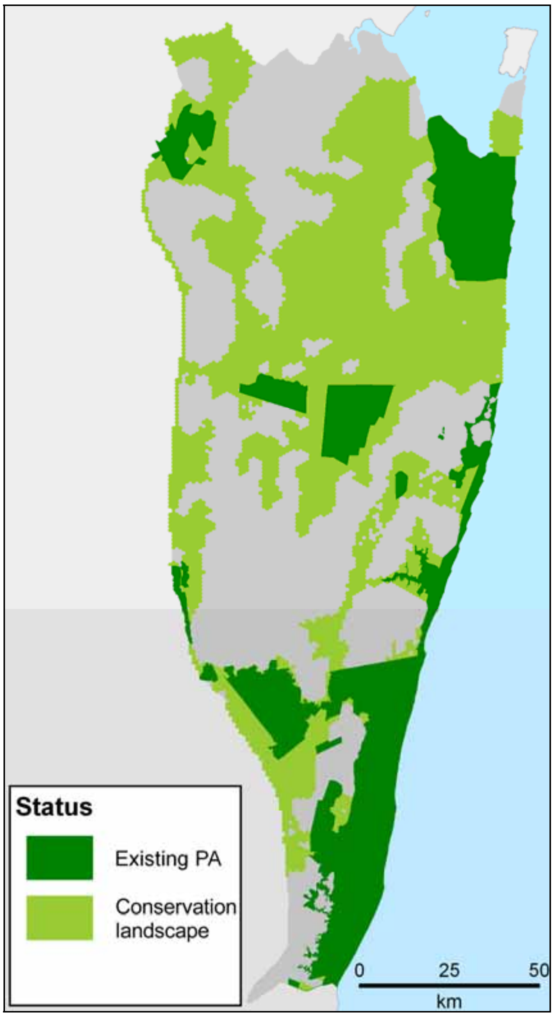

Figure 3-5: Boundaries of the proposed conservation landscape for Maputaland

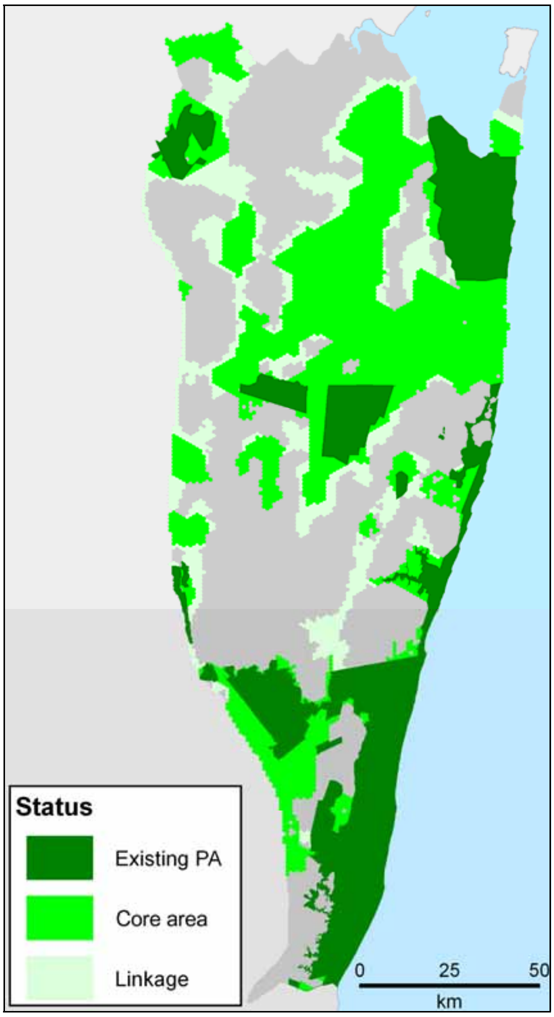

Figure 3-6: Suggested zoning system for the Maputaland conservation landscape

Combining the assessment results with the agricultural transformation risk data shows that most of the landscape has a low likelihood of being converted to agriculture (Figure 3-8). However, there are some core areas to the north of Maputo Special Reserve, around Lake Sibaya and to the north and south of Ndumo Game Reserve that are more at risk. Thus, it would be better to focus resources on conserving these areas first, before they lose their conservation value.

One way of helping to conserve this landscape is to encourage the establishment of sustainable harvesting projects, particularly on communally-owned land. The economic potential of these industries obviously depends on a number of factors but results from an initial study (Easton, 2004) suggest that the core areas have the potential to produce US$36 million of game animals for trophy and biltong hunting, while the linkages could produce US$14.8 million.

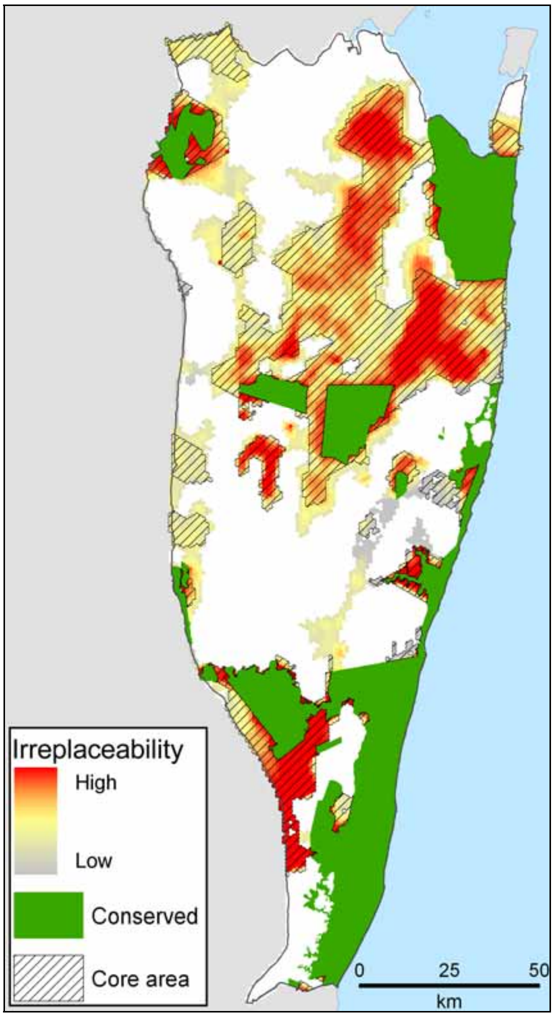

Figure 3-7: Initial irreplaceability scores for the conservation landscape

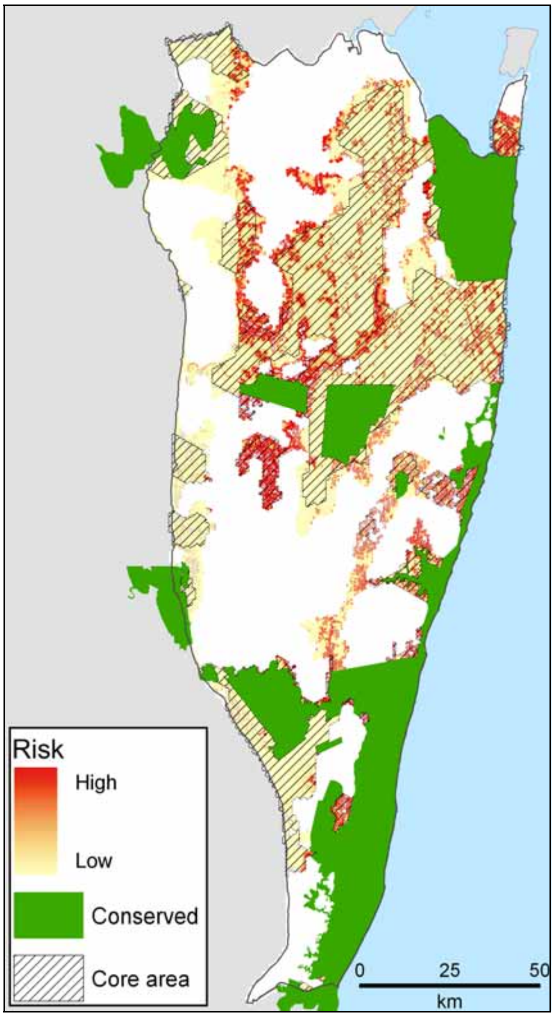

Figure 3-8: Agricultural transformation risk for the conservation landscape

4 DISCUSSION AND RECOMMENDATIONS FOR FUTURE WORK

4.1 Introduction

Systematic conservation planning is a long term process that should involve a series of conservation assessments. This chapter discusses the results from the first MCA and makes recommendations for future work. The first section focuses on recommendations on how the MCA results should be adapted and disseminated to ensure that they are used by the relevant implementation agencies. The second section suggests how the next MCA could be improved by collecting further data and modifying the conservation planning software. The final section provides recommendations for the long-term development of the Maputaland CPS, focusing both on improving the quality of biodiversity distribution data in Maputaland and on ensuring that the system becomes a mainstream part of the region's land-use planning system.

4.2 The first Maputaland Conservation Assessment

This iteration of the MCA is the first transnational conservation assessment for this important region. It provides essential information on the effectiveness of the current PA system and identifies a number of important areas that need to be protected to conserve Maputaland's biodiversity. This section discusses the results from the MCA and makes suggestions on how these outputs should be adapted and incorporated into the land-use decision making process.

4.2.1 A discussion of the MCA results

The present PA system meets 53 of the 110 conservation feature targets, and >50% of the target value for an additional 23 features. However, this means that a number of features are not fully conserved in the PA system, with landcover types in the north of Maputaland and plant species particularly poorly protected (Appendix B). This is why many of the irreplaceable areas within Maputaland are found around Mlawula Nature Reserve and to the west and south of Maputo Special Reserve. Thus, the MCA shows that the biodiversity of the Mozambique and Swaziland sections of Maputaland is relatively less well protected than the South African section. However, some parts of the South Africa section have high irreplaceability levels and the most obvious of these is found to the south of Mkhuze Game Reserve. Additional areas lie to the south of Ndumo Game Reserve and around Tembe Elephant Park, Sileza Nature Reserve and Lake Sibaya (Figure 2-6).

The irreplaceability scores were used to define Maputaland's conservation landscape, ensuring that all of the important areas described above were included. A number of additional areas were added to ensure that the connectivity targets were met and these included a corridor that stretches along the west side of the Lubombo Mountains and another that joins the north-west corner of Ozabeni with the Sileza Nature Reserve.

Comparing the conservation landscape with the original irreplaceability map shows that a few of the core areas and some of the linkages have relatively low irreplaceability scores (Figure 3-3). Therefore, these areas could be swapped with other similar areas without affecting target attainment. It should also be noted that these irreplaceability scores are partly based on connectivity value, so that any planning unit that neighbours an existing PA automatically has a higher value. Thus, establishing new PAs in the future could automatically increase the irreplaceability values of any adjoining areas (Smith et al., 2006).

The risk of agricultural transformation map suggests that initial conservation action should focus on the parts of the landscape that fall within the Cretaceous and Alluvial zones in central and northern Maputaland (Figure 3-8).

The results of the MCA also confirm the importance of current TFCA initiatives. All four of the TFCA zones fall within the Maputaland conservation landscape and so there is great scope for the MCA to help refine these TFCA boundaries. The only large core area that is not covered by a TFCA zone is the one to the south of Mkhuze Game Reserve, but this falls within a number of private game reserve and so is likely to maintain its conservation value without further intervention. There are, however, many parts of the conservation landscape that fall outside the boundaries of these existing or proposed conservation initiatives. Thus, it is important for decision makers to recognise that implementing the proposed TFCA will only be part of the process of conserving Maputaland's biodiversity.

4.2.2 Mainstreaming the Maputaland Conservation Assessment

Two steps are needed to ensure that the results from the MCA are used for making land-use decisions in Maputaland. First, the results from the MCA need to be discussed with the implementation agencies and adapted where necessary. Such changes may need to incorporate information that was either not available during the MCAs development or could not be captured in a spatial form. In particular, it will be important for information on future funding opportunities and local community support to be used to identify areas where conservation action is most feasible.

Second, it is vital that the results from the revised MCA are disseminated in a format that can be used by the different implementation agencies (Pierce et al., 2005). These products should include maps showing priority areas both at a region wide and local district level, as well as documents explaining how these areas could be managed to maintain their important biodiversity.

4.3 Future Maputaland Conservation Assessments

Conservation assessments should be repeated whenever new relevant data and resources are available. It is hoped that the next MCA will be carried out during 2007, which represents a relatively short time between successive MCAs. However, this is advisable because a number of conservation initiatives are currently underway in Maputaland and so the PA system is constantly being expanded and funds are available for this new MCA to be undertaken. In addition, the first MCA identified a number of ways in which the Maputaland CPS could be improved, so in this section we will list the improvements that should be adopted before future MCAs are undertaken.

4.3.1 Improved conservation feature data

The conservation feature data in the Maputaland CPS could be improved in a number of ways but our main suggestions are listed below:

A) Improved landcover data

The Maputaland landcover system should be refined by sub-dividing the following types: Lubombo aquatic, Lubombo thicket, Lubombo forest, *Acacia* woodland, *Acacia* thicket and *Terminalia* woodland. In addition, the hygrophilous grasslands should be mapped using satellite imagery from a range of dates to identify when these areas are flooded. Further work is also needed to map the extensive charcoal collection areas in Mozambique, which are difficult to distinguish from less impacted woodland on the satellite imagery.

B) More species

A number of species were selected for inclusion in the Maputaland CPS but a lack of data on their distributions made them difficult to map accurately, and so they were excluded from the final system (Appendix C). These included five mammal, two bird, one reptile and two fish species (Table C-1) and we recommend that these should be mapped and included in the next MCA.

C) Improved species distribution models

The species distribution models were rule-based and assumed that a species was found wherever suitable habitat was available. This was the only appropriate approach, given the lack of distribution data, but we suggest that this could be refined by further expert review. In particular, this expert review should allow for distribution changes due to over-harvesting of some relevant species. This expert review should also be used to refine the distribution maps of species, such as the pink-backed pelican and Cape vulture, which have specific feeding patterns that could be better represented spatially.

D) Improved ecological process data

Several suggested ecological processes were excluded from the Maputaland CPS because of a lack of data (Table C-1) but these should be included in future MCAs. In particular, it is important that data on the hydrology of

Maputaland is included as this plays an important role in maintaining current biodiversity levels (Taylor et al., 2006).

E) Improved target data

The conservation landscape design is highly dependent on the target values, so it is important that they are based on the best available data. The landcover type and large mammal targets were developed using widely recognised techniques and high quality information and so these can be used with relative confidence. In contrast, some of the other species targets had to be based on target setting exercises for similar species and these need to be reviewed further and improved where necessary.

F) Including freshwater and marine data

The MCA focused on Maputaland's terrestrial biodiversity because of data availability and time constraints. However, it is vital that future assessments also include data on freshwater and marine biodiversity, as this will allow the development of a conservation landscape and seascape that would be more ecologically viable and easier to manage.

4.3.2 Improved opportunity and constraints data

A number of extra datasets would improve the real world relevance of the Maputaland CPS. Most of these would focus on the economic value of the region's ecosystem services and these should include data on water provision, fisheries and plant resources. Data on the spatial distribution of charcoal production should also be used to identify areas that are threatened by unsustainable charcoal collection, as well as estimating the financial value of a sustainable charcoal industry.

4.3.3 Improved software

The MCA used the MARXAN computer program because this conservation planning software has a number of unique and relevant features. In addition, the developers of MARXAN are continuously updating and improving the software based on user feedback. The developers plan to release a modified version of MARXAN in the near future named MarZone, which will allow users to develop conservation plans that include different types of management zones. More specifically, MarZone will allow zone-specific targets to be set for each conservation feature and this has definite relevance for future MCAs. For example, it would allow separate targets to be set for state-, private- and communally-managed PAs and it would also allow different targets to be set for strict protection and sustainable harvesting zones.

More long-term versions of MARXAN could be enhanced in a number of other ways but the MCA has identified two key improvements. First, a function should be added that allows the minimum core area size to be specified. The current version often identifies portfolios containing patches of planning units that are too small to be ecologically viable. The only way to minimise the number of these small patches is to increase the boundary length modifier, but this indirect approach can lead to overly-large portfolios. Second, a function should be added that allows the minimum patch size for key species to be specified.

The MCA overcame these limitations by running an initial analysis, based on meeting the area-based targets alone, and then modifying the portfolio to meet the connectivity and patch-based targets. This reduced the real-world relevance of the initial MARXAN outputs and made it more difficult to explain the conservation assessment process to the relevant stakeholders. Thus, we feel that it is important that members of the Maputaland conservation planning community engage with the developers of MARXAN in suggesting new improvements. In this way, we hope that future MCAs should not be affected by these software limitations.

4.4 Long-term developments for the Maputaland CPS

This report has stressed that systematic conservation planning should not be a one-off process and that assessments need to be repeated at regular intervals. Moreover, given that this approach can provide a framework to guide a range of conservation policies, including PA system development, PA management and funding allocation, there is a need for conservation agencies to establish long-term systems to ensure its sustainability

(Knight et al., 2006a). This is certainly the case for Maputaland and so this section will describe the two broad areas where long-term systems need to be developed and implemented.

4.4.1 Data collection systems

The MCA was hampered by a lack of data and this was especially problematic when producing distribution maps for the different species. This might seem surprising, given that a large number of researchers and naturalists have studied a number of Maputaland's species (Douglas, 1998). However, these data were either unavailable or not recorded with sufficient spatial resolution to be used for distribution mapping. Therefore, it is extremely important to encourage every group involved in collecting distribution data within Maputaland to record the location of their samples using a GPS unit and to archive these data in a central database.

Thus, we suggest that the Maputaland range states should collaborate to develop such a data collection system and ensure that anyone who seeks permission to conduct research in the region must agree to archive their relevant data. We also suggest that the conservation agencies engage with amateur naturalists and encourage then to adopt the same data collection system. These distribution datasets would increase both the number of species that could be included in the MCA and improve the quality of the existing distribution maps. In addition, they would provide information on which areas are relatively under-sampled and allow targeted data collection to fill in any gaps.

All three of the Maputaland range states have developed biodiversity distribution databases but they differ in their functionality and scope. Therefore, we recommend that the three countries work together to produce a system that can be applied throughout Maputaland.

4.4.2 Mainstreaming the Maputaland CPS

The development of the Lubombo TFCA initiative has created a number of management structures that ensure the three Maputaland range states work together to conserve the region's biodiversity. This means that there is great potential for the Maputaland CPS to be used and updated, as long as the process can be mainstreamed into existing land-use planning systems. Therefore, we suggest that the following commitments are incorporated into the Lubombo TFCA protocols:

A) ***To recognise the Maputaland CPS as the most suitable source of conservation data for guiding land-use planning in the region.***

B) ***To support the continued maintenance and development of the Maputaland CPS by building capacity and providing adequate resources in all three range states.***

C) ***To ensure that the relevant government agencies from the three range states collaborate to undertake a biennial target attainment review and MCA.***

D) ***To incorporate the MCA results into land planning policy by designing appropriate management structures and MCA dissemination products***

The people and Governments of Mozambique, South Africa and Swaziland have shown great vision in developing the Lubombo TFCA and other associated conservation initiatives. This report has described the first Maputaland Conservation Assessment, which provides a wealth of information for guiding these activities. It also describes how the Maputaland CPS should be developed to help ensure that it remains an important tool for land-use planning and provides a framework for conserving Maputaland's biodiversity.

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Appendices

APPENDIX A - DESCRIPTION OF THE GIS DATA

Most of the GIS data in the Maputaland conservation planning system describes the biodiversity and conservation of the region and these coverages are described in the main section of this report. This appendix gives details on the format and geographical reference system of these data and also describes how the physical GIS data were produced.

A. The Maputaland conservation planning system details

The Maputaland conservation planning system contains both raster and vector data. Details of each GIS layer are given below but all these layers share some characteristics. All of the raster layers were resampled to have a resolution of 25m and all of the spatial data in the Maputaland conservation planning system is based on the UTM 36S reference system. The details of this system are listed below:

Reference system name	Universal Transverse Mercator Zone 36
Projection	Transverse Mercator
Datum	WGS84
Delta WGS84	0, 0, 0
Ellipsoid	WGS 84
Major s-axis	6378137.000
Minor s-axis	6356752.314
Origin longitude	33
Origin latitude	0
Origin X	500000
Origin Y	10000000
Scale factor	0.9996
Measurement units	Metres

B. Physical GIS layers

Digital elevation model

The digital elevation model was derived from the Shuttle Radar Topography Mission (SRTM) dataset. This is a freely available data source that has a resolution of 90m. The data for Maputaland included a few areas where no data were recorded and these data holes generally occurred over water. This problem was resolved by first mapping the holes and then producing a 100 m buffer around each hole and using ArcView to determine the mean elevation values of the SRTM pixels that fell within each buffer polygon. Thus, we calculated the mean elevation of the pixels that surrounded each hole and reclassified these holes accordingly. Finally, the SRTM data were resampled in Idrisi using the RESAMPLE bilinear method to produce a GIS layer with the standard 25m resolution.

Slope

The slope layer was based on the DEM layer and was produced using the SURFACE module in Idrisi.

APPENDIX B - CONSERVATION FEATURE DETAILS

Details on each of the conservation features are given below, including the amount found in the current PA system and the representation target.

Table B-1: Landcover type current protection levels and targets

Name	Target type	Target	Total amount	Conserved amount	Target met (%)
Lubombo aquatic N	Area (ha)	886	3131	252	28.4
Lubombo aquatic C	Area (ha)	686	2262	0	0.1
Lubombo aquatic S	Area (ha)	410	1487	409	99.8
Rock faces N	Area (ha)	445	1654	171	38.5
Rock faces C	Area (ha)	494	1837	62	12.5
Rock faces S	Area (ha)	254	976	129	50.6
Lubombo grassland N	Area (ha)	1166	3862	527	45.2
Lubombo grassland C	Area (ha)	448	1170	4	0.9
Lubombo grassland S	Area (ha)	386	1255	203	52.6
Lubombo woodland N	Area (ha)	23605	114078	12079	51.2
Lubombo woodland C	Area (ha)	11839	45718	1698	14.3
Lubombo woodland S	Area (ha)	5374	23053	7095	132.0
Lubombo thicket N	Area (ha)	6575	24860	1907	29.0
Lubombo thicket C	Area (ha)	5716	21144	962	16.8
Lubombo thicket S	Area (ha)	2514	9505	2240	89.1
Lubombo forest N	Area (ha)	1644	5267	122	7.4
Lubombo forest C	Area (ha)	747	2082	1143	153.2
Acacia woodland N	Area (ha)	47894	129281	2311	4.8
Acacia woodland S	Area (ha)	26486	28998	13766	52.0
Acacia thicket N	Area (ha)	6106	21784	368	6.0
Acacia thicket S	Area (ha)	9313	33611	12383	133.0
Floodplain grassland N	Area (ha)	10589	24856	1369	12.9
Floodplain grassland S	Area (ha)	2274	5733	2567	112.9
Reed beds	Area (ha)	10150	18353	9781	96.4
Riverine thicket	Area (ha)	5233	8563	2449	46.8
Riverine forest	Area (ha)	2012	3551	2327	115.7
Sedge & grass swamp	Area (ha)	11180	13287	5226	46.8
Hygrophilous grasslands	Area (ha)	47323	56881	36081	76.2
Woody grassland	Area (ha)	102855	173705	69654	67.7
Terminalia woodland	Area (ha)	152384	308116	36845	24.2
Woodland on red sands	Area (ha)	7274	10518	2682	36.9
Sand thicket	Area (ha)	36074	47045	8772	24.3
Sand forest	Area (ha)	50309	66766	15142	30.1
Inland evergreen forest	Area (ha)	13070	15213	11451	87.6
Swamp forest	Area (ha)	4043	4824	2514	62.2
Mangroves N	Area (ha)	1354	4216	2278	168.2
Mangroves S	Area (ha)	105	143	105	100.0
Beach	Area (ha)	2440	4199	2073	85.0
Dune thicket	Area (ha)	1229	2132	1561	127.0
Dune forest N	Area (ha)	1770	4267	1679	94.9
Dune forest S	Area (ha)	4915	11837	11772	239.5
Open Water	Area (ha)	20705	72472	51962	251.0
Mud Flats	Area (ha)	3671	12850	7979	217.4
Salt marsh and flats	Area (ha)	3742	13097	5125	137.0

Table B-2: Animal species current protection levels and targets

Name	Target type	Target	Total amount	Conserved amount	Target met (%)
Samango monkey	Individuals	1000	2966	2278	227.8
Black Rhino S	Individuals	200	650	165	82.3
Black Rhino N	Individuals	90	1011	42	46.6
African Elephant	Individuals	600	2188	378	63.0
African wild dog	Individuals	16	953	164	1026.4
Oribi	Individuals	1000	3139	333	33.3
Lion	Individuals	300	1379	280	93.2
Swamp nightjar	Area (ha)	104470	261177	109671	105.0
Southern banded snake eagle	Area (ha)	66535	106459	44886	67.5
Saddle billed stork	Area (ha)	4262	16393	2732	64.1
Cape vulture	Colony	1	1	0	0.0
Mangrove kingfisher	Area (ha)	11090	44359	10163	91.6
Denham's bustard	Individuals	150	1153	529	352.5
Pel's fishing owl	Area (ha)	3510	7023	2412	68.7
Gaboon viper	Individuals	1000	3584	3441	344.1
Setaro's dwarf chameleon	Area (ha)	8520	22109	20601	241.8
Warren's girdled lizard	Area (ha)	744	4468	362	48.6
Pygmy wolf snake	Area (ha)	996	236321	95304	9568.6
Zululand dwarf burrowing skink	Area (ha)	744	326854	109462	14712.6
Fitzsimon's dwarf burrowing skink	Area (ha)	744	56362	47079	6327.8
Coastal dwarf burrowing skink	Area (ha)	744	56362	47079	6327.8
Fairy shrimp	Area (ha)	1945	3218	652	33.5
Pennington's white mimic	Area (ha)	702	83348	27360	3897.5
Zulu buff	Area (ha)	420	70318	17469	4159.2
Orange whisp	Area (ha)	702	13288	5226	744.5
Zulu darner	Area (ha)	702	4824	2514	358.2
St Lucia purple fruit chafer	Area (ha)	702	14276	9977	1421.2
Maputaland cannibal snail	Area (ha)	240	38667	26168	10903.2
Major large black millipede	Area (ha)	780	1495	1143	146.6
Peter's flat backed millipede	Area (ha)	2400	38667	26168	1090.3
Ingwavuma slender spined millipede	Area (ha)	2400	190201	22138	922.4
Ivory striped wingless grasshopper	Area (ha)	702	14276	9977	1421.2
Inhaca wingless grasshopper	Area (ha)	702	16104	13451	1916.1
Hlatikulu earthworm	Area (ha)	1272	1495	1143	89.9

Table B-3: Plant species current protection levels and targets

Name	Target type	Target	Total amount	Conserved amount	Target met (%)
Brachystelma vahrmeijeri	Area (ha)	320	2708	0	0.0
False white stinkwood	Area (ha)	800	10854	1208	151.0
Natal white stinkwood	Area (ha)	800	1707	1516	189.5
Crassula maputensis	Area (ha)	640	31111	654	102.2
Encephalartos aplanatus	Area (ha)	1418	68987	59	4.2
Encephalartos ngoyanus	Area (ha)	1418	3854	2420	170.6
Encephalartos umbeluziensis	Area (ha)	1418	4154	2145	151.3
Excoecaria madagascariensis	Area (ha)	7	14	0	0.0
Swazi fig	Area (ha)	800	1845	1523	190.3
Hawortia limifolia sub umbombo	Area (ha)	800	5668	2181	272.6

Table B-3 (continued): Plant species current protection levels and targets

Name	Target type	Target	Total amount	Conserved amount	Target met (%)
Helichrysum tongense	Area (ha)	16	7534	826	5162.9
Nidorella tongensis	Area (ha)	245	491	491	200.0
Ozoroa sp Nov (suffrotex)	Area (ha)	800	18737	7556	944.5
Tonga pelargonium	Area (ha)	800	148838	28041	3505.1
Kosi palm	Area (ha)	16	3903	2016	12599.3
Rhus kwazuluana	Area (ha)	800	11692	10287	1285.9
Streptocarpus confusus lebombo	Area (ha)	62	123	53	86.2
Thesium vahrmeijeri	Area (ha)	800	5152	355	44.3
Vanilla roscheri	Area (ha)	52	104	0	0.0
Pepper-bark tree	Area (ha)	800	2378	1176	147.0

Table B-4: Connectivity-based ecological process targets

Ecological process name

A1) Maintaining East-West connectivity through the Lubombo Mountains

i) To retain connectivity for terrestrial forest and woodland organisms, maintain in an undisturbed state at least 3 gorges, one per sub-region of the Lubombos – recommend Mbuluzi (north), Usuthu (central), Mkhuze (south). Optional and desirable the Ingwavuma Gorge.

ii) To retain connectivity for plains fauna (zebra, wildebeest and associated fauna) maintain at least two plains corridors, one in the north, south of the Mbuluzi River (Conservancy areas) and one in the south, Munywana corridor (currently in the Munywana Game Reserve).

A2) Maintaining North-South connectivity along the Lubombo Mountains

Maintain in an undisturbed state the uninhabited west facing slope of the Lubombo Mountains from and including the crest of the mountain to the base of the mountain, running the full length of the range. This should connect the nodes of Mlawula Nature Reserve, with the Muti Muti Forest Reserve, Chilobi Forest (unprotected), Usuthu Gorge, Ingwavuma Gorge, Border Cave, Pongola Poort Nature Reserve, Mkhuze Gorge and isolated forest patches to the south.

A3) Maintaining North-South connectivity along the coastal dune zone

Maintain in an undisturbed state the North-South connectivity corridor along the coastal forest/scrub belt from Ponta Maria in the north to Mapelane in the south. Laterally this should be from the primary dune on the seaward side to the base of the primary dune on the western side (this is a minimum specification)

A4) Maintaining dry season/wet season corridors

i) Southern corridor: Mkhuze, Phinda, Lower Mkhuze, Ozabeni.

ii) Central/Northern: Usuthu Gorge, Ndumo, Tembe, Futi, Maputo Reserve

Table B-5: Area-based ecological process current protection levels and targets

Name	Target type	Patch size	Patch number	Conserved amount	Target met (%)
B5) Maintaining fire regimes					
Lubombo woodland N Fire	Patch	>4000	1	1	100
Lubombo woodland C Fire	Patch	>4000	1	0	0
Lubombo woodland S Fire	Patch	>4000	1	1	100
Acacia woodland N Fire	Patch	>4000	1	0	0
Acacia woodland S Fire	Patch	>4000	1	1	100
Hygrophilous grasslands Fire	Patch	>4000	1	1	100
Woody grassland Fire	Patch	>4000	1	5	500
Terminalia woodland Fire	Patch	>4000	1	1	100
Woodland on red sands Fire	Patch	>4000	1	0	0
B6) Maintaining herbivory	This target was the same as for the African elephant				

APPENDIX C - ADDITIONAL CONSERVATION FEATURES

Several important species (Table C-1) and ecological processes (Table C-2) were not included in the first Maputaland conservation assessment because there was insufficient data to map them adequately. Therefore, it is recommended that further information is collected on these conservation features, so that they can be included in subsequent assessments.

Table C-1: Recommended species for inclusion in future conservation assessments

Latin name	English name	Group name
Amblysomus marleyi	Marley's Golden mole	Mammals
Calcochloris obtusirostris	Yellow golden mole	Mammals
Paraxerus palliatus	Tonga red squirrel	Mammals
Myosorex sclateri	Sclater's forest shrew	Mammals
Mellivora capensis	Honey badger	Mammals
Macronyx ameliae ameliae	Rosy-throated longclaw	Birds
Pelecanus rufescens	Pink-backed pelican	Birds
Afroedura marleyi	Marley's flat gecko	Reptiles
Silhouettea sibayi	Sibayi goby	Fish
Barbus brevipinnis	Shortfin barb	Fish

Table C-2: Recommended ecological processes for inclusion in future conservation assessments

Ecological process name	Process type
Sand source and corridors	Connectivity
Carbon capture by hardwood and evergreen forests	Carbon sequestration
Carbon capture by peat wetlands	Carbon sequestration
Interfaces between major geological units	Edaphic interfaces
Primary catchments for ground water recharge and drainage towards estuaries and low lying swamps and drainage lines.	Hydrological processes
Hydrological processes (flooding, sediment transport and deposition) responsible for shaping the river system and flood plain.	Hydrological processes
Maintaining sediment transport and input into floodplains along the major rivers	Hydrological processes

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