Mgobozeleni Estuary Management Plan

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Glossary and Abbreviations

Amsl	above mean sea level
Anthropogenic	Having to do with people, or caused by humans
Benthic Macroinvertebrates	Or benthos, refers to invertebrates attached to, living on (epifauna) or in (infauna) the substratum, that can be captured by a 500 µm net or sieve
BGIS	Biodiversity Geographic Information System (GIS) developed and managed by the South African National Biodiversity Institute and accessed at http://www.bgis.sanbi.org/
Biodiversity	The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. This includes diversity within species, between species and of ecosystems
Catchment	In relation to a watercourse or watercourses or part of a watercourse, this term means the area from which any rainfall will drain into the watercourse or watercourses or part of a watercourse, through surface flow to a common point or common points
Community	Assemblage of organisms characterised by a distinctive combination of species that occupy a common environment and interact with one another
Community composition	All taxa, plants and animals, present in a community
Cumulative impact	Impact on the environment which results from the incremental or combined effects of one or more developmental activities in a specified area over a particular time period, which may occur simultaneously, sequentially, or in an interactive manner
CWDP	Coastal Waters Discharge Permit under the National Environmental Management: Integrated Coastal Management Act No. 24 of 2008
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs (National)
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs (KwaZulu-Natal)
Dilution	The reduction in concentration of a substance due to mixing with water
DWS	Department of Water and Sanitation (formerly Department of Water Affairs (DWA) and Department of Water Affairs & Forestry (DWAF))
EFZ	Estuarine Functional Zone. Low lying land adjacent to the river or estuary periodically flooded and where river borne materials are deposited, including areas adjacent to the estuary banks and below the 5 m amsl for the intermittently open estuaries along the KZN coastline, as described on BGIS
EIA	Environmental Impact Assessment in terms of the 2014 Regulations under the National Environmental Management Act No. 107 of 1998
Environmental Flows	The quantity and quality of water required to sustainably keep aquatic systems healthy and in the classified ecological management category
Environmental impact	A discrete (definable) interaction between a project activity and one or more components of the environment (biophysical and social)
Eutrophic	Rich in mineral and organic nutrients that facilitate prolific plant growth
GIS	Geographic Information System. GIS is a combination of computer software and hardware tools used for creating maps and analysing spatial data. GIS links the map and database information so that questions can be asked and answers given in map or visual form
Guidelines	Guidelines for the Development and Implementation of Estuarine Management Plans in terms of the National Estuarine Management Protocol, published by the Department of Environmental Affairs in March 2015

Habitat	The natural home of an organism or community of organisms (this also includes the surrounding area). This includes biotic and abiotic features. Habitat loss or fragmentation is one of the primary causes of the loss of biodiversity and resilience
Hypertrophic	Conditions characterised by elevated mineral and organic nutrients in aquatic environments resulting in boom-and-bust cycles of plant growth often leading to cycles of oxygen super-saturation and oxygen depletion in the water column
IAP	Invasive Alien Plant. A plant species that does not naturally occur in a specific area and whose introduction does or is likely to cause economic or environmental harm or harm to human health
ICM Act	National Environmental Management: Integrated Coastal Management Act No.24 of 2008
Invasive alien species	A species that does not naturally occur in a specific area and whose introduction does or is likely to cause economic or environmental harm or harm to human health
IOE	Intermittently Open Estuary, also known as Temporarily Open/Closed Estuary. This is an estuarine classification that groups all estuaries that are periodically closed off from the sea by a sand bar. These systems can close for varying lengths of time, and during closure, the areas upstream from the mouth are back-flooded. The highest water level reached by KwaZulu-Natal estuaries during natural mouth closure events is approximately 5 m above mean sea level
KZN	KwaZulu-Natal
MAR	Mean Annual Runoff
MER	Marine & Estuarine Research cc
NEMA	National Environmental Management Act No. 107 of 1998
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act No. 36 of 1998
Oligotrophic	Conditions characterised by low mineral and organic nutrients resulting in limitations to plant growth / primary production
PES	Present Ecological Status. This is a measure of the health of a water resource. The status is based on a comparison between the original / reference condition and the present state according to the reserve determination method of the Department of Water and Sanitation (DWAF 2008. Water Resource Protection and Assessment Policy Implementation Process. Resource Directed Measures for protection of water resources: Methodology for the Determination of the Ecological Water Requirements for Estuaries. Version 2). This is generally denoted by a classification that can range from an “A” being unmodified to an “F” being critically modified
Protocol	National Estuarine Management Protocol in terms of section 33 of the National Environmental Management: Integrated Coastal Management Act No. 24 of 2008; Government Notice No. 341, published in Government Gazette No. 36432 on 10th May 2013
Runoff	Runoff is the water yield from an individual catchment – the sub-catchment plus the runoff from all upstream sub-catchments. Runoff includes any seepage, environmental flow releases and overflows from the reservoirs in a catchment, if they are present
SANBI	South African National Biodiversity Institute
Special Limit Values	Department of Water Affairs and Sanitation’s more stringent water quality limits / requirements that are applied when wastewater / effluent quality should be higher than General Limit Values for release to a water resource without a water use licence in accordance with GN 169 of 2013
Stormwater run-off	Stormwater run-off from paved areas, including parking lots, streets, residential subdivisions, buildings, roofs, highways, etc
TOCE	Temporarily Open/Closed Estuary. Also known as an Intermittently Open Estuary

TWQR	Target Water Quality Range established by the Department of Water Affairs and Forestry in a set of guidelines published in 1996
Wastewater	Water containing solid, suspended or dissolved material (including sediment) in such volumes, composition or manner that, if spilled or deposited in the natural environment, will cause, or is reasonably likely to cause, a negative impact
WWTW	Wastewater treatment works. Facility for the treatment of domestic or industrial wastewater designed to remove biological or chemical waste products from water to ensure that water discharged downstream/to the environment is of an acceptable quality
WULA	Water Use Licence Application under the National Water Act No. 36 of 1998

1 Introduction

iSimangaliso has three major estuary systems, viz. Lake St Lucia, Mgobozeleni and Kosi Bay, all of which are categorised as estuarine coastal lakes (Figure 1). Estuarine coastal lakes are estuaries that have a large water surface area. These are usually drowned river valleys filled in by reworked sediments and separated from the sea by vegetated sand dune systems. These types of estuaries can be permanently open or closed for periods when the link with the sea is lost and can have large salinity fluctuations driven by fluctuations in freshwater input, evaporation, and sea condition. The tidal prism is small and marine and river input have little influence on water temperatures, which are directly related to solar heating and radiation. Estuarine, marine and freshwater organisms all occur depending on the salinity condition of the system. These are three of nine estuarine coastal lakes on the South African coast and are now the only three intact systems within the sub-tropical bioregion.

The Mgobozeleni estuarine lake system, which incorporates two lake areas linked physically and biologically to the sea via a narrow channel, lies strategically between the other two iSimangaliso estuary systems, Kosi Bay in the north and Lake St Lucia in the south. Like Kosi Bay, it is situated on the Mozambique coastal plain and is composed of two interconnected lakes, and has a reed-lined channel leading to the Indian Ocean at the coastal resort of Sodwana Bay.

This document details the Estuary Management Plan (EstMP) for the Mgobozeleni system (Figure 1) and draws on the Situation Assessment background report (iSimangaliso, 2015b) and other supporting documents. This plan provides a summary of the situation assessment, which describes the estuary's features, health status, the activities and issues affecting estuary health, and the management objectives and programme of actions for estuary management.

1.1 Framework for Estuary Management Plans

The development of three Estuary Management Plans for iSimangaliso is governed by section 34 of the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) (ICM Act) read with the National Estuarine Management Protocol 2013 (the Protocol). However, implementation is also governed by the World Heritage Convention Act (Act No. 49 of 1999) (WHC Act) read together with the ICM Act. This is because iSimangaliso is required to conduct its affairs in accordance with an Integrated Management Plan (Section 21 (2) WHC Act). The Department of Environmental Affairs (DEA) has also published *Guidelines for the Development and Implementation of Estuarine Management Plans* (DEA, 2015).

The Protocol states that as the responsible authority, iSimangaliso must develop the EstMPs. Also, section 34 (1) (b) (i & ii) state that the EstMP must be consistent with the Protocol and the National Coastal Management Programme (NCMP). The Protocol is silent about the adoption of one or more EstMPs in the iSimangaliso circumstances. Neither a provincial management programme nor a municipal coastal programme is applicable to iSimangaliso. However, the national coastal management programme is applicable to iSimangaliso. Section 52 of the ICM Act requires consistency between coastal management programmes and other statutory plans. A statutory plan means a plan, policy or programme adopted by an organ of state.

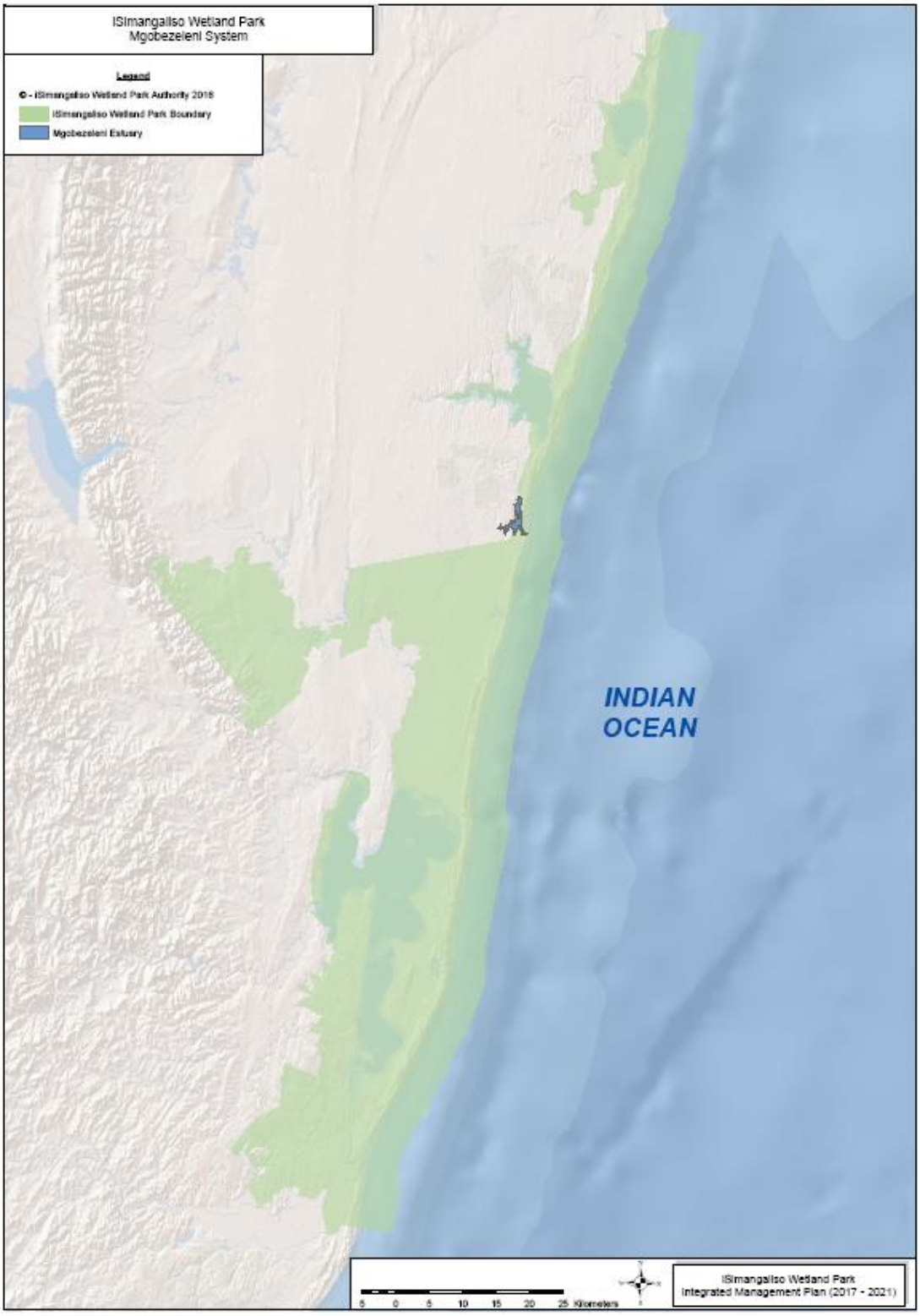

Figure 1 Location of the Mgobozeleni system within the iSimangaliso Wetland Park

The IMP for iSimangaliso is such a statutory plan. The Minister approves the IMP and, consequently, to give effect to the purpose of the ICM Act, the EstMP can, therefore, only form part of the IMP.

This EstMP has taken into consideration all the requirements of the ICM Act and the Protocol. In terms of section 34(1) (d) of the ICM Act, iSimangaliso is required to submit an annual report to the Minister on the implementation of the EstMPs. iSimangaliso already reports to the Minister through the Department annually and will include this EstMP reporting requirement in that annual report.

The development of these EstMPs followed a three-step process that involved a scoping phase (Situation Assessment Report), objecting setting phase and the development of the implementation phase.

Prior to the ICM Act and the Protocol, all the estuaries in iSimangaliso were managed in terms of the provisions of the IMP and various statutes, including:

- World Heritage Convention Act, 1999 (Act 49 of 1999).
- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA).
- National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003).
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Heritage Resources Act, 1999 (Act 25 of 1999).
- KwaZulu-Natal Heritage Act, 1997 (Act 10 of 1997).
- National Forests Act, 1998 (Act 84 of 1998).
- National Water Act, 1998 (Act 36 of 1998).
- Marine Living Resources Act, 1998 (Act 18 of 1998).
- Seashore Act, 1935 (Act 21 of 1935).
- Maritime Zone Act, 1994 (Act 15 of 1994).

Before the proclamation of iSimangaliso, all the estuaries in iSimangaliso were in protected areas and were managed as part of a greater conservation area by the duly appointed conservation manager for the particular area.

Most of the estuary (Figure 2) lies within the iSimangaliso Wetland Park. The iSimangaliso Wetland Park Authority is accordingly the responsible authority for the development and implementation of an Estuary Management Plan for St Lucia Estuary (including the five rivers that are part of this estuarine system) and any other activity that influences the system[1].

[1] National Estuarine Management Protocol in terms of section 33 of the National Environmental Management: Integrated Coastal Management Act No. 24 of 2008; Government Notice No. 341, published in Government Gazette No. 36432 on 10th May 2013.

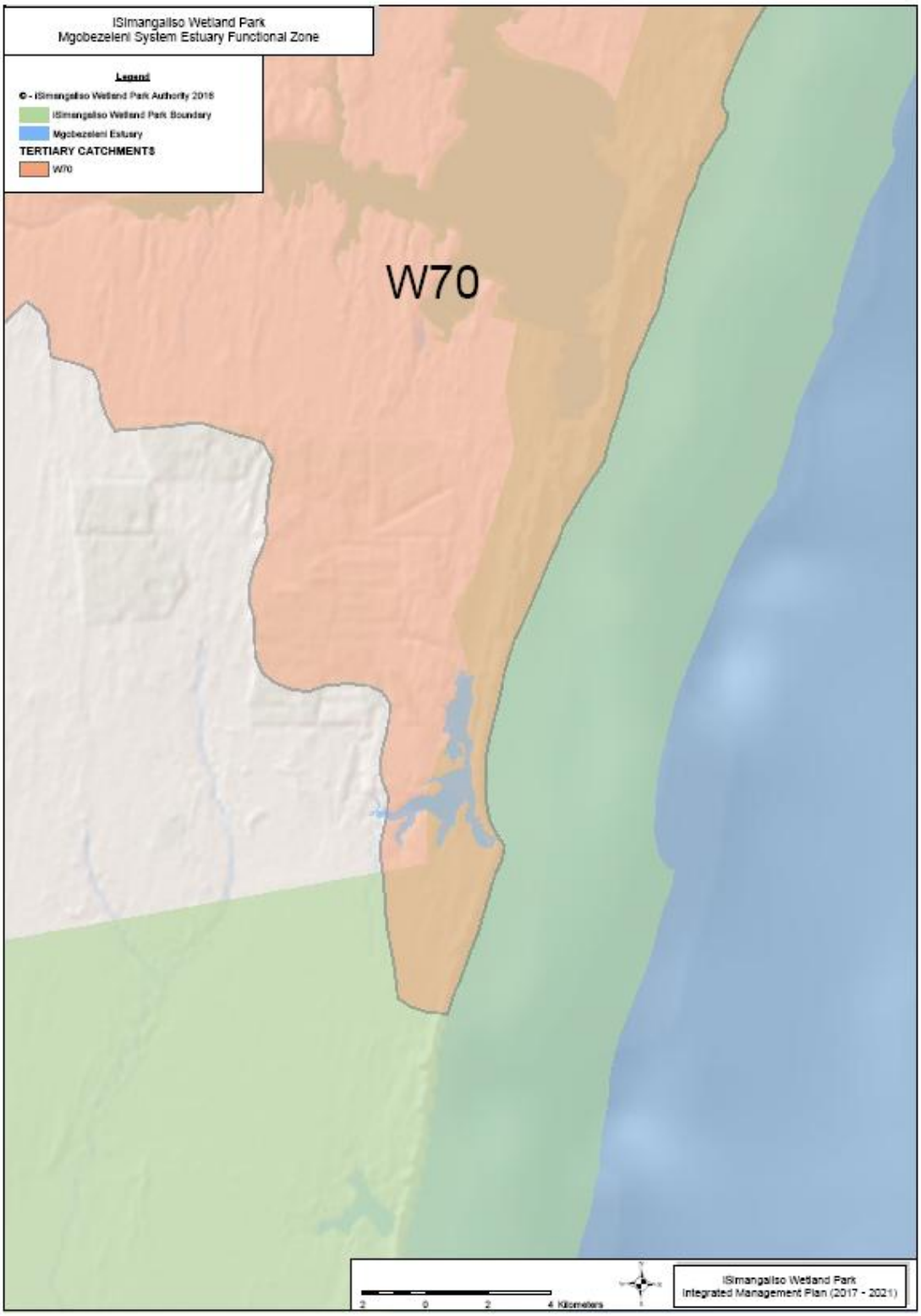

Figure 2 **Mgobozeleni Estuary (blue outline) with the tertiary catchments indicated (shaded and labelled)**

Given the legislative and institutional complexity of coastal management in South Africa, the purpose of an EstMP is to provide for the integrated and coordinated management of activities affecting estuarine resources. The top five such activities prioritised in the National Biodiversity Assessment (SANBI, 2012) were:

- Flow modification e.g. water abstraction (either directly from the system or indirectly by alien plants, timber plantations), urban stormwater runoff, etc.
- Pollution e.g. wastewater treatment works, industrial effluent, agrochemicals, etc.
- Exploitation of living resources e.g. fish, invertebrates, plants and plant-parts.
- Habitat destruction (e.g. low-lying development, bridges, mining, etc).
- Climate change (reflected in modified rainfall patterns, temperature changes, increased storminess and sea level rise).

The EstMP Guidelines have, therefore, determined the core sectors to be addressed by the management objectives within each EstMP. These are:

- Resource use.
- Conservation.
- Water quantity and quality.
- Socio-cultural values.
- Capacity building.
- Land use regulation.
- Compliance monitoring and enforcement.
- Climate change.

The EstMP for Mgobozeleni has been developed using existing and available information to:

- Develop a Situation Assessment.
- Set a vision and management objectives, which are aligned with iSimangaliso's IMP.
- Provide a description and guidance for the key management actions and programme.

EstMPs regulate and manage human activities impacting on estuaries and in, this particular case, on the Mgobozeleni Estuary. This means that this EstMP will describe the current status of the estuary and associated activities and will not table future developments. Importantly, as the first EstMP published in terms of the requirements of the ICM Act and the Protocol, it provides opportunities to identify and address many of the factors identified in the Situation Assessment as impacting on the health of the system. In addition, there are opportunities to explore positive interventions to improve estuarine functioning, including rehabilitation of habitat where possible.

2 The Mgobozeleni Estuary

2.1 Background

This section provides an overview of the key features, concerns and issues of the Mgobozeleni system to provide context for the management objectives and actions (Section 3).

The Mgobozeleni system is situated in the southern region of the Mozambique coastal plain to the east of the Lubombo mountains and links with the sea at Sodwana Bay. It is included in the list of South African estuaries as one of the rarer types of estuary, being classified with the estuary category of 'coastal lake' on the basis of its size and the relative extent of tidal influence (Whitfield & Baliwe, 2013).

The Mgobozeleni system is largely groundwater driven and water balance and estuary hydrodynamics will be influenced by direct abstraction via boreholes and wells in the catchment as well as plantations. The estuary has a diversity of important habitats with strong tropical influences, including swamp forest, mangrove, reeds and sedge swamp. It is an important coastal estuarine lake albeit smaller than its two neighbours (Kosi to the north and Lake St Lucia to the south) and fulfils an important nursery function and stepping stone role in estuarine-coastal connectivity.

There have not been any recent detailed surveys of the fauna and flora of the Mgobozeleni system, including the catchment, which detracts from the confidence level of any health assessment. What does emerge from the available information is that there is considered to have been degradation and species loss from the system, particularly from the original tidal area, which supported the mangrove floral and faunal community.

Any management or development actions would have to take cognisance of the delineated estuary boundary, which includes the lakes and channel forms, being intrinsic components of the Mgobozeleni system, and a buffer zone. The basis of any possible artificial breaching policy would also have to be seriously considered in the light of information regarding historical closure patterns.

The estuary has been described recently as being in good condition generally but with high levels of disturbance at the mouth (Whitfield & Baliwe, 2013). Current estimates of estuary health suggest a Present Ecological Status of a B, being "*largely natural with few modifications*"[2] (SANBI, 2011).

2.2 Geographical Boundaries of the Estuary

It is important to define the boundaries of the estuary and by virtue of this the extent of the plan. This step defines and maps the geographic boundaries of the estuary as follows:

- **Downstream boundary.** The estuary mouth, which may include the surf zone, seaward extent of the flood tide delta and/or transitional waters. This extension can be determined on salinity observations, and variations observed in historical aerial photographs or satellite imagery.
- **Upstream boundary.** The extent of tidal influence, i.e. the point up to where tidal variation in water levels can still be detected or the extent of saline intrusion or the extent of back-flooding during the closed mouth state, whichever is furthest upstream.

[2] In accordance with the PES classification system developed by the Department of Water and Sanitation (DWAF 2008).

- **Lateral boundaries.** The lateral boundaries include all areas below the high tide mark, all estuarine vegetation (including mangroves, swamp forest, reeds/sedges and supratidal salt marsh), and any floodplain areas below the upstream boundary as determined by the 1:100 flood line. Where these boundaries have not been defined by scientific methods, they can be defined at a desktop level using the 5 m topographical contour as indicative of 5 m above Mean Sea Level (MSL) along each bank. It should be noted that the littoral active zones adjacent to an estuary can stretch beyond the 5 m contour and should be incorporated in the estuarine functional zone in specific cases where scientific work determines these are an integral part of the estuary function.

2.3 The Geographical Boundary of the Mgobozeleni Estuary

The geographic boundary of the estuary is defined by the 5 m amsl topographical contour. The coastal management line may also be a useful guide when defining the terrestrial extent of the estuary area. The 1,000 m development buffer provides an indication of the area in which listed activities are regulated relative to the high water mark in accordance with the EIA Regulations, and the extent of the coastal protection zone for rural areas as defined by the ICMA. These zones are designed to more formally regulate certain activities that may cause degradation of the estuary. The 1:100-year floodline is also an important guideline for land-use and town planning, in that it indicates areas of high risk where development should not be allowed. The location of the 1:100 year floodline needs to be determined so that future planning can take this into account. It will also provide an indication of existing and future activities that are at risk.

The estuary boundary is depicted graphically using the 5 m amsl topographical contour in Figure 2.

2.4 Summary of Key Features and Health Status of the Mgobozeleni Estuary

2.4.1 Estuary Type

In South Africa, estuaries are generally classified on the basis of physiographic (tidal prism and size), hydrographic (mouth state and mixing process) and salinity characteristics (Whitfield, 1992). Of the five generally recognised estuary types, the Mgobozeleni system is classified as an estuarine lake system (Whitfield & Baliwe, 2013). Estuarine coastal lakes are estuaries that have a large surface area. The estuaries have been formed over time with changes in sea level creating drowned river valleys, which are then filled in by reworked sediments and separated from the sea by vegetated sand dune systems. These types of estuaries can be permanently open or closed for periods when the link with the sea is lost and can have large salinity fluctuations, driven by fluctuations in freshwater input, evaporation, and sea condition. The tidal prism is small and marine and river input have little influence on water temperatures, which are directly related to solar heating and radiation. Estuarine, marine and freshwater organisms all occur depending on the salinity condition of the system. These are three of nine coastal lake estuaries on the South African coast and are now the only three intact systems within the sub-tropical bioregion.

2.4.2 Estuary Health Status

The health status of an estuary is determined using the Estuary Health Index (EHI). The EHI is a standardised metric for use in estuary management and the determination of ecological water requirements. To determine overall health, the estuary is evaluated by estimating the estuary conditions, both physical and biological characteristics, for the Reference Condition and then scoring the present conditions relative to this estimated Reference Condition. The score derived from this assessment is the Present Ecological State (PES), which falls into one of six categories (A-F) detailed overleaf.

Estuary Health Index Score	Present Ecological State	Description
100 – 91	A	Unmodified, natural
76 – 90	B	Largely natural with few modifications
61 – 75	C	Moderately modified
41 – 60	D	Largely modified
21 – 40	E	Highly degraded
0 – 20	F	Extremely degraded

The Mgobozeleni Estuary was described in the National Biodiversity Assessment (SANBI, 2011) as being in good condition generally with artificial breaching influencing estuarine health. At that time, the estimates of estuary health suggested a Present Ecological Status category of 'B', being "*largely natural with few modifications*"[3] (SANBI, 2011). A preliminary Recommended Ecological Category has been generated for all estuaries in the country and for the Mgobozeleni system this has been determined to be 'A or Best Attainable State' given that the estuary is:

- Located within a proclaimed protected area and World Heritage Site; within the St Lucia Ramsar Site (Figure 3).
- Listed as a national priority for estuary conservation (SANBI, 2011).
- In relatively good condition considering the current status state of the collective estuarine resource in KwaZulu-Natal and South Africa (van Niekerk & Turpie, 2012; Whitfield & Baliwe, 2013).
- The only estuary between the larger St Lucia Lake System to the south and Kosi Bay to the north (i.e. along a stretch of *ca.* 170 km of coastline) (see Figure 4 for the delineation of the estuarine functional zone).
- Recognised as an important nursery habitat for estuary-dependant marine fauna.
- Known to support a number of rare and threatened species, being situated within a transition zone between the tropics and subtropics (iSimangaliso Wetland Park Authority, 2011).

[3] In accordance with the PES classification system developed by the Department of Water and Sanitation (DWAF 2008).

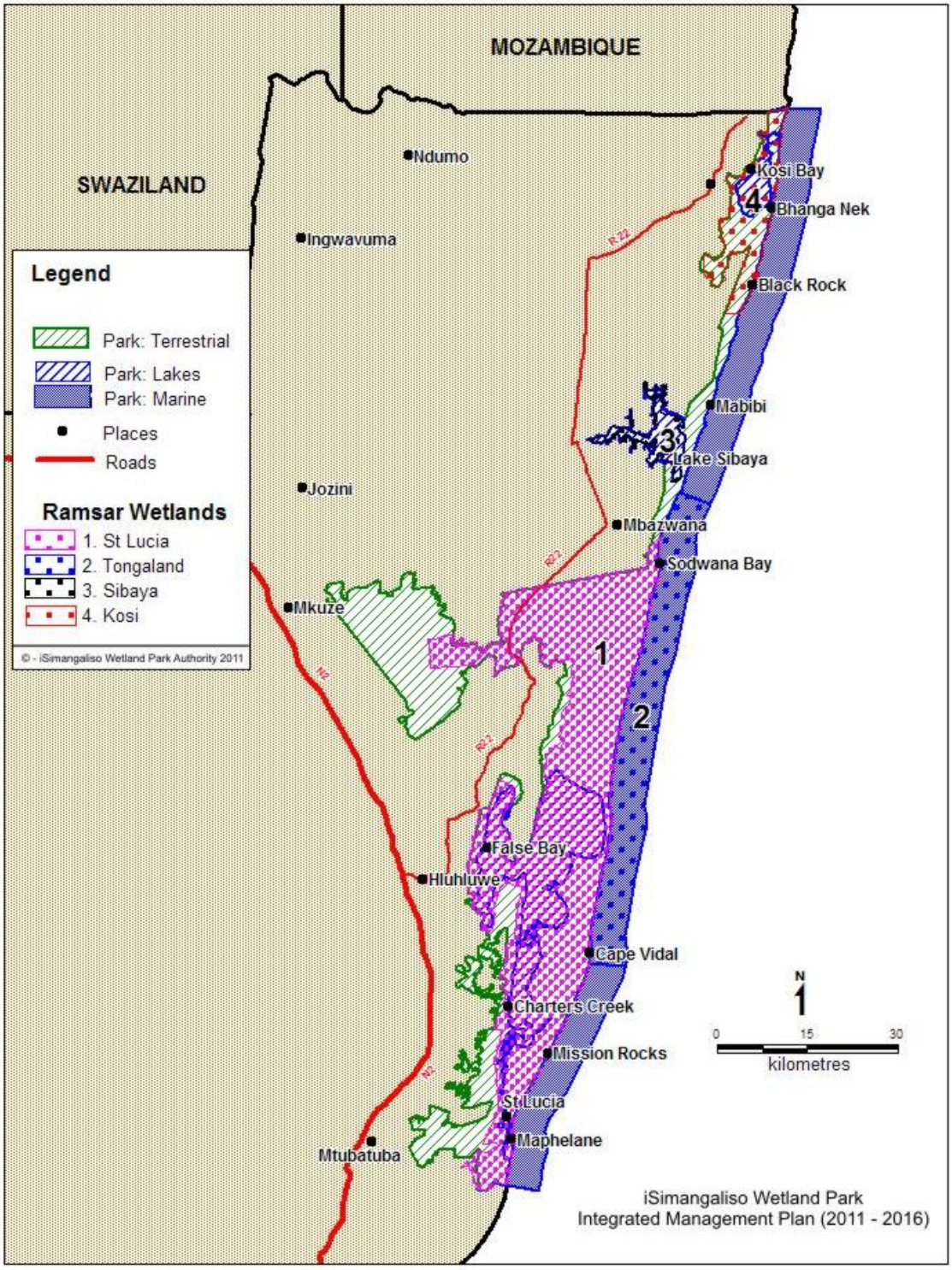

Figure 3 **iSimangaliso Wetland Park Ramsar Sites (Source: iSimangaliso Wetland Park Authority, 2011)**

Figure 4 Mgobozeleni estuarine functional zone

2.4.3 Key Features

The Mgobozeleni Estuary, although smaller than its neighbouring systems, is an important nursery habitat for estuarine dependent marine animals. It also has important plant communities with swamp forests and mangroves, supports a diverse bird population. Historically, a small population of hippo were also resident in the upper estuary but have not been recorded since the mid 1970s.

The estuary has two small streams, which provide some freshwater input, but it is largely a groundwater fed system. It is also relatively shallow with the lake portions having a maximum depth of 5 m. Due to the absence of large volume rivers discharging into these water bodies, siltation has not been considered to be an issue for this estuary.

The sandbar, which controls the mouth position and state of the inlet is a north extending barrier. The mouth position varies and can be placed anywhere from Jesser Point in the south to an area 200 – 300 m north of Jesser Point. Regular breaching of the estuary just south of Jesser Point used to be undertaken once the estuary had moved north, positioned along the dune vegetation on the landward side of the beach or closed. This was done to prevent either damage to the dune forest, inundation of the road by backflooding of the estuary or for parking on the beach. here is disagreement around the frequency of mouth closure in the historical records with "flow considered to contribute to the maintenance of an open estuary which closed only occasionally to an estuary mouth that "closes frequently on almost each spring tide".

Water quality information is unavailable at present so it is not possible to comment on this aspect of the estuary although the occurrence of bilharzia amongst surrounding communities as well as the records of the snail hosts suggests this may be present in the fresher parts of the estuary.

The lower estuary is surrounded on both sides by dune forest. Mangroves (only the black mangrove, *Bruguiera gymnorrhiza)* in combination with the mangrove fern, *Acrostichum aureum* occurred just above the bridge and were considered to be some of the largest specimens of this species in South Africa. Inundation, as a result of bridge construction in the early and late 1970s, resulted in the death of this mangrove stand. This area is now dominated by sedges and reeds. The estuary also has good stands of swamp forest.

As the only estuary between Lake St Lucia and Kosi Bay, the system has always been regarded as an important nursery area. The numbers of fish species found in the estuary range from 19 – 28 with the estuarine species being dominant. The habitat provided by this estuary means that it provides important bird habitat with 98 species recorded within the system.

2.5 Strategic Analysis of Threats and Issues

Estuaries and the adjacent marine environments are subjected to accumulated anthropogenic impacts both directly and indirectly from their catchments and are often the focus of both consumptive and non-consumptive resource use. Given the role that estuaries play in the broader coastal environment, and their sensitivity to human impacts (DEAT, 2000), a focused and coordinated approach to sustainable use of these ecosystems becomes essential to the continued delivery of ecosystem values, goods and services.

The main threats and issues that may affect the ecological health and integrity of the Mgobozeleni Estuary are:

- Artificial breaching and mouth manipulation.
- Direct surface water abstraction and indirect abstraction of the major groundwater feeds affecting the freshwater volumes reaching the estuary (activities such as *Eucalyptus* spp. plantations affecting ground water recharge required to maintain the water balance of the system). Changes in water volumes through the system may result in a loss of connectivity between the different parts of the estuary and is very likely influencing the mouth status[4]. Therefore, it is important to ensure that the environmental (ecological) reserve is determined and adequate flow is maintained to preserve water quantity/volume or flow. The ecological reserve for the estuary has not yet been determined but is the subject of a Department of Water Affairs and Sanitation study due to be completed during 2016/2017.
- Water quality. Recent studies suggest water quality in the estuary may be deteriorating but no data are available.
- Alien species. Several alien plant species occur around the system and associated with the water body. *Casuarina equisetifolia* alters dune dynamics with the potential to influence estuary mouth dynamics. Casuarinas were removed from the vicinity of the mouth but seed bank reestablishment needs to be controlled. Animal alien invasive species also occur such as the snail, *Tarebia granifera*.
- Climate change – rainfall, sea level rise and temperature changes.

Key impacting activities that affect the ability of the Mgobozeleni Estuary to continue to deliver ecosystem goods and services are described below.

2.5.1 Artificial Breaching and Mouth Manipulation

Breaching is the term for the opening of an estuary mouth and is a natural response to rainfall and sea conditions. It is an important natural and highly seasonal process in the life-cycle of an estuary as it establishes the connection of an estuary with the sea. This allows for the immigration and emigration of fish and invertebrates, tidal exchanges, flushing and the re-establishment of salinity gradients along the estuary, which is one of the drivers of estuarine diversity and productivity.

Artificial breaching is the active removal of the sandbar from an estuary by human manipulation. This is usually done in response to rising water levels that rise behind the sand barrier once the estuary is cut off from the sea. A variety of fish species and invertebrates have life histories geared to the natural cycles of opening and closing, and along with many plants and birds are dependent on these natural cycles. Once estuaries close, habitat, nutrients and food availability increase dramatically thereby providing ideal conditions for growth and survival.

[4] Prof M Bruton (Personal Communication).

Artificial breaching in KwaZulu-Natal is most often carried out during winter or when rainfall is low. Unseasonal flushing of these systems reduces the nursery function for many fish and invertebrates by the removal of food resources and the premature flushing of juvenile fish and prawns out into a hostile marine environment while they are still too young to cope.

Thus, artificial breaching disrupts the natural cycle and, therefore, has a negative effect on the plants and animals within estuaries, (which in one study showed a twentyfold decrease in biomass). Artificial breaching is a convenient, but disruptive, means of altering the natural processes of an estuary. This is often done for the benefit of a few individuals but at the expense of the ecological health and services that these important systems provide and, in this way, has a ripple effect through many other lives. It is recognised and has been shown in the literature to be a highly damaging activity for estuaries.

The Mgobozeleni Estuary has been subject to high levels of artificial breaching in order to protect beach access at this popular tourist node and in response to concerns that the northward position of the mouth (Figure 5) would lead to the erosion of the coastal dunes and loss of dune forest (Begg, 1978). More recently, the reasons for artificial breaching have been ecological in order to protect a small stand of mangrove saplings that have been reported to have established near the mouth (Taylor, pers. comm.). Artificial breaching is known to interfere with water and sediment budgets as well as salinity regimes and as such is considered to be a significant impacting activity on the ecological health and integrity of an estuary.

2.5.2 Water Quality

It has been reported that the water quality of the Mgobozeleni estuary has declined markedly as a result of contaminated groundwater inputs (Bate, pers. comm.). Current levels of nutrients (nitrogen and phosphorus) would need to be determined and actions developed should eutrophication be confirmed.

2.5.3 Casuarina equisetifolia

Casuarina equisetifolia was historically planted on the south bank of the lower reaches to stabilize sand movement (Begg, 1978). This stabilization acts against the normal sediment movement patterns of the highly dynamic estuary and beaches, and once stands of the tree have established, they tend to accelerate dune and beach erosion (Digiamberardino, 1986). In addition to influencing dune morphology, *C. equisetifolia* alters dune and beach vegetation structure and species composition (Avis, 1995; Kraus *et al.,* 2003) decreasing biological diversity and compromising beach integrity (Awale & Phillott, 2014). This tree has since been identified as invasive alien species (Conservation of Agricultural Resources Act No. 43 of 1983; National Environmental Management: Biodiversity Act No. 10 of 2004; Invasive Species South Africa 2014) particularly in the province of KwaZulu-Natal.

These trees will be removed as a component of the current upgrade and restoration project to this tourism node.

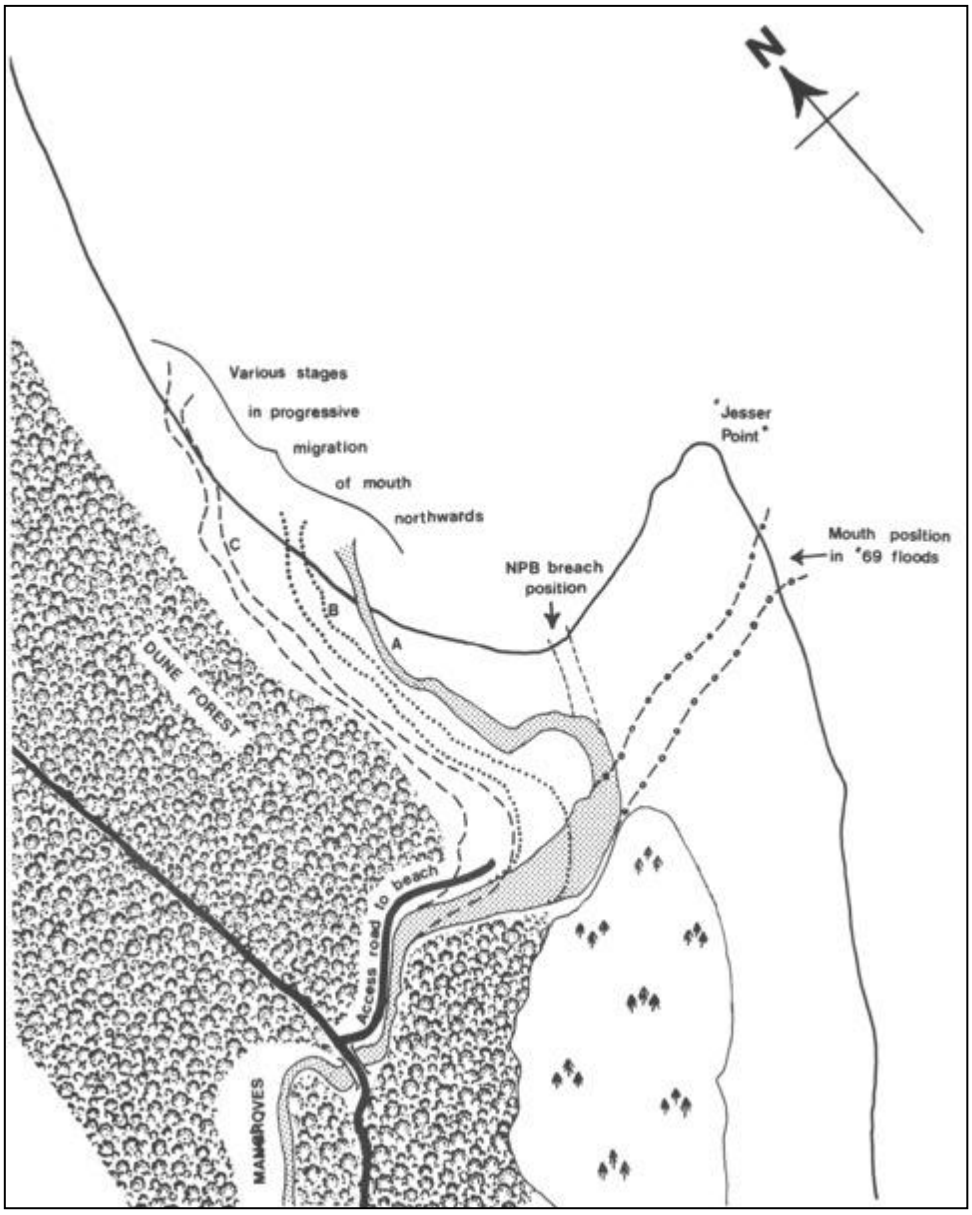

Figure 5 Mgobozeleni Estuary mouth positions (Begg, 1978)

2.5.4 Tourism and Recreation

The Sodwana Bay camp is a highly popular tourism node within the iSimangaliso Wetland Park, with high numbers of visitors accessing and using the beaches, which also provide access to popular recreational fisheries and globally renowned SCUBA diving opportunities. During peak seasons, the lower reaches of the estuary have been subject to impacts that vary from swimming to pollution by solid waste from holiday makers and contamination by fuel oils from boats (Bruton, 1976b). The artificial breaching is linked in part to the tourism activities and drives mouth manipulation. The 2011 National Biodiversity Assessment reported a high fishing pressure on this estuary (van Niekerk & Turpie, 2012) but no substantiating literature could be found to support this assertion; therefore, this should be investigated further.

2.5.5 Invasive Alien Species

The Mgobozeleni system is known to have populations of the invasive alien freshwater snail *Tarebia granifera* (Appleton *et al.,* 2009; Miranda *et al.,* 2011). This parthenogenetic snail has proved to be a very successful invader of estuaries and lake systems on the KwaZulu-Natal north coast, although the significance of possible ecological impacts on these brackish-water habitats remains unknown (Miranda *et al.,* 2011).

2.5.6 Development Pressures

Human activities adjacent to estuaries can individually or in combination potentially generate significant effects on their health and integrity. Developments on the western boundary of the Mgobozeleni Estuarine Functional Zone (EFZ) and in the region of the mouth have the potential to degrade the estuary's health unless these activities are monitored for impacts on key processes. Any settlement developments should be assessed against run-off impacts as part of the implementation of iSimangaliso's Zone of Influence (Buffer) Zone Policy. The impacts of plantation establishment has been documented and any future commercial plantation licenses need to be evaluated against the water requirements of the estuary.

3 Management Plan

3.1 Vision and Guiding Principles for Management of Activities Affecting the Management of Estuaries in the iSimangaliso Wetland Park

The vision, mission and management goals for the iSimangaliso Wetland Park are set out in the World Heritage Convention Act. These apply to the estuaries that fall within the Park. Although these are outlined in Chapter 4 of the IMP they are repeated here for ease of reference.

iSimangaliso's vision is to create Africa's greatest conservation-based tourism destination driven by community empowerment. Its mission is to protect, conserve and present the Wetland Park and its World Heritage Values for current and future generations in line with the standards laid down by UNESCO and the World Heritage Act, and to deliver benefits to communities living in and adjacent to the Park by facilitating optimal tourism and related development.

This aligns closely with the national estuaries protocol, which provides the national (strategic) vision for estuary management in South Africa, which states that:

The estuaries of South Africa are managed in a sustainable way that benefits the current and future generations.

3.2 Management Objectives and Key Actions

The specific key management objectives for the Mgobozeleni Estuary complex are described and paired with the management goals of the Integrated Management Plan (IMP).

There are four overarching and interdependent management goals for iSimangaliso, which are derived from the World Heritage Convention Act. These are:

1. **Management goal 1:** To protect, conserve, enhance and present the Park's:
    a. World Heritage values (ecological processes; superlative natural phenomena and scenic beauty; and biodiversity and threatened species); and its
    b. Cultural heritage.
2. **Management goal 2:** To promote, manage, oversee, market and facilitate optimal tourism and related development in the Park.
3. **Management goal 3:** To promote the empowerment and development of historically disadvantaged communities in and adjacent to the Park.
4. **Management goal 4:** To ensure that iSimangaliso's operations are properly funded and cost-effectively managed while maintaining an appropriate system of internal control and reporting of accounting, management, and statutory information.

The IMP's five-year implementation plan is defined by identifying strategic drivers, key objectives and actions to support the achievement of the management goals, and setting timeframes over a five-year period. The same approach is followed here as estuaries are not managed separately from the rest of the Park. The table below shows the relationship between the National Estuarine Management Strategic Objectives and iSimangaliso's Management Goals.

National Estuarine Management Strategic Objectives (Defined by the National Estuarine Management Protocol 2013)	Management Goals for the iSimangaliso Wetland Park (Defined by the World Heritage Convention Act (IMP Chapter 4))	Strategic Driver (Defined in IMP in Chapter 4)					
		1	2	3	4	5	6
		Park Operations and Conservation Management	Commercial Development (Tourism)	Empowerment & Transformation	Effective Corporate Governance	Interpretation, Presentation & Education	Research
To conserve, manage and enhance sustainable economic and social use without compromising the ecological integrity and functioning of estuarine ecosystems	To promote, manage, oversee, market and facilitate optimal tourism and related development in the Park		▲	▲			
	To promote the empowerment and development of historically disadvantaged communities in and adjacent to the Park		▲	▲			
To maintain and/or restore the ecological integrity of South African estuaries by ensuring that the ecological interactions between adjacent estuaries; between estuaries and their catchments; and between estuaries and other ecosystems, are maintained	To protect, conserve, enhance and present the Park's World Heritage values (ecological processes; superlative natural phenomena and scenic beauty; and biodiversity and threatened species)	▲					▲
To manage estuaries co-operatively through all spheres of government; and to engage the private sector/ entities and civil society in estuarine management	To ensure that iSimangaliso's operations are properly funded and cost-effectively managed while maintaining an appropriate system of internal control and reporting of accounting, management, and statutory information				▲		

National Estuarine Management Strategic Objectives (Defined by the National Estuarine Management Protocol 2013)	Management Goals for the iSimangaliso Wetland Park (Defined by the World Heritage Convention Act (IMP Chapter 4))	Strategic Driver (Defined in IMP in Chapter 4)					
		1	2	3	4	5	6
		Park Operations and Conservation Management	Commercial Development (Tourism)	Empowerment & Transformation	Effective Corporate Governance	Interpretation, Presentation & Education	Research
To protect a representative sample of estuaries (such protection could range from partial protection to full protection) in order to achieve overall estuarine biodiversity targets as determined by the 2011 National Biodiversity Assessment and the subsequent updates	To protect, conserve, enhance and present the Park's World Heritage values (ecological processes; superlative natural phenomena and scenic beauty; and biodiversity and threatened species)	▲					▲
To promote awareness, education and training that relate to the importance, value and management of South African estuaries	To protect, conserve, enhance and present the Park's World Heritage values (ecological processes; superlative natural phenomena and scenic beauty; and biodiversity and threatened species)					▲	
To minimize the potential detrimental impacts of predicted climate change through a precautionary approach to development in and around estuaries and with regard to the utilization of estuarine habitat and resources	To protect, conserve, enhance and present the Park's World Heritage values (ecological processes; superlative natural phenomena and scenic beauty; and biodiversity and threatened species)	▲					

The EstMP is a subsidiary plan to the IMP. Like the IMP, the EstMP is high level plan implemented through the annual plan of operation which takes account of prevailing conditions such as availability of financial and human resources.

The activities to be implemented under this EstMP fall mainly into the Park Operations & Conservation Management (1), and Research (6) strategic drivers, and are detailed below. Additional activities that relate to socio-economic development of the estuary and surrounds have not been singled out as they form part of the broader strategic plan of the iSimangaliso Wetland Park Authority. These are included in Chapter 4 of the IMP under the Commercial Development (2), Empowerment and Transformation (3), and Interpretation, Presentation & Education (5) strategic drivers.

3.3 Strategic Driver 1: Park Operations and Conservation Management

Key Objectives	1. Key actions	Timeframes	Lead Agency
1. To conserve, protect and maintain the Mgobozeleni estuarine system's biodiversity, eco-system health, sense of place and ecological processes, and minimise internal and external negative impacts on the system	1.1. Implementation of the Conservation Operational Plan, report regularly and revise annually	2017-2021	Ezemvelo KZN Wildlife & iSimangaliso
	1.2. Manage and monitor consumptive and non-consumptive recreational and community based natural resource use of the estuarine resources	2017-2021	Ezemvelo KZN Wildlife & iSimangaliso
	1.3. Review and refine the zonation of the Mgobozeleni Estuary in order to better protect estuarine dependent fish and invertebrate species and their habitats	2017-2021	iSimangaliso
	1.4. Implement an effective compliance system which includes both awareness and law enforcement	2017-2021	Ezemvelo KZN Wildlife
	1.5. Implement the policy of minimum interference in the estuarine system, allowing it to function as naturally as possible, limiting breaching and then only for ecological reasons.	2017-2021	iSimangaliso
	1.6. Support DWS' initiative to manage catchment water use.	2017-2021	DWS
	1.7. Support DWS in the completion of the reserve determination study for the Mgobozeleni Estuary and relevant catchments.	2017-2021	DWS
	1.8. Implement the Zone of Influence (Buffer Zone) Policy, which stipulates compliance with legal requirements and due process for the authorisation and operation of developments in the Zone of Influence	2017-2021	iSimangaliso
	1.9. Participate in planning in the Zone of Influence, including through the Municipal IDPs	2017-2021	iSimangaliso

3.4 Strategic Driver 6: Research

Key Objectives	Key Actions	Timeframes	Lead Agency
1. Improve the scientific understanding of the Mgobozeleni system in order to monitor its ecosystem health and inform management decisions	2.1 Authorise and process research from external research institutions to conduct research in the Mgobozeleni Estuary in accordance with the research policy	2017-2021	iSimangaliso
	2.2 Review the current monitoring programme, identify areas needing strengthening, including selected physico-chemical variables, indicators that reveal presence of contaminants, status of estuarine plants and animals	2017-2021	iSimangaliso

4 Zonation of Estuary Activities

The zonation of the Mgobozeleni Estuary follows the same system as the zonation for the Park as defined by the IMP (Chapter 5). The iSimangaliso estuaries are multiple use areas. Zonation helps to manage and protect both the sensitive areas and species within these systems as well as separate potentially conflicting activities. Increasing development and utilization result in the resource deteriorating, which usually lead to conflicts between stakeholders (users) of that particular estuary.

Within the general provisions of the Restricted (Marine) and Controlled (Marine) Zonation which apply to the Mgobozeleni Estuary, the following zones also apply:

- No wake zones.
- No boating zones.
- No take zones (particularly at the mouth).

Zonation of the Mgobozeleni Estuary is illustrated in Figure 6 and the zones are described in the following tables.

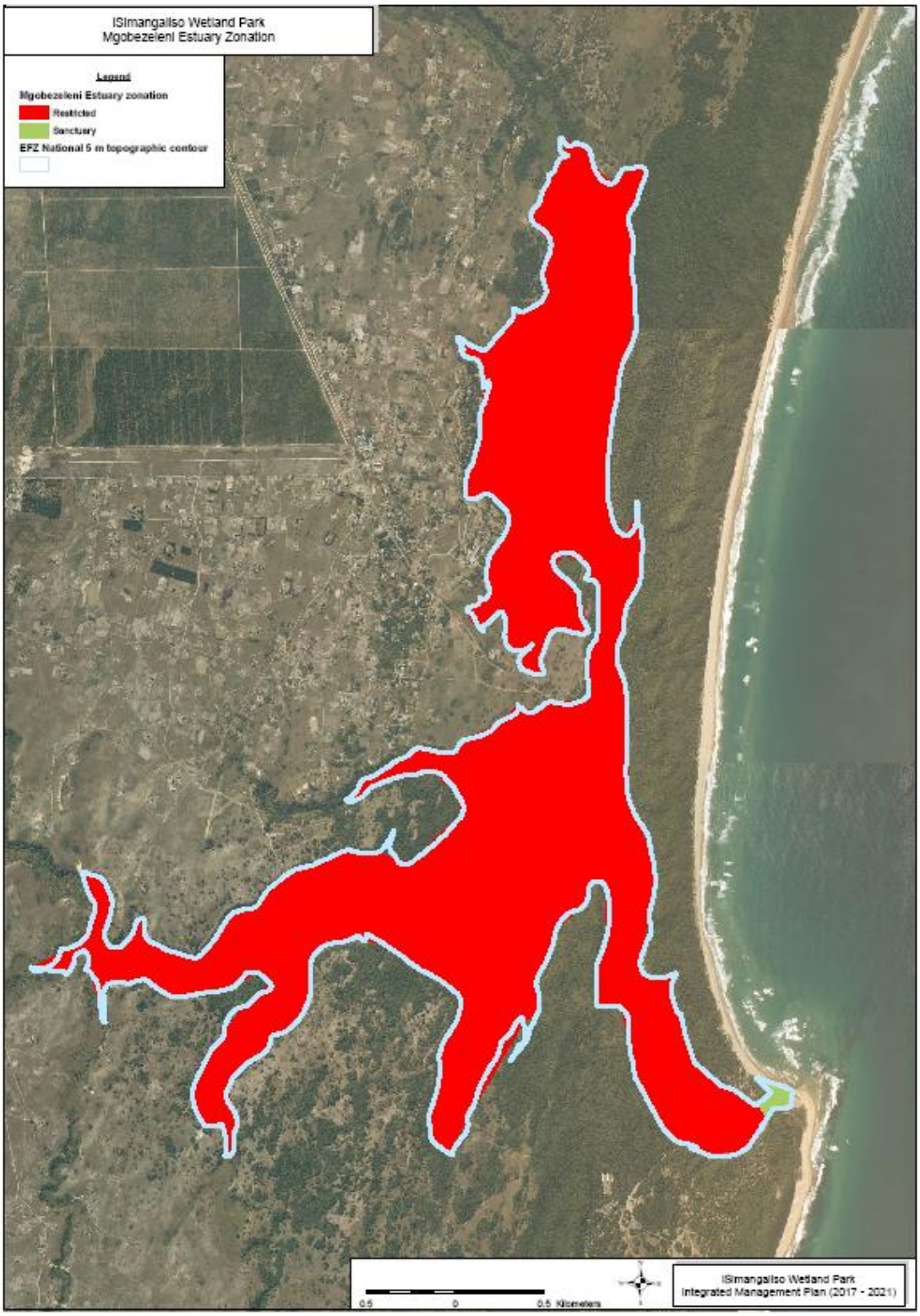

Figure 6 Proposed Zonation of the Mgobozeleni Estuary)

Restricted (Marine)

PARTLY MODIFIED NATURAL ENVIRONMENT. Although only partly modified, normally less pristine and less sensitive than Wilderness or Sanctuary areas. Similar in principle to a Terrestrial Restricted Zone.

Inherent Attributes/ Characteristics	A marine area that may have some (but limited in extent and impact) adjacent current human settlement, developed infrastructure (e.g. buoys, piers) and/or consumptive activities, (e.g. fishing), management interventions and some visual evidence (limited in extent and impact but relatively more than that acceptable for Sanctuary zones) of their occurrence in the recent past. Nevertheless, regardless of whether current or residual, the human-induced modifications to the environment must either pose no significant threats (to ecological processes, biodiversity and landscape quality) or it is feasible to dispose of or remove them and/or mitigate their negative impacts over time. Accordingly, the area must have the potential for restoration to a state that the general public regards, for the most part, as largely unmodified and/or near-pristine. This may require proactive and responsive management interventions indefinitely for the maintenance of the above.
Focal Purpose of Zone	i Conservation of biodiversity and ecological processes. ii Where applicable, the restoration and maintenance of natural landscapes and ecological processes. iii Provide visitors with a high quality nature-based outdoor experience in a marine environment.

Permissible Uses & Activities NOTE 1	*Inshore:* i Walking on beaches and rocks and fossicking (non-extractive). ii Horse riding. iii Cycling. iv Swimming, snorkelling, surfing, surf-skiing, kite and wind surfing and kayaking. v Recreational NOTE 2 and subsistence rock and surf angling. vi Concession, research, and monitoring and management beach driving only. vii Boat launching at recognised boat-launching sites (concession, research and monitoring and management only). viii Special interest/educational activities within parameters of other permissible and non-permissible uses and activities. ix Restricted subsistence invertebrate harvesting in designated areas. x Scientific research and monitoring with a scientific permit. xi Law enforcement patrols and reaction. xii Management intervention to restore/maintain ecological processes and the unspoilt appearance of the landscape. *Offshore* i Scuba diving. ii Snorkelling. iii Kayaking, surf-skiing, and kite and wind-surfing. iv Use of motorised vessels. v Recreational fishing (pelagic only). NOTE 2 vi Spearfishing (pelagic game fish only). vii Special interest/educational activities within the parameters of other permissible and non-permissible uses and activities. viii Artificial substrates including artificial reefs. ix Research and monitoring with a scientific permit. x Law enforcement patrols and reaction. xi Management intervention to restore/maintain ecological processes and the unspoilt appearance of the landscape. *Estuarine Lakes:* i Walking on estuary margins. ii Boats operating under concessions or licenses, iii Access (including on foot, horseback and canoe) within the parameters of other permissible and non-permissible uses and activities. iv Highly regulated scientific research and monitoring that cannot be carried out elsewhere in the Park. v Essential management activities and interventions, including law enforcement operations (scheduled patrols and reaction) applying the 'minimum tool' principle. vi Special access, assessed on a case by case basis, and requiring permits. vii Launching of boats when the mouth is open.
Non-Permissible Uses & Activities	*Inshore:* i Beach driving except under recreational and educational use permits for concession operators, and authorised management and research, and monitoring vehicles. ii Harvesting of intertidal organisms other than subsistence invertebrate harvesting or under special permit. iii Collection of marine aquarium fish, invertebrates and plants except for educational or scientific purposes, and under special permit. iv Collection of organic (e.g. driftwood, shells) and inorganic (e.g. rocks, sand) materials except for

	educational or scientific purposes and under special permit. v Commercial fishing. vi Launching from non-recognised sites except under special permit. *Offshore.* i. Fishing for, or being in possession of, bottom fish. ii. Chumming or feeding of fish (including sharks). iii. Jet skis except for fishing and under special permit. iv. Parasailing from boats. v. Collection of marine aquarium fish, invertebrates and plants except for educational or scientific purposes and under special permit. vi. Use of fish aggregating devices (FADs), anchored or drifting. vii. Commercial fishing. *Estuarine Lakes:* i **All forms of extractive use**, including rock and surf angling NOTE 3, harvesting of intertidal or shallow subtidal organisms, and collection of biota and marine products (e.g. shells, driftwood, rocks and sand). ii Fossicking. iii Driving except for essential management activities and scientific research and monitoring under special permit.
Use Intensity/ Frequency NOTE 3	Regulated and controlled use of low and moderate intensity with entry/access restricted to and controlled at entrance gates or other demarcated points of entry.
Development Nodes	Only Low and Medium (temporary) Intensity Tourism Day Visitor Nodes and Park Management Nodes permitted.
Development Restrictions	Only very low key, unobtrusive and low impact development permitted from base of dunes to the low water mark. No development of any type or form permitted from low water mark to outer limit of Marine Reserve, regardless of circumstances or needs. Development from base-of-dune to dune-crest and inland must conform to restrictions laid down for the adjacent Development Node or Terrestrial Zone which, in most instances, will be a Terrestrial Restricted or Controlled Zone.

NOTES: Restricted (Marine)

NOTE 1: All permissible activities are subject to parameters set by legislation and the Permissible Activities Framework in the IMP.

NOTE 2: No-take areas will be introduced within restricted zones into the future.

NOTE 3: Actual density levels, activities and group sizes are specified in the Development Node and Activities Frameworks in the IMP**.**

Controlled (Marine)

MODIFIED NATURAL ENVIRONMENT. Noticeably less pristine than a Controlled Pelagic Zone and, thus, normally less sensitive to the development of visitor facilities. Similar in principle to a Terrestrial Controlled Zone.

Inherent Attributes/ Characteristics	A marine area where the seascape, ecosystems and habitats, and ecological processes may have been noticeably transformed by past or present developments (piers, buoys) or human activities (fishing, estuary mouth manipulation) within the area or in the terrestrial area immediately adjacent to it, but with significant interventions over time it could be restored to: i A natural setting that appears to the general public as largely unmodified. ii A system in which the ecological processes function naturally. iii A situation in which, as a combination of achieving the above, the area could be regarded as partly modified and, hence, could be upgraded to a Controlled Pelagic Zone. Proactive and responsive management interventions may be required indefinitely for the maintenance of the above.
Focal Purpose of Zone	i Where applicable, the restoration and maintenance of natural landscapes and ecological processes. ii Provide an affordable, comfortable, informative, safe, enjoyable and sustainable outdoor recreational experience in a relatively-unspoilt marine environment.

Permissible Uses & Activities NOTE 1	*Inshore:* i Walking on beaches and rocks and fossicking. ii Swimming, snorkelling, surfing, surf-skiing, kite and wind surfing and kayaking. iii Horse riding. iv Cycling. v Concession, research and monitoring, and management beach driving only. vi Recreational and subsistence rock and surf angling. vii Boat launching (self and concession) at recognised boat-launching sites. viii Special interest/educational activities within parameters of other permissible and non-permissible uses and activities. ix Controlled subsistence invertebrate harvesting in designated areas. x Research and monitoring with a scientific permit. xi Law enforcement patrols and reaction. xii Management intervention to restore/maintain ecological processes and the unspoilt appearance of the landscape. *Offshore.* i Scuba diving. ii Snorkelling. iii Kayaking, surf-skiing, kite and wind-surfing, and parasailing from boat. iv Use of motorised vessels. v Recreational pelagic fishing (except at 2-mile reef = only in waters > 30 m). vi Spear fishing (except at 2-mile reef = only in waters > 18 m, only pelagic game fish). vii Special interest/educational activities within the parameters of other permissible and non-permissible uses and activities. viii Establishment of artificial substrates including artificial reefs. ix Research and monitoring with a scientific permit. x Law enforcement patrols and reaction. xi Management intervention to restore/maintain ecological processes and the unspoilt appearance of the landscape. *Estuarine Lakes:* i Walking on estuary margins and fossicking. i Concession, research and monitoring, and management beach driving only. ii Recreational and subsistence rock and surf angling. iii Boat launching (self and concession) at recognised boat-launching sites. iv Special interest/educational activities within parameters of other permissible and non-permissible uses and activities. v Controlled subsistence invertebrate harvesting in designated areas. vi Research and monitoring with a scientific permit. vii Law enforcement patrols and reaction. viii Management intervention to restore/maintain ecological processes and the unspoilt appearance of the landscape.
Non-Permissible Uses & Activities	*Inshore.* i Vehicles on the beach except for boat launching purposes at recognised launch sites, and concession beach driving and authorised management and research and monitoring vehicles NOTE 2. ii Launching from non-recognised sites except under special permit. iii Jet skis except under special permit. iv Harvesting of intertidal organisms other than subsistence invertebrate harvesting or under special permit.

	v Collection of marine aquarium fish, invertebrates and plants except for educational or scientific purposes and under special permit. vi Collection of organic (drift wood, shells) and inorganic (e.g. rocks, sand) materials except for educational or scientific purposes and under special permit. vii Commercial fishing. *Offshore.* i Fishing for, or being in possession of, bottom fish[5]. ii Chumming or feeding of fish (including sharks). iii Jet skis except under special permit. iv Collection of marine aquarium fish except for educational or scientific purposes and under special permit. v Use of fish aggregating devices (FADs), anchored or drifting. vi Commercial fishing. *Estuarine Lakes:* i Vehicles on the beach barrier except for boat launching purposes at recognised launch sites, concession beach driving and authorised management and research and monitoring vehicles **NOTE 2**. ii Launching from non-recognised sites except under special permit. iii Jet skis except under special permit. iv Harvesting of intertidal organisms other than subsistence invertebrate harvesting or under special permit. v Collection of marine aquarium fish, invertebrates and plants except for educational or scientific purposes and under special permit. vi Collection of organic (drift wood, shells, etc) and inorganic (e.g. rocks and sand) materials except for educational or scientific purposes and under special permit. vii Commercial fishing.
Use Intensity/ Frequency **NOTE 2**	Regulated and controlled use of moderate intensity and relatively high frequency, with entry/access restricted to and controlled at entrance gates or other demarcated points of entry.
Development Nodes	Only Tourism Day Visitor Nodes and Park Management Nodes permitted.
Development Restrictions	Only very low key, unobtrusive and low impact development permitted from base of dunes to the low water mark. No development of any type or form permitted from the low water mark to the outer limit of the Park boundary (3 nautical miles) regardless of circumstances or needs. Development from base-of-dune to dune-crest and inland must conform to restrictions laid down for the adjacent Development Node or Terrestrial Zone which, in most instances, will be a Terrestrial Controlled Zone.

5 There are a number of reasons why the Authority has taken the decision to prohibit all bottom fishing in the Park. Firstly, the then Minister of Environmental Affairs and Tourism declared South Africa's line fishery in a state of emergency in 2000 because of the crisis in this fishery (Government Gazette, 29 December 2000 No. 21949, Notice 4727 of 2000). In the Southern African marine line fish status reports, a number of species of commercial and recreational marine fish, including bottom fish species, were considered over exploited and/or collapsed and stock rebuilding is required. Firstly, there is also an extensive body of scientific literature that motivates for protection of reef fish in the iSimangaliso Wetland Park and the Natal Bioregion. Secondly, bottom fish are often highly resident, a key feature that makes these species vulnerable to overexploitation. Thirdly, the area south of Cape Vidal falls in the Natal Bioregion, which up to now has not received adequate protection consistent with the other bioregions in South Africa.

NOTES: Controlled (Marine)

NOTE 1: All permissible activities are subject to parameters set by legislation and the Permissible Activities Framework in the IMP.

NOTE 2: In the event of changes to the **regulations** governing the use of vehicles in the coastal zone, for example, a lessening of current restrictions, iSimangaliso will review its restrictions related to permissible and non-permissible activities in the Marine Controlled Zone, to give equivalent force to the above restrictions that rely significantly on the prohibition of vehicles in the coastal zone..

4.1 Appropriate buffers to the estuary boundary

The Park's Zone of Influence is the buffer to the estuary beyond the Park's boundaries and includes the delineation of a ground water capture zone.

5 Integrated Monitoring Plan

Good data need to be available to assess long-term changes in the hydrological, hydrodynamic and ecological health and functioning of the Mgobozeleni estuarine system. A review of the monitoring plan for the Mgobozeleni estuarine system will be undertaken as part of this EstMP (see key action in the plan in Section 3.4 (Research)). The monitoring plan that is finally put in place should be made as practical as possible and with essential indicators selected, taking into account availability of human and financial resources. It should aim at collecting appropriate and reliable quantitative data, which are essential for the implementation of management actions and review of the responses of the system.

The table below defines a comprehensive monitoring plan for the Mgobozeleni system, and is a good starting point for the review. Given that the current resource constraints are likely to persist during the lifetime of this EstMP, it is unlikely that all indicators will be included. However, the indicators should cover the following:

- Biological. Diversity and Abundance and Areal Coverage.
- Exploitation of Living Resources: Invertebrates and Fish.
- Water Quantity and Quality.

Focal Areas and Indicators	Monitoring Objective	Frequency	Location	Collection/Analytical Method
Water Quality: Essential physical parameters (salinity, temperature, dissolved oxygen, conductivity, depth, pH and turbidity/suspended solids) Inorganic nutrients (phosphates, nitrates, ammonium etc) Toxic substances (heavy metals, hydrocarbons, pesticides, herbicides, etc) Coliform bacteria (*Escherichia coli* and total coliforms)	To determine changes in water quality in response to management actions	Monthly	A minimum of ten fixed sample sites	According to laboratory specifications and/or as stipulated in the Methods for the Determination of the Ecological Water Reserve for Estuaries (DWA, 2010)
Water Quantity: Water flow into the estuary Depth of the estuary	To detect decreases in volume of water reaching the estuary to inform management actions To assess the sediment entering the system	Monthly	Water quantity measures from all water sources	Installation of suitable flow measurement stations Review of new WULAs and plantation permit applications
Mouth Condition and Bathymetry	To assess mouth behaviour and long term changes in mouth dynamics To detect changes in depth and sedimentation rates	Daily Every 5 years	Mouth and sand barrier Whole system	Mouth condition by trained observers with GPS and photography Installation of water level recorders Bathymetric surveys

Focal Areas and Indicators	Monitoring Objective	Frequency	Location	Collection/Analytical Method
Biological : Diversity and Abundance and Areal coverage Phytoplankton/Microphytobenthos Macrophytes (reedswamp, other peripheral vegetation types, alien invasives) Macrocrustaceans (prawns and crabs) Fish Birds Reptiles Mammals	To determine baseline and then on-going changes in biota in response to management actions	Quarterly for the 1st year for fauna Then twice a year once during summer and winter rainfall months Twice a year for macrophytes	A minimum of ten fixed sample sites	As stipulated in the Methods for the Determination of the Ecological Water Reserve for Estuaries (DWA, 2010) Fixed photo monitoring/aerial photography of macrophyte coverage
Exploitation of living resources : Macrocrustaceans, Fish, Reed and Thatch Grass Permits issued Levels of non-compliance	To assess the level of exploitation of living resources to inform management actions	Weekly	Through-out system for fish Reed swamp for Reeds and Thatch Grass harvesting	Patrol survey of the number of permits issued and non-compliance

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