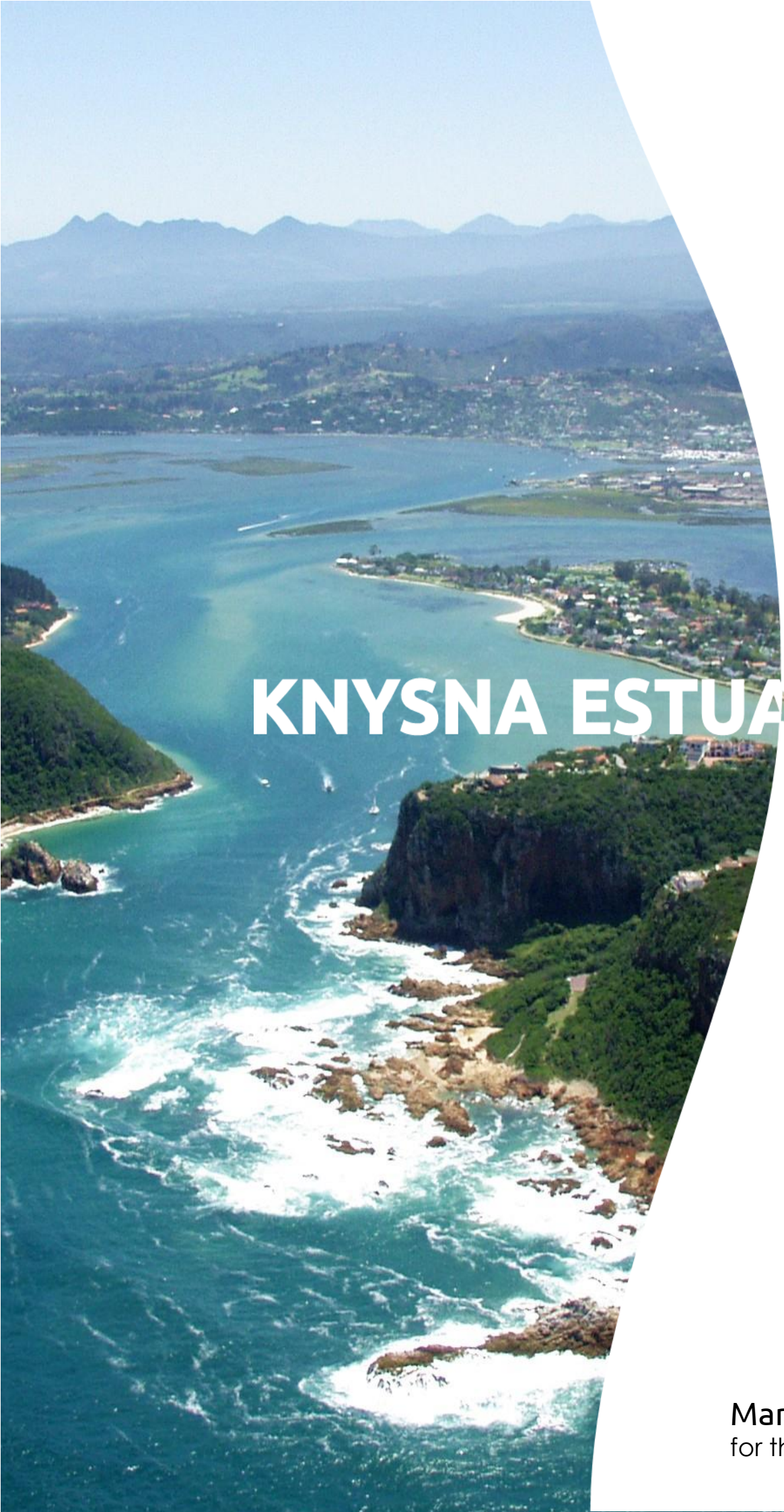


South African
NATIONAL PARKS

KNYSNA ESTUARY

Part of the
Knysna Protected
Environment

Management Plan
for the period 2025 - 2029



Acknowledgement

This plan was prepared by Mr Len du Plessis, with significant input and help from Mr Clement Arendse, Mr Johan Baard, Ms Elzette Bester, Ms Pat Bopape, Mr Owen Govender, Ms Jessica Hayes, Ms Cloverley Lawrence, Ms Vuyiswa Radebe, Dr Ian Russell, Dr Kyle Smith, Mr André Spies, Ms Megan Taplin and various stakeholders.

Suggested citation: SANParks, 2025. Knysna Estuary Management Plan. SANParks. Pretoria.

Cover page photograph by: Knysna Tourism

Section 1: Authorisation

The Knysna Estuary Management Plan is hereby internally accepted and authorised as required for managing the estuary in terms of Section 34 of the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) and the National Estuarine Management Protocol.



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Park Manager: Knysna section — Date: 17 February 2025



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Mr. P.S. Mokoena
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Ms. H. Sello
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Ms. P. Yako
Chair: SANParks Board — Date: 03 March 2025

Approved by the Minister of Forestry, Fisheries and the Environment



Dr. D.T. George, MP
Minister of Forestry, Fisheries and the Environment — Date: 13 March 2025



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Acronyms and abbreviations

amsl	Above mean sea level
BGCMA	Breede-Gouritz Catchment Management Agency
BSP	Biodiversity Social Projects
CBD	Central Business District
CDF	Conservation Development Framework
CES	Cultural Ecosystem Services
CML	Coastal Management Line
DEA	Department of Environmental Affairs (now DFFE)
DEA&DP	Western Cape Department of Environmental Affairs and Development Planning
DFFE	Department of Forestry, Fisheries and the Environment
DM	District Municipality
DoE	Department of Education
DWS	Department of Water and Sanitation
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuarine/Estuary Management Plan
GRDM	Garden Route District Municipality
GRNP	Garden Route National Park
ICMA	National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008)
IDP	Integrated Development Plan
KM	Knysna (Local) Municipality
LUPA	Western Cape Land Use Planning Act, 2014 (Act No. 3 of 2014)
MAR	Mean Annual Runoff
MLRA	Marine Living Resources Act, 1998 (Act No. 18 of 1998)
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEM: BA	National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)
NEM: PAA	National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)
NEMP	National Estuarine Management Protocol 2021
NMU	Nelson Mandela University
NWA	National Water Act, 1998 (Act No. 36 of 1998)
REC	Recommended Ecological Category
REI	River-estuary interface zone
SAEON	South African Environmental Observation Network
SAMSA	South African Maritime Safety Authority
SANParks	South African National Parks
SAR	Situation Assessment Report
SPLUMA	Spatial Planning and Land Use Management Act, 2013 (Act No.16 of 2013)
TPC	Threshold of Potential Concern



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Executive summary

The Knysna Estuary, classified as an estuarine bay, is located within the warm temperate biogeographic region of South Africa. The estuary is situated in the Knysna section of the Garden Route National Park and is proclaimed as a Protected Environment under the National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEM: PAA). The landward boundaries of the Estuary Functional Zone used in this Estuarine Management Plan are those defined in the 2018 National Biodiversity Assessment. The area of the Estuary Functional Zone is ~2 400 ha, and the catchment is ~419 km2 in extent. The estuary is ~9km long and three different hydrographic regimes have been described, the marine embayment, lagoon and the estuary regimes. The upper reaches of the larger rivers flowing into the estuary fall mostly within the boundaries of the Garden Route National Park whilst the middle reaches generally flow through privately owned areas, largely supporting agriculture and forestry practices. The estuary and surrounds have been modified by urban development in the town of Knysna.

Out of the 290 estuaries in South Africa, Knysna is rated highest in terms of conservation importance and ecosystem services provision. The estuary supports an estimated 42% of the country's known estuarine plant and vertebrate species, is an important nursery for many fish species, and supports high abundances of waders, shorebirds, and piscivorous birds. There are various pressures and threats to the estuary including climate change, exploitation of natural resources, pollution, alien species, freshwater flow reduction, extensive land-use change, infrastructure development, and siltation resulting from poor catchment management. The current ecological status of the Knysna Estuary has been categorised as a B (largely natural with few modifications).

In general, spatial zonation of activities on an estuary is used to prevent user conflict and to guide sustainable utilisation of resources without degradation of the estuarine environment. Given the location of the Knysna Estuary within the Garden Route NP, the proposed zonation of the estuary is dictated by the zonation scheme used by SANParks which comprises visitor-use zones, special management overlays and buffer zones. The Knysna Estuary has been largely zoned as low-intensity leisure, with a high-intensity leisure zone in the main channel. The current zonation identified areas of high sensitivity, such as endangered Cape eelgrass beds and saltmarshes, which were zoned as quiet. Special management overlays were applied to the use zones and included various resource-use management areas including a proclaimed bait reserve, harbour, jet ski and waterskiing areas, areas where no motorised vessels are allowed, no wake channels, idle speed zones, no wake areas in open water and the preferred channel.

In line with the recommended extent of protection for the Knysna Estuary, the establishment of two additional habitat reserves - whilst modifying the boundaries of the existing bait reserve - has been proposed. The proposed habitat reserves were spaced along the longitudinal axis of the estuary to ensure that representative habitats, coinciding with reported changes in benthic fauna, and aim to increase habitat and associated biota protection in all three hydrographic regions of the estuary

Currently estuarine related issues are discussed on three platforms: the Estuary Authority Pollution Committee, Knysna Park Forum and various local, regional and provincial coastal and estuary forums. Moving forward it has been proposed that a sub-committee of the Knysna Park Forum be established (the Estuarine Management Committee) which will consist of various relevant stakeholders and authority representatives.

Knowledge acquired from past studies along with identified threats and pressures helped guide the development of management objectives and actions during three stakeholder meetings held in April and May 2022. The vision developed for the Knysna Estuary is *"A healthy and functional estuarine system providing diverse benefits for current and future generations through a collaborative and inclusive approach that encourages shared ownership and pride*". Following on from this, a total of 11 objectives and 43 management actions were identified. A hierarchy of the vision, objectives, and actions derived for the Knysna Estuary from stakeholder engagements is presented in Figure 1. These in turn were used to develop an integrated monitoring program covering resource and compliance monitoring along with baseline or surveillance monitoring. Furthermore, to achieve and retain the desired classification (B/C) several physical, chemical and biological attributes and processes need to achieve or be retained within limits of natural or near natural variability. A set of monitoring indicators to assess these variables complement some of the existing monitoring initiatives for the estuary and, where financial and human capital permits, will be monitored alongside the monitoring programmes by or on behalf of the Department responsible for Water Affairs (DWS).



Although significant effort is directed at monitoring programmes within the Knysna Estuary and its catchment, additional, shorter term research projects have been completed which complement existing knowledge and ongoing monitoring programmes. However, most of the research in the Knysna Estuary has centred on estuarine biota and environmental processes, while less emphasis has historically been placed on socio-ecological processes. To improve understanding of the dynamics of the whole system, and effectively inform management decisions, disciplinary research should be complemented with interdisciplinary and/or transdisciplinary studies.

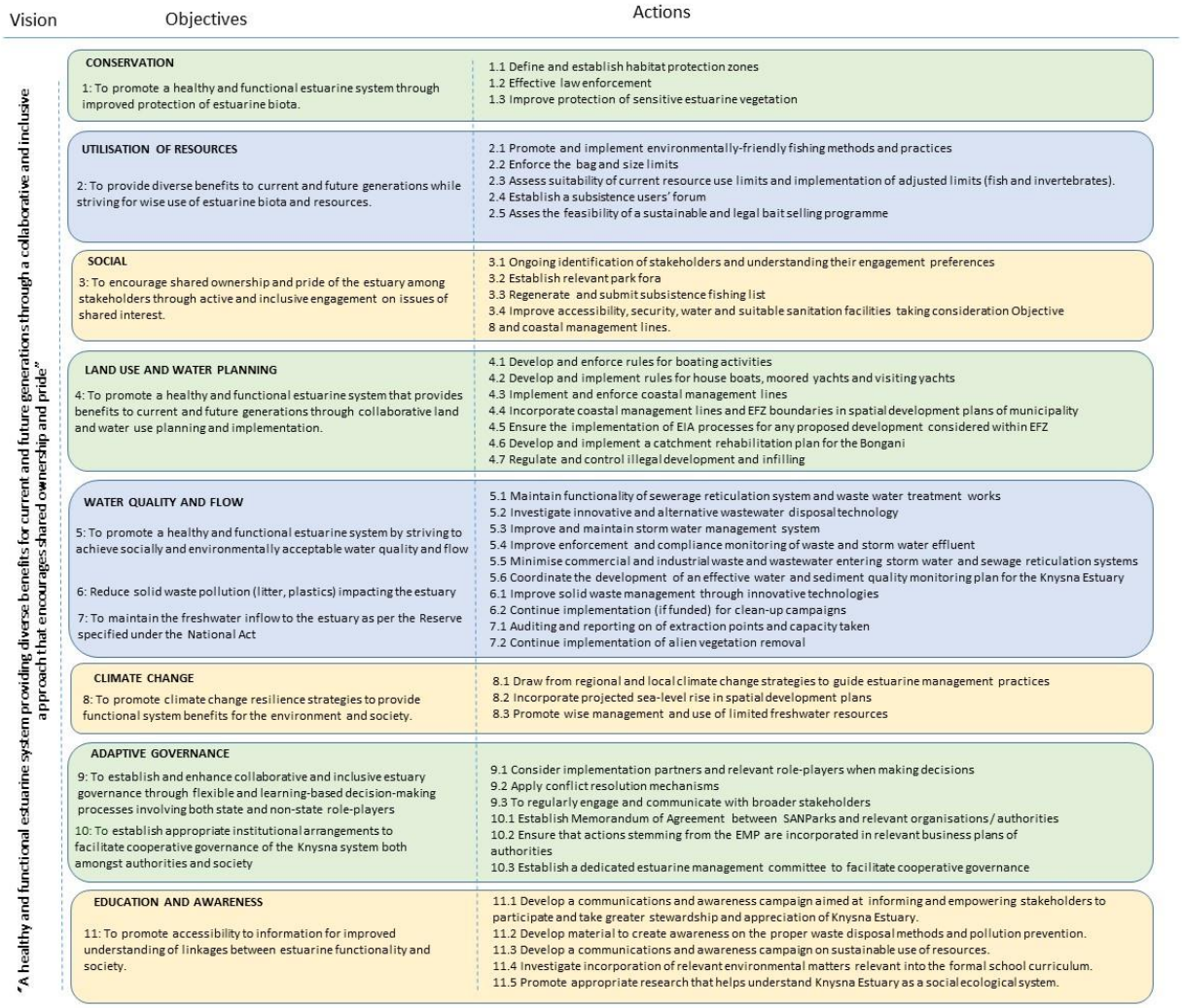


Figure 1: Hierarchy of the vision, objectives and actions derived for the Knysna Estuary during stakeholder engagements.

SANParks is identified as the responsible management agency in the NEM: PAA, therefore this EMP will be reviewed every five years.

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Section 2 – Introduction

2.1 Background

Sections 33 and 34 of the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) (ICMA) envisage that estuaries are to be managed in a collaborative and co-operative manner using Estuarine Management Plans (EMPs). The ICMA also envisages that EMPs are to be developed in accordance with a National Estuarine Management Protocol (the Protocol) published in terms of the ICMA. The ICMA recognises the importance of estuaries and their management; and identifies the Protocol as a guiding tool to support this. The Protocol identifies the need and minimum requirements for the development of EMPs, and delegates responsibility to relevant authorities to help align and co-ordinate estuary management. This EMP has been developed in accordance with the provisions of the ICMA and the Protocol.

The Knysna Estuary is a permanently open system located in the Knysna Section of the Garden Route National Park (GRNP)(Appendix 1, Map 1). As such, the estuary is protected in its entirety and management of the system falls under the jurisdiction of SANParks.

2.2 Context of the estuarine management plan

To provide guidance in the development of estuarine management plans for individual estuaries, an estuarine management framework has been provided by the National Department responsible for Environmental Affairs (DEA 2015) and structured in terms of the three main phases, namely the Scoping phase, Objective setting phase and the Implementation phase (Figure 1).

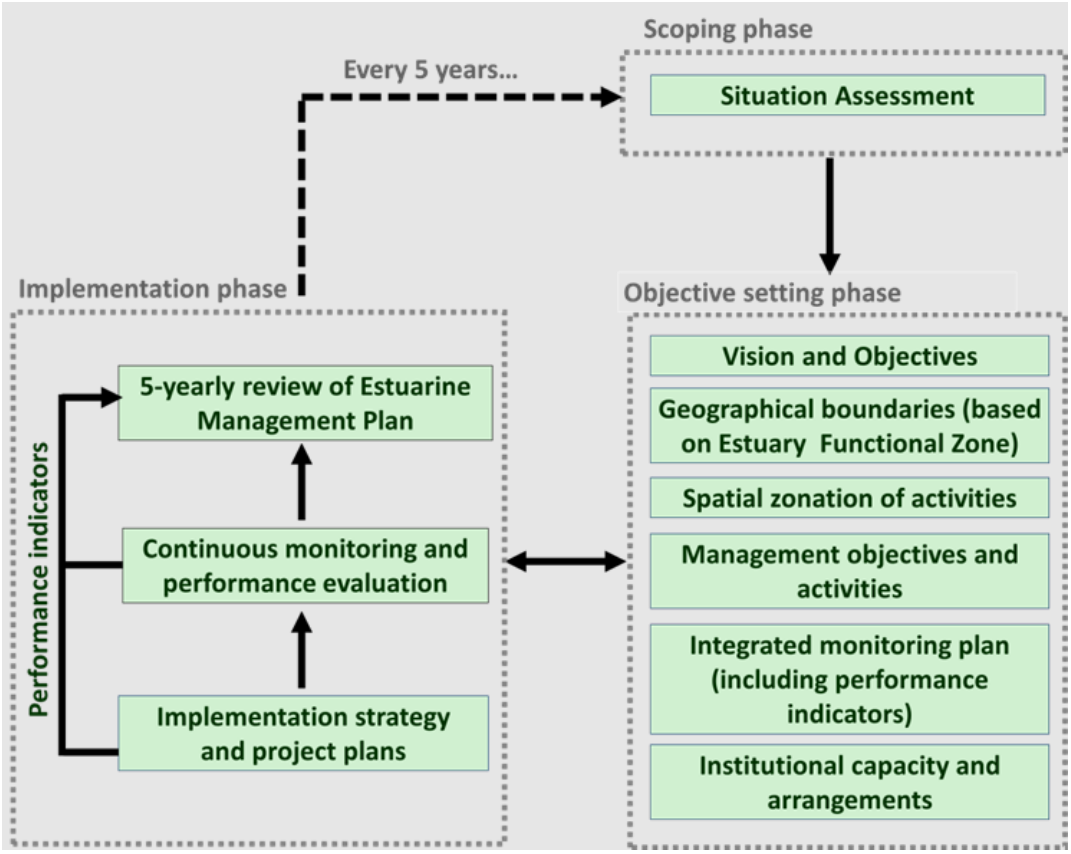


Figure 2: Framework for the development of estuarine management plans (DEA 2015).

2.3 Structure of this management plan

This introductory chapter (section 1) is followed by a synopsis of the Situation Assessment Report, providing context to this management plan (section 2). Then follows a description of the geographical boundaries (section 3) and the vision and objectives to achieve the vision (or goals) for estuarine management planning in the Knysna estuarine system as developed by the stakeholders (section 4).

Overall, management objectives, as well as details on the associated actions to address these objectives are presented in section 5 to assist with the confirmation of specific priorities for implementation over the next ten years. Section 6 presents the proposed zonation planning for Knysna Estuary. Section 7 presents an integrated monitoring plan for the Knysna Estuary. Finally, section 8 proposes institutional arrangements to oversee and coordinate the implementation and future reviews of the EMP, as well as on the importance of estuaries and the need for sound environmental management.



Section 3 – Synopsis of situation assessment

Background
The Knysna Estuary, an estuarine bay 1633 ha in extent, is located in the Knysna Section of the Garden Route National Park. The Knysna National Lake Area, which encompassed the Knysna Estuary, was proclaimed in 1985 under the Lake Areas Development Act. This was later repealed and the estuary and surrounds proclaimed as a Protected Environment under the NEM: PAA.

Catchment characteristics
The upper reaches of rivers flowing into the estuary are largely within the Garden Route National Park whilst the middle reaches are generally in privately owned areas supporting agriculture and forestry practices and with some indigenous vegetation. The estuary and surrounds have been modified by developments in the town of Knysna, including retaining structures, landfills, causeways, roads, factories, small-boat harbours, a waterfront complex, golf courses, and residential developments.

The climate in the region is moderate with maximum day-time temperatures in summer averaging 25.0°C, and 18.8°C in winter. Southwesterly winds predominate most of the year, though warm northerly and northeasterly winds frequently occur in winter. The mean annual rainfall varies between 700 mm y^{-1} at the coast and 1161 mm y^{-1} in the Outeniqua Mountains at Buffelsnek, with average annual rainfall in the Knysna River catchment estimated at 928 mm y^{-1}. Rainfall occurs throughout the year with peaks generally experienced in February, March, May, September, November and December.

The Knysna River catchment lies within the Cape Fold Belt with long east-west orientated faults and folds. Most of the catchment lies in quartzite formation of the Table Mountain Group whilst mesozoic rock outcrops that weather into sand and mud occur in low-lying areas north of the estuary. The substratum of the estuary consists predominantly of unconsolidated sandy sediments of marine, fluvial and aeolian origin.

The Knysna River is significantly the largest river draining into the estuary. The main tributaries are the Kruis, Rooiels and Gouna rivers. Smaller systems which flow into the estuary, include the Salt, Bongani and Bigai rivers. Numerous drainage lines and stormwater inlets discharge surface waters directly into the estuary from surrounding lands, including much of Knysna town.

Reduced freshwater inflows into the Knysna Estuary can result in salinity, periodically increasing up to 36 g kg^{-1} in the upper reaches. Such changes could be expected to have significant impacts on biota, and gradual reduction in both primary and secondary productivity. During floods, the salinity throughout the estuary can drop to almost 0 g kg^{-1}. Likely effects of flow reductions and modifications on the estuarine environment have been estimated within the reserve assessment for the estuary, with freshwater inflow guidelines presented to maintain a desired ecosystem condition.

Ecological function and state of the estuary
Three different hydrographic regimes have been described in the estuary: 1. The marine embayment regime, (extending inland from the estuary mouth between 3 km during neap tides and 7.5 km during spring tides) which is well flushed by tidal flows and exhibits salinities and temperatures similar to that of the ocean; 2. The lagoon regime (extending inland from the upper reaches of the bay regime and seldom beyond White Bridge) which is flushed less rapidly and is considered a transition zone between the estuary and the marine embayment; 3. The estuary regime (extending inland from the upper reaches of the lagoon regime) which is strongly influenced by the inflow of freshwater from the Knysna River and demonstrates strong vertical stratification in salinity and water temperature.

Portions of the estuary near the mouth have, in the past, been found to be as deep as 16 m below MSL. The channel between the Knysna Heads is 120 m wide and up to 15 m deep.

The main channel becomes progressively shallower along its length and is approximately 2 m in depth at the end of the tidal reach. There are no recent bathymetric maps of the estuary. Prior to the 1990s, siltation in the estuary from external sources was considered virtually absent, with perceived siltation emanating from the internal movement of sediments. Siltation problems within the estuary generally occur where artificial structures such as bridges and causeways have been constructed.

The earliest water chemistry data was collected in 1952, and illustrated how salinity, pH and dissolved oxygen vary along the longitudinal axis of the estuary. Water quality assessments undertaken from 1990 to 1994, when compared with earlier datasets (1952 to 1984), demonstrated that no clear long-term changes in recorded parameters occurred at that time. Water temperatures vary seasonally with maximum temperatures of 29°C in summer and minimum temperatures (outside of marine upwelling events) of 12°C in winter. Ocean temperatures are generally colder than estuary temperatures, with variations in water temperature occurring within the estuary due to tidal fluctuations.

Overall, the Knysna Estuary can be considered a nutrient poor (oligotrophic) system due mainly to the large volumes of nutrient poor marine waters that pass through the Heads twice daily. Changes in nutrient levels are affected by specific events such as river flooding and stormwater inflows. Localised regions of high nutrient inputs can result from stormwater and sewage plant inflows. Changes in the nutrient levels in sediments in these areas have been noted, with periodic eutrophication resulting in localised proliferation of algae, and die-back of eelgrass.

Thirty-nine phytoplankton species have been recorded in the estuary. The zooplankton community is numerically dominated by copepods, with species composition varying spatially and influenced by the hydrodynamics of the system. Macrophytes (e.g., salt marsh plants, seagrass, sedges, and reeds) act as a nutrient sink, are an important food source for estuarine biota, and provide a refuge and nursery to many fish and invertebrate species. Intertidal salt marsh plants dominate the estuary (551.9 ha) followed by submerged macrophytes, consisting mainly of endangered Cape eelgrass *Zostera capensis* and paddle weed *Halophila ovalis* (447.3 ha), supratidal salt marsh species (133 ha), and reeds and sedges (37.8 ha). The Knysna Estuary supports the largest and most stable remaining stands of Cape eelgrass in South Africa, estimated at 353 ha. Recent assessments have found the extent of eelgrass beds within the estuary to be increasing. Several anthropogenic threats to intertidal wetlands occur including trampling and sediment compaction from people traffic and unmoored boats; the uprooting of plants and sediment disturbance from the collection of benthic bait organisms such as prawns; the construction of causeways and housing developments; and siltation resulting from poor catchment management.

The invertebrate fauna in Knysna Estuary is dominated by benthic (mud dwelling) species, with relatively low faunal diversity found on the sparse rocky banks. Approximately 310 species of benthic macrofauna have been listed in the Knysna Estuary. The critically endangered false limpet *Siphonaria compressa* has been found in intertidal eelgrass meadows at Bollard Bay, while the protected pansy shell *Echinodiscus bisperforatus* occurs and breeds on sand banks in the main channel of the estuary.

Over 100 fish species have been recorded in the Knysna Estuary. Marine estuarine-dependent and marine estuarine-opportunistic species numerically dominate the fish community, with Sparidae and Mugilidae being the most important families. The Knysna Estuary is home to the endangered Knysna seahorse *Hippocampus capensis,* whilst the rare estuarine dwarfgoby *Pandaka silvana* is also endemic to this system.

Sixty-seven waterbird species have been recorded on the Knysna Estuary. The estuary supports globally significant abundances of African Black Oystercatcher, along with substantial numbers of waders and other shorebirds (e.g. curlew sandpiper, grey plover, whimbrel and greenshank) in summer, and larger piscivorous birds (e.g. cormorants, herons and egrets) in winter. Densities have been described as low, with higher abundances in summer due to the seasonal influx of Palearctic migrants. Low bird abundances have been assumed to be due to disturbance from bait collection and recreational activities, as well as low invertebrate densities. Additional pressures on estuarine birds (not necessarily confined just to the estuary) include dwindling availability of prey due to overfishing and shifts in distributions of prey species likely due to climate change, harassment by dogs, loss of breeding habitat, and hunting along migration routes.



Out of the 290 estuaries in South Africa, Knysna has been rated highest in terms of conservation importance and ecosystem service provision in South Africa, and supports an estimated 42% of the country's estuarine plant and vertebrate biodiversity. This rating was determined by comparing biota (plants, invertebrates, fish and birds), size, biogeographic zone, rarity of estuary type and habitat diversity across all estuaries in the country.

The current ecological status of the Knysna Estuary, as well as its desired future status, was assessed during reserve determination studies, with the system currently categorised as a B (largely natural with few modifications). The biotic health of the system is not as good as the physical habitat and due to this disparity, the ecological state is given in the 2018 National Biodiversity Assessment as a B/C. The Knysna Estuary falls within a protected area and therefore should ideally be Category A (unmodified, natural) or Best Attainable State (BAS). Achievement of an A is impossible given current developments and pressures, hence the Recommended Ecological Category is BAS which is a B.

An intermediate reserve assessment in 2006 modelled various water-use and development scenarios. The massive tidal exchange significantly mitigates anthropogenic nutrient inputs. Due to the marine nature of the system, any impacts of freshwater abstraction will be felt predominantly in the upper reaches of the estuary above the Red Bridge. So, while most abstraction scenarios result in the whole estuary having an Ecological Category of a Low B, it must be recognised that the impact of the scenarios in the upper reaches will be far more severe. The system is also on a negative trajectory in terms of ecosystem health, which is driven predominantly by anthropogenic non-flow factors.

Ecosystem services

The value of ecosystem services supplied by the Knysna Estuary has been estimated at between R1,258 billion and R1,311 billion per year. The larger value is based on studies undertaken up to 2005 and both the methods used and values estimated at that time, are likely outdated by now. A preliminary list of ecosystem services, which could potentially serve as a basis for more detailed studies, include i) provisioning services including freshwater from the Knysna River; fish and bait resources; direct and indirect livelihood/job provision. ii) regulatory services, which include waste dilution; storm water regulation; carbon sink in the form of seagrass beds; and iii) cultural services including aesthetic value; recreation; sense of place and cultural heritage; spiritual and social experiences; opportunities for scientific knowledge generation; environmental education.

Impacts

There are various environmental pressures and threats to Knysna Estuary, including alien species, climate change, exploitation of natural resources, pollution, freshwater flow reduction, land-use change and infrastructure development. Within the Knysna Estuary, 22 alien species have been recorded covering a range of taxa. Expected impacts of climate change on South Africa's estuaries include wind regime shifts; increasing air temperature; modification of terrestrial climatic and hydrological processes; ocean acidification and estuarine pH shifts; sea level rise; increasing wave energy; increasing frequency and intensity of coastal storms; changed upwelling and biogeochemical inputs from coastal waters; and water temperature shifts. Due to the large marine influence on the Knysna Estuary, climate impacts are likely to originate mostly from marine processes rather than terrestrial. These would include impacts of coastal storms and storm surges, sea level rise, changes in oceanographic currents and the influence of wind-induced upwelling. The degree of impact by different climate stressors is likely to vary between the hydrographic regions of the system.

Socio-economic context

Knysna is located within a national coastal corridor, as well as a national development corridor, and extensive development and transformation of the estuary's shoreline and surrounds have

occurred over the years. Numerous challenges exist with aging infrastructure, significant backlogs in the upgrade of roads and storm water systems, and a strained wastewater treatment plant that cumulatively contribute to increasing pollution of the Knysna Estuary.

Over-exploitation of natural resources poses the single biggest threat to estuarine fish conservation. Although the primary direct impact of bait harvesting is a reduction in the density of targeted species, the impact of bait collecting is further exacerbated through sediment disturbance and illegal activities including, exceeding daily bag limits, illegal sale of bait organisms, and using banned implements including garden forks and shovels.

Boating activities have a variety of potential ecological impacts including pollution (engine emissions, sound emissions, antifouling paint leaching), disturbance of birds and fish, habitat damage including aquatic vegetation, bank erosion and resuspension of sediments leading to increased turbidity.

Knysna is one of seven local municipalities that fall within the Garden Route (Eden) District Municipality and has the third highest average annual population growth rate of 1.1% and a total population of 76 150 individuals, which is projected to increase to 79 426 by 2023. The wholesale and retail trade, catering and accommodation, transport, communication, finance, real estate and business services, general government, and social and personal services provide the most jobs. The natural and scenic appeal of the Knysna Estuary is a key tourism attraction along with the region's temperate climate, well-developed infrastructure, and proximity to airports. Tourism is a key economic driver in the Knysna region, as well as an important source of employment. In addition, resource extraction, mainly fishing, is an essential estuarine service, providing an estimated 70.4 tons of fish per annum.

History and cultural heritage

The Knysna Estuary and surrounds has a rich cultural and archaeological heritage, with Middle Stone Age deposits indicating that the region has been inhabited for tens of thousands of years by modern humans. Some of the earliest inhabitants of the southern Cape region were the Khoi (pastoralists) and San (semi-nomadic hunter-gatherers). The earliest European inhabitants of the area were a group of Portuguese sailors whose ship was wrecked in Plettenberg Bay in 1630. Harvesting of indigenous timber surrounding Knysna began in 1763, and the creation of a port in Knysna Estuary enabled faster transportation of timber to outside markets. As one of the earliest commercial harbours in the country, the first loading wharf was constructed in 1776. The harbour was de-proclaimed in 1959. Access to, and transportation of timber in and around the Knysna Estuary, coupled with construction and processing factories, and the establishment of the town and associated residences over the last ±250 years have impacted, and likely transformed, the Knysna Estuarine system to what we see today.

Legislative instruments

Legislation specific to estuarine management includes the ICMA and the accompanying National Estuarine Management Protocol. Key legal instruments that are applicable to estuarine management comprise national, provincial and local management documents, including the Garden Route National Park Management Plan compiled in accordance with the NEM: PAA.

Information gaps

While considerable research has been undertaken in Knysna Estuary, it is striking that this has centred almost entirely on estuarine biota and processes. Such knowledge provides important building blocks for understanding how the estuary functions. Bathymetric surveys of the Knysna Estuary along with assessments of the likely origin of sediments would be helpful to evaluate changes in the quantity and spatial distribution of sediments. However, to improve understanding of the dynamics of the whole system, and effectively inform management decisions, disciplinary research should be complemented with interdisciplinary (studies that draw on and integrate knowledge from across social and natural scientific disciplines) and/or transdisciplinary (studies that incorporate local and practice-based knowledge and involve non-academic stakeholders in a process of co-learning) research. A useful place to start is to better understand the range of ecosystem services (tangible and intangible) derived from the Knysna Estuary, who the beneficiaries are, how services are mobilised and appropriated, and where possible thresholds and conflicts might arise. Implementation of the reserve with disclosure of water-use licences issued, levels of compliance, and how these relate to the gazetted reserve for freshwater inflows to the estuarine environment are required for effective freshwater resource management. Proposed habitat reserves should be compared to, inter alia, invertebrate macrophyte avifauna distribution and abundance within the estuary to ensure representative areas are protected.



Section 4 – Confirmed geographical boundaries

Geographical Boundary of the Estuary

The ICMA defines an estuary as "*a body of surface water - that is permanently or periodically open to the sea; in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the body of surface water is open to the sea; or in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water*".

Similarly, the National Water Act, 1998 (Act No. 36 of 1998) (NWA) defines an estuary as "*a partially or fully enclosed water body that is open to the sea permanently or periodically, and within which the seawater can be diluted, to an extent that is measurable, with freshwater drained from land*".

The 2018 NBA: Estuarine Realm Technical Report (Van Niekerk et al*.,* 2019) provides a more detailed definition of an estuary, that is, "*a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action, salinity penetration or back-flooding under closed mouth conditions. During floods an estuary can become a river mouth with no seawater entering the former estuarine area or, when there is little or no fluvial input, an estuary can be isolated from the sea by a sandbar and become fresh or even hypersaline*". Given this extended definition and the fact that it is not currently incorporated into or reflected in any legislation, Van Niekerk et al. (2019) noted the importance of updating the relevant legislation to include a broader definition of an estuary, which includes the EFZ.

Although inclusion of the EFZ in the description of an estuary is deemed important, the only legislated definition of an EFZ can be found in the 2014 Environmental Impact Assessment (EIA) Regulations, as amended, which defines the EFZ as "*the area in and around an estuary which includes the open water area, estuarine habitat (such as sand and mudflats, rock and plant communities) and the surrounding floodplain, as defined by the 5 m topographical contour (referenced from the indicative mean sea level)*". Van Niekerk et al. (2019) notes the shortcomings of using a 5m topographical contour as a reference for all estuaries and instead provides for a broader definition of an EFZ as "*The open water area of an estuary together with the associated floodplain, incorporating estuarine habitat (such as sand and mudflats, salt marshes, rock and plant communities) and key physical and biological processes that are essential for estuarine ecological functioning*". The Protocol requires that a geographical description of the EFZ is provided as part of the EMP and that the definition of an EFZ as provided in the 2018 NBA (or subsequent revisions) is used.

The definitions provided in the 2018 NBA: Estuarine Realm Technical Report (Van Niekerk et al. 2019) will therefore be used to delineate the boundaries of the Knysna Estuary and its EFZ (Appendix 1, Map 2 & 3).

The Knysna Estuary is classified as an estuarine bay and is located within the warm temperate biogeographic region of South Africa. An estuarine bay is described as an estuary that is permanently linked to the sea by unrestricted, deep mouths and are dominated by tidal processes, with tidal amplitudes close to those of the sea (Van Niekerk et al., 2019). The size of the estuary and its EFZ is approximately 2,400 ha, extending over a length of 19 km. The area the estuary occupies, when the floodplain is included in the calculation is approximately 2,284 ha (DWS 2017). The catchment for the Knysna Estuary is approximately 419 km^2 (41,900 ha) (DWS 2017).

Table 1: Geographical boundaries of the Knysna Estuary and EFZ.

Downstream boundary	34° 4'58.05"S 23° 3'37.82"E (Estuary mouth)
Upstream boundary	33°59'54.62"S 23° 0'11.90"E
Lateral boundaries	EFZ as described in the 2018 NBA



Section 5 – Vision, strategic objectives and key principles

Vision

For estuarine management to be effective, it is especially important that responsible management authorities and other key stakeholders have a common understanding of what needs to be accomplished. Without a clear idea of what the management of the particular estuary entails, there will be no sound basis for collaboration and prioritisation of management decisions. For this reason, it is important that the vision for an EMP be developed jointly by the stakeholders to truly reflect the shared environmental, social and economic expectations within limits for sustainable development. In the case of the Knysna Estuary, this exercise was undertaken at a stakeholder meeting and a shared vision emerged as follows:

VISION FOR KNYSNA ESTUARY

"A healthy and functional estuarine system providing diverse benefits for current and future generations through a collaborative and inclusive approach that encourages shared ownership and pride."

Strategic objectives

In the context of a vision, strategic objectives (or goals) are generally phrased as statements that translate the values defined in the shared vision into tangible outcomes, rather than actions of how to achieve them. The Protocol provides a list of national objectives which national government views as desired outcomes of estuarine management in South Africa, which is listed in the box below. These outcomes reflect the estuarine environment in a holistic context, considering not only ecological values (biodiversity, conservation), but also social (heritage areas, archeologically significant sites, baptism areas, sense of place) and economic values (property / land use planning, ecotourism, recreation).

National objectives for estuarine management in South Africa:

- To conserve, manage and enhance sustainable economic and social use without compromising the ecological integrity and functioning of estuarine ecosystems,
- 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 ecosystem, are maintained,
- To manage estuaries co-operatively through all spheres of government and to engage the private sector/entities and civil society in estuarine management,
- To protect a representative sample of estuaries (such protection could range from partial protections to full protection) to achieve overall estuarine biodiversity targets as determined by the NBA 2011 and the subsequent updates,
- To promote awareness, education and training that relate to the importance, value and management of South African estuaries,
- To minimise the potential detrimental impacts of predicted climate change through a precautionary approach to development in and around estuaries and regarding to the utilisation of estuarine habitat and resources.

In the case of the Knysna Estuary, the strategic objectives for the EMP were discussed and articulated during a public participation session conducted with the relevant stakeholders. Based on the outcome of these discussions, a set of strategic objectives were distilled as presented in Table 2.

Table 2: Strategic objectives for the Knysna EMP

CONSERVATION	• To promote a healthy and functional estuarine system through improved protection of estuarine biota.
UTILISATION OF RESOURCES	• To provide diverse benefits to current and future generations while striving for wise use of estuarine biota and resources.
SOCIAL	• To encourage shared ownership and pride of the estuary among stakeholders through active and inclusive engagement on issues of shared interest.
LAND AND WATER USE PLANNING	• To promote a healthy and functional estuarine system that provides benefits to current and future generations through collaborative land- and water-use planning and implementation.
WATER QUALITY AND FLOW	• To promote a healthy and functional estuarine system by striving to achieve socially and environmentally acceptable water quality and flow. • To reduce solid waste pollution impacting the estuary. • To maintain the freshwater inflow to the estuary as per the Reserve specified under the National Water Act.
CLIMATE CHANGE	• To promote climate change resilience strategies to provide functional system benefits for the environment and society.
ADAPTIVE GOVERNANCE	• To establish and enhance collaborative and inclusive estuary governance through flexible and learning-based decision-making processes involving both state and non-state role-players • To establish appropriate institutional arrangements to facilitate cooperative governance of the Knysna system both amongst authorities and society.
EDUCATION AND AWARENESS	• To promote accessibility to information for improved understanding of linkages between estuarine functionality and society.

Management objectives, prioritisation of associated actions and performance monitoring

The aim of this chapter is to present a holistic perspective of the range of issues, impacts and/or threats that should be addressed in the Knysna Estuary to achieve the vision and strategic objectives. The management objectives and proposed actions listed here, arose from management issues and associated actions identified during stakeholder consultation. This information was supplemented by issues identified by the project team during the situation assessment phase. Information pertaining to specific management actions include: i) the relevant legislation and responsible management agent, ii) existing risks that may arise if the action is not executed, iii) its relative priority, as informed by stakeholders and the situation assessment study, and iv) performance indicators against which progress could be tracked. Targets and timeframes for each action are provided.

During the implementation phase of the EMP, the information provided in this chapter will form the basis for the development of the implementation plans when prioritisation and execution must be confirmed with various responsible agents. It is important to note that many of the proposed actions reside with existing mandates of the responsible agents and should therefore be considered in the business plans of such authorities.

A modified version of the categories addressing Management Objectives for estuaries as listed in the Protocol is used to provide structure for the Management Objectives for the Knysna EMP. These categories were used to provide structure to the Management Objectives for the Knysna EMP (see Table 2).

Note that compliance and enforcement are captured under the other listed categories due to the cross-cutting nature of this category.



Conservation

Objective 1: To promote a healthy and functional estuarine system through improved protection of estuarine biota.

Action 1.1: Develop Regulations for defining and establishing habitat protection zones for consideration by DFFE	
Relevant legislation	MLRA; NEM: PAA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks & DFFE
Estimated budget	Existing SANParks & DFFE
Performance indicator/target	Draft Regulations created
Timeframe	Year 2
PRIORITY	**High**

Action 1.2: Undertake effective law enforcement	
Relevant legislation	MLRA; ICMA, NEM: BA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Low
Resource requirements	Internal DFFE & SANParks
Estimated budget	Existing DFFE & SANParks
Performance indicator/target	Number of patrols conducted, and offences registered
Timeframe	Ongoing
PRIORITY	**High**

Action 1.3: Improve protection and rehabilitation of vulnerable estuarine vegetation (e.g. protection of salt marsh vegetation and eelgrass, undertake vegetation rehabilitation, prevention of vegetation destruction due to increased use). Inclusion of priority areas in habitat protection zones	
Relevant legislation	MLRA; ICMA; NEM: PAA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Low
Resource requirements	Internal SANParks, DFFE & SANBI
Estimated budget	Existing SANParks, DFFE & SANBI
Performance indicator/target	Inclusion of identified priority areas into habitat protection zones
Timeframe	Year 3
PRIORITY	**High**

Utilisation of resources

Objective 2: To provide diverse benefits to current and future generations while striving for wise use of estuarine biota and resources.

Action 2.1: Assess and promote environmentally-friendly fishing methods and practices	
Relevant legislation	MLRA; ICMA; NEM: PAA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks DFFE &
Estimated budget	Existing SANParks DFFE &
Performance indicator/target	Monitoring results
Timeframe	Year 1, ongoing
PRIORITY	**Medium**

Action 2.2: Enforce relevant regulations for all biota as specified by the Marine Living Resources Act	
Relevant legislation	MLRA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal DFFE & SANParks
Estimated budget	Existing DFFE & SANParks
Performance indicator/target	Number of patrols conducted, offences registered, and compliance reports produced
Timeframe	Ongoing
PRIORITY	**High**

Action 2.3: Assess suitability of current resource-use limits and motivate for amendments to MLRA (time; size; quantity) for selected fish and invertebrate species if justified	
Relevant legislation	MLRA; ICMA; NEM: PAA; NEM: BA
Responsible agent	DFFE, SANParks
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal DFFE & SANParks
Estimated budget	Existing DFFE & SANParks
Performance indicator/target	Assessment findings. Recommendations for changes in resource-use limits, if justified
Timeframe	Year 2
PRIORITY	**High**

Action 2.4: Establish a subsistence users' forum to promote communication on sustainable resource-use.	
Relevant legislation	MLRA; ICMA; NEM: PAA
Responsible agent	SANParks, DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	High
Resource requirements	Internal SANParks & DFFE
Estimated budget	Existing SANParks & DFFE
Performance indicator/target	Forum minutes
Timeframe	Year 1
PRIORITY	**High**



Action 2.5: Asses the feasibility of a sustainable and legal bait selling programme	
Relevant legislation	NEM: PAA; MLRA
Responsible agent	SANParks & DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks & DFFE
Estimated budget	Existing SANParks & DFFE
Performance indicator/target	Feasibility report and recommendations to DFFE
Timeframe	Year 3
PRIORITY	**Medium**

Social

Objective 3: To encourage shared ownership and pride of the estuary among stakeholders through active and inclusive engagement on issues of shared interest.

Action 3.1: Ongoing identification of stakeholders and understanding their engagement preferences, thereby empowering them to participate and take greater stewardship and appreciation of the Knysna Estuary	
Relevant legislation	NEM: PAA; ICMA; MSA; NWA
Responsible agent	All role-players (SANParks; KM; BOCMA)
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Forum minutes
Timeframe	Ongoing
PRIORITY	**High**

Action 3.2: Establish and engage with stakeholders through appropriate fora	
Relevant legislation	MLRA; NEM: PAA; ICMA
Responsible agent	SANParks
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Records of engagement
Timeframe	Ongoing
PRIORITY	**High**

Action 3.3: Regenerate and submit subsistence fishing list to enable local communities to benefit from concessions for subsistence fisher people	
Relevant legislation	MLRA
Responsible agent	DFFE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	High
Resource requirements	Internal DFFE
Estimated budget	Existing DFFE
Performance indicator/target	Final list
Timeframe	Year 2
PRIORITY	**High**

Action 3.4: Improve accessibility, security, water and sanitation facilities at selected sites along estuary frequently used by fisher people.	
Relevant legislation	NEMA, Municipal Systems Act
Responsible agent	KM
Existing risk to biodiversity	Low
Existing risk to socio-economics	Medium
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Records of interventions
Timeframe	Year 3
PRIORITY	**Medium**

Land and water use planning

Objective 4: To promote a healthy and functional estuarine system that provides benefits to current and future generations through collaborative land and water use planning and implementation.

Action 4.1: Develop guidelines and enforce rules for boating activities in the Knysna Estuary (e.g. permitting, speed limits, zoning)	
Relevant legislation	NEM: PAA; SAMSA legislation
Responsible agent	SANParks
Existing risk to biodiversity	Medium
Existing risk to socio-economics	High
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Guidelines developed and rules enforced
Timeframe	Year 2
PRIORITY	**High**

Action 4.2: Develop and implement rules for house boats, moored yachts and visiting yachts residing for short or long term stays in the Knysna Estuary, including sewage management	
Relevant legislation	NEM: PAA; SAMSA legislation; NWA, Municipal Systems Act
Responsible agent	SANParks
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Guidelines developed and rules enforced
Timeframe	Year 2
PRIORITY	**Medium**

Action 4.3: Implement and enforce coastal management lines (in terms of the ICMA linked to land-use planning and development, including restriction of development in EFZ (cross reference to 'Climate Change' category)	
Relevant legislation	ICMA
Responsible agent	DEA&DP
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal DEA&DP
Estimated budget	Existing DEA&DP
Performance indicator/target	Development proposals influenced
Timeframe	Ongoing
PRIORITY	**Medium**



Action 4.4: Incorporate coastal management lines and EFZ boundaries in spatial development plans of municipality	
Relevant legislation	LUPA; SPLUMA; ICMA; Knysna Planning by-law
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	SDF
Timeframe	Linked to revision of the SDF
PRIORITY	**High**

Action 4.5: Ensure the implementation of Environmental Impact Assessment processes for any proposed development considered within EFZ of the Knysna Estuary as per NEMA	
Relevant legislation	LUPA; SPLUMA; ICMA; NEMA
Responsible agent	DEA&DP & KM
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal DEA&DP & KM
Estimated budget	Existing DEA&DP & KM
Performance indicator/target	EA processes implemented
Timeframe	Ongoing
PRIORITY	**High**

Action 4.6: Develop and implement a catchment rehabilitation plan for the Bongani catchment to reduce sedimentation in estuary	
Relevant legislation	LUPA; SPLUMA; NWA; NEMA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	Low
Resource requirements	KM Internal
Estimated budget	KM Existing
Performance indicator/target	Implementation of a rehabilitation plan
Timeframe	Year 3
PRIORITY	**High**

Action 4.7: Regulate and control illegal development and infilling in river catchments including the Bongani, Bigai and Salt River	
Relevant legislation	LUPA; SPLUMA; NWA; NEMA; Municipal Planning by-law; NEMWA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Compliance reports
Timeframe	Ongoing
PRIORITY	**High**

Water quality and flow

Objective 5: To promote a healthy and functional estuarine system by striving to achieve socially and environmentally acceptable water quality and flow.

Action 5.1: Maintain functionality of water and sewerage reticulation systems including water and wastewater treatment works to ensure compliance with the prescribed effluent discharge standards.	
Relevant legislation	NEMA; NWA; ICMA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Upgrade plans and monitoring results
Timeframe	Ongoing
PRIORITY	**High**

Action 5.2: Investigate innovative and alternative wastewater disposal technology appropriate for the Knysna system	
Relevant legislation	NEMA; NWA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Upgrade plans and monitoring results
Timeframe	Year 3
PRIORITY	**Medium**

Action 5.3: Improve and maintain stormwater management system and attend to illegal ingress of sewage into stormwater systems	
Relevant legislation	NEMA; NWA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Compliance reports and monitoring results
Timeframe	Ongoing
PRIORITY	**High**

Action 5.4: Improve enforcement and compliance monitoring of waste and storm water effluent (through engagement at higher levels between the relevant authorities)	
Relevant legislation	NWA
Responsible agent	All role players (DWS & DFFE)
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal DWS & DFFE
Estimated budget	Existing DWS & DFFE
Performance indicator/target	Compliance reports
Timeframe	Ongoing
PRIORITY	**High**



Action 5.5: Minimise commercial and industrial waste and wastewater (e.g. fats, oils and chemicals) entering stormwater and sewage reticulation systems	
Relevant legislation	LUPA; SPLUMA
Responsible agent	GRDM, KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal GRDM & KM
Estimated budget	Existing GRDM & KM
Performance indicator/target	Compliance reports
Timeframe	Ongoing
PRIORITY	**High**

Action 5.6: Co-ordinate the development of an effective water and sediment quality monitoring plan for the Knysna Estuary (including sources of pollution) specifically to identify roles, responsibilities and funding for inclusion in the monitoring of the system	
Relevant legislation	NWA; NEMP: PA
Responsible agent	SANParks
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Monitoring plan
Timeframe	Year 1
PRIORITY	**High**

Objective 6: To reduce solid waste pollution (litter, plastics) impacting the estuary

Action 6.1: Improve solid waste management through innovative technologies specifically in the CBD and northern areas of Knysna (e.g. litter disposal, sufficient tamper proof bins, cargo nets, stormwater grids, bio-incineration)	
Relevant legislation	NEMWA; MSA
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Compliance reports and monitoring results, records of interventions
Timeframe	Ongoing
PRIORITY	**High**

Action 6.2: Continue implementation (if funded) for clean-up campaigns through Working for the Coast project, environmental days and volunteers	
Relevant legislation	NEM: PAA
Responsible agent	DFFE
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	Internal DFFE
Estimated budget	Existing DFFE
Performance indicator/target	Working for the Coast deliverables
Timeframe	Ongoing
PRIORITY	**High**

Objective 7: To maintain the freshwater inflow to the estuary as per the Reserve specified under the National Water Act

Action 7.1: Auditing and reporting on extraction points and volume abstracted	
Relevant legislation	NWA; NEM:BA
Responsible agent	BGCMA
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal BGMCA
Estimated budget	Existing BGMCA
Performance indicator/target	Report on audit of extraction points and volumes abstracted
Timeframe	Ongoing
PRIORITY	**High**

Action 7.2: Continue implementation of alien vegetation removal through Working for Water Programme to reduce water losses in the catchment	
Relevant legislation	NEM: PAA
Responsible agent	DFFE
Existing risk to biodiversity	High
Existing risk to socio-economics	Medium
Resource requirements	DFFE allocation
Estimated budget	DFFE allocation
Performance indicator/target	Working for Water deliverables
Timeframe	Ongoing
PRIORITY	**High**

Climate change

Objective 8: To promote climate change resilience strategies to provide functional system benefits for the environment and society.

Action 8.1: Draw from regional and local climate change strategies to guide estuarine management practices	
Relevant legislation	ICMA; NEM: PAA; Municipal by-laws
Responsible agent	SANParks & KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal SANParks & KM
Estimated budget	Existing SANParks & KM
Performance indicator/target	Amendments to plans and frameworks, if required
Timeframe	Ongoing
PRIORITY	**Medium**

Action 8.2: Incorporate projected impacts of sea-level rise and severe weather events in spatial development plans of municipality (e.g. protection or timeous /managed retreat)	
Relevant legislation	Municipal by-laws
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	SDF & IDP amendments
Timeframe	Linked to the revision of the SDF
PRIORITY	**Medium**



Action 8.3 Promote wise management and use of limited freshwater resources	
Relevant legislation	NWA; Municipal by-laws
Responsible agent	KM
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal KM
Estimated budget	Existing KM
Performance indicator/target	Awareness campaigns and/or materials
Timeframe	Ongoing
PRIORITY	**High**

Adaptive Governance

Objective 9: To establish and enhance collaborative and inclusive estuary governance through flexible and learning-based decision-making processes involving both state and non-state role-players.

Action 9.1: To consider implementation partners and relevant role-players when making decisions	
Relevant legislation	Various legislation
Responsible agent	All role-payers
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal
Estimated budget	Existing
Performance indicator/target	Records of engagement through various Fora
Timeframe	Ongoing
PRIORITY	**High**

Action 9.2: Apply conflict resolution mechanisms for resolving conflicts (e.g. arbitration opportunities / meetings)	
Relevant legislation	Various
Responsible agent	All role-layers
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal
Estimated budget	Existing
Performance indicator/target	Minutes of engagements
Timeframe	Ongoing
PRIORITY	**High**

Action 9.3: To regularly engage and communicate with broader stakeholders	
Relevant legislation	NEMA, NEM: PAA, ICMA
Responsible agent	SANParks
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Records of engagement
Timeframe	Ongoing
PRIORITY	**High**

Objective 10: To establish appropriate institutional arrangements to facilitate co-operative governance of the Knysna system both amongst authorities and society.

Action 10.1: Establish Memoranda of Agreement and Understanding between SANParks and relevant organisations to formalise roles and responsibilities, including participation of relevant staff in forums (e.g. between SANParks and KM for the EMP, and SANParks and SAMSA for boating activities, etc.)	
Relevant legislation	NEM: PAA; Municipal by-laws, SAMSA Regulations
Responsible agent	SANParks
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal SANParks and relevant organisations (KM, SAMSA)
Estimated budget	Existing SANParks and relevant organisations (KM, SAMSA)
Performance indicator/target	MoA and/or MOU
Timeframe	Year 1
PRIORITY	**High**

Action 10.2: Ensure that actions stemming from the EMP are incorporated in relevant business plans of authorities (e.g. Parks Plan, IDP, etc.) to ensure that these are timeously planned for and included in budgets (All agencies responsible for management actions as part of EMP)	
Relevant legislation	NEM: PAA, Municipal by-laws, NEMA, ICMA, NWA, NEM: BA, SAMSA legislation
Responsible agent	All role-players (SANParks; KM; BGMCA DWS; DFFE; SAMSA; GRDM)
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal
Estimated budget	Existing
Performance indicator/target	Implementation and performance plans of respective organisations
Timeframe	Year 1, ongoing
PRIORITY	**High**

Action 10.3: Establish an estuarine management committee to facilitate co-operative governance among different management agents, including pollution management. This forum should be strengthened through consultation with experts as required	
Relevant legislation	NEMA, NEM: PAA, ICMA, NWA, MLRA
Responsible agent	SANParks
Existing risk to biodiversity	Low
Existing risk to socio-economics	Medium
Resource requirements	Internal
Estimated budget	Existing
Performance indicator/target	Management committee established
Timeframe	Year 1
PRIORITY	**High**

Education and awareness

Objective 11: To promote accessibility to information for improved understanding of linkages between estuarine functionality and society.

Action 11.1: Develop a communications and awareness campaign aimed at informing and empowering stakeholders to participate and take greater stewardship and appreciation of the Knysna Estuary	
Relevant legislation	NEM: PAA; ICMA; MLRA; NWA, NEM: BA
Responsible agent	SANParks
Existing risk to biodiversity	High
Existing risk to socio-economics	High
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Awareness material
Timeframe	Year 2
PRIORITY	**High**



Action 11.2: Develop materials and communication campaigns to create awareness on proper waste disposal methods and ways to prevent pollution of the Knysna Estuary given that it is the economic hub of the town (using innovative and relevant communication platforms)	
Relevant legislation	Municipal by-laws; NEMWA
Responsible agent	KM
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	KM Internal
Estimated budget	KM Existing
Performance indicator/target	Awareness material
Timeframe	Year 2
PRIORITY	**High**

Action 11.3: Develop materials and communication campaigns on sustainable use of resources and ways to prevent degradation of the Knysna Estuary, given that it is South Africa's most important estuary (with a focus on using 21st century communication technologies commonly used by youth)	
Relevant legislation	NEM: PAA; ICMA; MLRA; NWA, NEM: BA
Responsible agent	SANParks
Existing risk to biodiversity	Low
Existing risk to socio-economics	Medium
Resource requirements	Internal SANParks
Estimated budget	Existing SANParks
Performance indicator/target	Awareness material
Timeframe	Year 2
PRIORITY	**High**

Action 11.4: Investigate incorporation of environmental matters relevant to Knysna Estuary in formal school curriculum	
Relevant legislation	NEMA; NEM: PAA; ICMA; MLRA; NWA, NEM: BA
Responsible agent	DoE
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	KM Internal
Estimated budget	KM Existing
Performance indicator/target	Awareness material
Timeframe	Year 3
PRIORITY	**Low**

Action 11.5: Promote appropriate research that helps understand the Knysna Estuary as a social ecological system	
Relevant legislation	NEMA; NEM: PAA; ICMA; MLRA
Responsible agent	SANParks
Existing risk to biodiversity	Medium
Existing risk to socio-economics	Medium
Resource requirements	Internal
Estimated budget	Existing
Performance indicator/target	Research database
Timeframe	Ongoing
PRIORITY	**High**

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Section 6 - Zoning

Guiding principles underpinning the zonation

The principles underpinning park zonation, as listed below, were informed by the SANParks Conservation Development Framework (CDF) planning manual, the Guidelines for Strategic Integrated Environmental Management and the National Environmental Management Act (NEMA). Accordingly, the zonation:

- is the foundation of all planning and development within a park, with the aim of ensuring its long-term sustainability;
- accommodates strategic, flexible and iterative planning procedures;
- is a “framework for planning” not a “plan for implementation” (i.e. implementation is dealt with through lower-level plans and programmes);
- is risk-averse and promotes a cautious approach, which considers the limits of current knowledge about the consequences of decisions and actions;
- recognises that the mandate of SANParks is to conserve biodiversity and heritage resources of national and international significance, in terms of both the NEM: PAA and the National Heritage Resources Act;
- ensures the integrity of the park’s scenic quality by limiting human intrusions into the landscape;
- accommodates a wide range of unique opportunities for experiences of solitude and nature-based recreation which do not conflict with the desired social and environmental states;
- confines development within the park to areas that are robust enough to tolerate transformation and without detracting from the “sense of place”;
- incorporates and gives effect to the demarcated Coastal Management Line/s (CMLs);
- rationalises and channels access into the park and internal movement through it;
- sets the limits of acceptable change; to minimise the loss of biodiversity and to reduce conflict between different park uses;
- recognises that park boundaries are not static in time and that there are factors beyond the current or future boundaries that can positively or negatively influence the park; and
- recognises that the park cannot exist in isolation and that planning needs to ensure that the park is integrated with the surrounding landscapes as well as the economic and social structures at local and regional scales.

Rationale for use zones

The primary function of a protected area is to conserve biodiversity. Other functions, such as the need to ensure that visitors have access to the park, and that adjoining communities and local economies derive benefits from the park, could potentially conflict with and compromise this primary function. Use zoning is the primary tool to ensure that visitors can have a wide range of quality experiences without compromising the integrity of the environment.

Furthermore, the expectations and recreational objectives of individuals who visit the park may differ. Some individuals visit the park purely to see the wildlife and natural landscapes. Other individuals wish to experience the intangible attributes such as (and not limited to) solitude, remoteness, wildness and serenity (which can be grouped as wilderness qualities), whilst some visit to engage in a range of nature-based recreational activities, or to socialise in a rest camp.

Different people have different accommodation requirements ranging from basic self-catering to luxury-catered accommodation. There is often conflict between the requirements of different users and different activities. Appropriate use zoning serves to minimise conflicts between different users of a park by separating potentially conflicting activities – such as game viewing and day-visitor picnic areas – whilst ensuring that activities that do not negatively impact the park's vital attributes and objectives (especially the conservation of the protected area's natural systems and its biodiversity) can continue in appropriate areas. Use zones serve to ensure that high-intensity facilities and activities are placed in areas that are robust enough to tolerate intensive use, as well as to protect more sensitive areas of the park from over-utilisation.

The zoning system

SANParks has adopted a multiple zoning system for its parks. The system comprises of:

- Visitor use zones encompassing the entire park;
- Special management overlays; and
- A buffer zone surrounding the park.

The zoning process and its linkage to the underlying environmental analysis

The zoning for the park was underpinned by an analysis and mapping of the sensitivity and value of the park's biophysical, heritage and scenic resources. This analysis examined the park's biophysical characteristics including: vegetation value (in particular the contribution to national conservation objectives); vegetation resilience to physical disturbance; hydrological sensitivity (areas vulnerable to disruption of hydrological processes such as floodplains and wetlands); topographic sensitivity (steep slopes); soil sensitivity (soils that are vulnerable to erosion); red list sensitivity; estuary sensitivity; marine sensitivity; and animal sensitivity. In addition, the heritage value and sensitivity of the sites were examined (mostly archaeological and cultural aspects). The visual sensitivity of the landscape was also surveyed to identify sites where infrastructure development could have a strong aesthetic impact. This analysis was used to inform users of the appropriate use of the different areas of the park, as well as to assist in defining the boundaries between zones. The zoning was also informed by the park's current infrastructure and tourism products, as well as the regional context (especially linkages to neighbouring areas and impacts from activities outside the park). Planned infrastructure and tourism products were also accommodated where these were compatible with the environmental informants. These were all interpreted in the context of the park's objectives and undertaken in an iterative and consultative process.

Quiet zone

Quiet zone objective

The main objective of the tourist-orientated zone which comprises of both quiet marine (and estuarine) and terrestrial components is to provide non-motorised medium to high volume visitor access to areas whilst limiting impacts by not providing neither infrastructure for motorised access nor accommodation facilities.

Quiet zone characteristics

This zone is characterised by unaccompanied non-motorised access to areas which generally retain a natural appearance and character. Access is controlled. Visitors are allowed accompanied or unaccompanied access, mainly on foot, for a wide range of experiences. A larger number of visitors are allowed within the quiet zone, permitting more frequent visitor contact when compared to the primitive zone (which is not included in the zonation of the Knysna Estuary). For the quiet marine and estuarine zone, unaccompanied, non-motorised activities are allowed in the area but only for canoeing, sailing or non-motorised vessels / boats. Anchoring and/or overnighting by sailing vessels/boats is not allowed. Within this zone, more sensitive areas must be protected by precinct level planning, which should direct development and utilisation to more robust areas. This zone can also provide non-motorised access within low and high intensity leisure zones away from vehicular access roads.

Quiet zone visitor activities and experience

Estuarine activities are limited and experience equates to relaxation in a natural environment. Access is allowed for non-motorised/sailing vessels/boats only. No anchoring or overnighting is permitted by sailing vessels/boats. Only non-motorised activities (canoeing, sailing, etc.) are permitted. Interaction with other users: Infrequent interaction between user groups.



Quiet zone limits of acceptable change
Biophysical environment: Some deviation from a natural/pristine state is allowed, but care should be taken to restrict impacts on the environment by managing non-motorised users, vessel numbers, resource-use, etc.

Aesthetics and recreational environment: Activities which impact on the relative natural appearance and character of the area should be restricted, as the presence of larger visitor numbers and the facilities required may impact on the feeling of "wildness" experienced within this zone.

Quiet zone facilities
Type and size: Access by non-motorised/sailing vessels/boats only. No anchoring or overnighting is permitted by sailing vessels/boats. No infrastructure in the marine or estuarine areas, only zone demarcations.

Sophistication of facilities: only zone demarcations.

Audible equipment and communication structures: None. Allowed, but must be managed to retain a relative level of solitude.

Access: Access by non-motorised/sailing vessels/boats only. No anchoring or overnighting is permitted by sailing vessels/boats.

Quiet zone infrastructure
Limited permanent management infrastructure is permissible in this zone, to service tourist and management needs. Given the potentially high-volume tourist usage of the zone, park operations staff may need to service tourist facilities in this zone.

Low intensity leisure zone
Low intensity leisure objectives
The objective of this tourist-orientated zone is to provide infrastructure for day and overnight visitors in a natural environment. Development footprints must be localised, with some areas having more of a primitive or even remote zone "feel." Impacts must be mitigated by using infrastructure to direct and manage the movement of park visitors away from the more sensitive areas that may occur within this zone.

Low intensity leisure characteristics
The underlying characteristic of this zone is motorised and non-motorised self-drive access, with basic self-catering facilities. Numbers of visitors are higher in the low intensity leisure zone as compared to the quiet zone. Small or seasonal commercial or catered facilities can be accommodated, however, these facilities must be small and aligned to the general ambiance of the zone. Relatively comfortable facilities are positioned in the landscape retaining an inherent natural and visual quality, which enhances the visitor experience of a more natural and mostly self-providing experience.

Low intensity leisure visitor activities and experience
Activities: Motorised and non-motorised vessel access. Access through designated launch sites. Recreational activities such as swimming, canoeing and sailing are allowed in designated areas. The catching of linefish and bait harvesting in terms of a recreational (MLRA) fishing permit is permitted excluding the Knysna bait reserves (in the relevant zone) and any area or species subsequently listed as no-take.

Low intensity leisure limits of acceptable change
Biophysical environment: Deviation from a natural/pristine state has resulted from impacts of existing infrastructure and user activities, but these impacts should be minimised and limited to restricted impact footprints as far as possible. However, it is accepted that some damage to the biophysical environment associated with tourist activities and facilities will be inevitable.

Aesthetics and recreational environment: Although it is inevitable that activities and facilities will impact on the wild appearance and reduce the wilderness characteristics of the area, these should be managed and limited to ensure that the area still provides a relatively natural outdoor experience.

Low intensity leisure facilities
Type and size: Water-based accommodation facilities in designated areas of the Knysna estuary can be considered. Zone demarcation and activities' boundary demarcations. Regulated slipway and jetty infrastructure.

Sophistication of facilities: Higher-end, low-volume water-based accommodation. Basic level of marine and estuarine access infrastructure (jetties and slipways).

Audible equipment and communication structures: No equipment and structures allowed. Limited cell phone coverage in the zone. Code of use for cell phones and radios required to retain relative level of solitude.

Access: Motorised and non-motorised vessel access permitted. Access through designated launch sites.

Low intensity leisure infrastructure
Infrastructure caters for tourism, legal and safety requirements. It is appropriately placed to limit impact on the environment.

High intensity leisure zone
High intensity leisure objective
The main objective of this tourist-orientated zone is the concentration and containment of commercial, tourism, managerial, operational and industrial park activities within a restricted and designated area, which is robust enough to tolerate development, and where these diverse activities can share multi-use infrastructure (roads, plumbing, power), thus reducing their overall footprint. As impacts and particularly cumulative impacts are higher, where possible the high intensity leisure zone must be placed in areas that have low sensitivity values and are sufficiently robust to tolerate development, and ideally be close to the periphery of the park

High intensity leisure characteristics
The main characteristic is that of a high-density tourist development node with modern commercial amenities such as restaurants and shops. This is the zone where more concentrated human activities are allowed. High intensity leisure is accessible by motorised transport (car/bus) on high volume transport routes. More concentrated and commercialised (including concessional) activities occur here than in low intensity leisure areas.

High intensity leisure visitor activities and experience
Activities: Accessible by a wide variety of vessels including high volume tourism and commercial operations. A variety of recreational and commercial tourism activities are permitted.

High intensity leisure limits of acceptable change
Biophysical environment: The greatest level of deviation from a natural/pristine state is allowed in this zone, and it is accepted that damage to the biophysical environment associated with tourist activities and facilities will be inevitable.

Aesthetics and recreational environment: Although it is inevitable that the high visitor numbers, activities and facilities will impact on the characteristics of the area, efforts are made to ensure that the area still provides a relatively natural outdoor experience appropriate for a national park.

High intensity leisure facilities
Type and size: Jetties, slipways, moorings, small boat harbours and associated management infrastructure.

Sophistication of facilities: Moderate to high density facilities.



Audible equipment and communication structures: Cell phone coverage in vicinity of camps. Code of use for cell phones and radios required to retain relative level of solitude.

Access and roads: Accessible by a wide variety of vessels including high volume tourism and commercial operations.

High intensity leisure infrastructure
Management guidelines that apply to low intensity leisure apply to high intensity leisure zone as well. Generally, the presence of high intensity leisure in a park indicates higher or more intense utilisation or development, with a higher diversity and concentration of facilities, and thus may require additional management or operational facilities. As high intensity leisure is by definition a high use area and must be located in an area of low sensitivity, the development of management and operations infrastructure in this zone must be favoured. In the park, most operations and administration infrastructure are situated in existing and well-established high intensity leisure zones. This includes infrastructure for tourism, legal and safety requirements, which is appropriately placed to limit impact on the environment.

Zonation of the Knysna estuary

The Knysna Estuary is a proclaimed protected environment in terms of the NEM: PAA, with regulations for the proper administration of the Knysna protected environment promulgated in GN. No. R.1175 of 2009. The Knysna protected environment encompasses the area formerly proclaimed as the Knysna National Lake Area. The regulations state that SANParks has jurisdiction over management of activities on the water body of the estuary, the rivers that flow into the estuary (Knysna, Salt, Bigai and Bongani and their associated wetlands), as well as the sea and seashore (termed the biodiversity control area) and partial jurisdiction, shared with relevant other organs of state within a 50 m buffer area around the estuary (termed the development control area) (Appendix 1, Map 4). The regulations assign powers to SANParks to manage land use, access and activities, as well as monitor the use of biological resources. This is most effectively achieved through zonation.

The most recent zonation for the water body of the Knysna Estuary was approved in 2020 as part of the GRNP Management Plan's zonation plan, a requirement in terms of the NEM: PAA.

Appropriate use zoning of the estuary serves to minimise conflicts between different users by separating potentially conflicting activities whilst ensuring that activities that do not negatively impact the estuary and its enjoyment by users can continue in appropriate areas. Within the current GRNP Management Plan significant changes were undertaken in terms of the zoning of the Knysna Estuary compared to previous iterations. The Knysna Estuary was largely zoned as low intensity leisure, with a high intensity leisure zone in the main channel. The current zonation identified areas of high sensitivity, such as endangered Cape eelgrass. beds and saltmarshes, which were zoned as quiet (Appendix 1, Map 5).

To enhance visitor experience and minimise conflict between differing activities, special management overlays were applied to the use zones according to the allowable activities within each zone as described in the GRNP Management Plan (SANParks 2020) (Appendix 1, Map 6) and included various resource-use management areas. These areas include a proclaimed bait reserve, harbour, jet ski and waterskiing areas, areas where no motorised vessels are allowed, no-wake channels, idle speed zones, no-wake areas in open water and the preferred channel.

The current bait reserve is an area demarcated by pole markers and signage in which the harvesting/collecting of bait by any means at any given time is prohibited. Only angling and

other boating activities as allowed in the special management overlays and in accordance with relevant legislation (e.g. MLRA) are permitted. This area covers the salt marshes between Thesen Island and Leisure Island (Government Gazette No. 12667 of 27 July 1990) (Appendix 1, Map 6). The area protects bait species as well as other estuarine fauna and flora on the intertidal mudflats and sandbanks.

The harbour area is a deep-water area demarcated by harbour walls providing sheltered floating/fixed jetty mooring facilities and slipways. Depending on access restrictions determined by the facility's management organisations, access is in some cases restricted to club's members only, alternatively facilities are accessible to the public. The jet ski and waterskiing area is an area of deep water designated for safe use and manoeuvring of jet-propelled personal watercraft and waterskiing. This area is the only area designated for jet-skiing as uses in other channel / open water areas could have safety implications (i.e. on other estuary users). Additionally, restricting use to this zone reduces the risk of collision with sandbanks in shallow areas, as well as potential damage to the environment caused by vessel activity in shallow waters. The areas where no motorised vessels are allowed are generally shallow and / or the use of motorised vessels can cause erosion / damage to sensitive intertidal areas, mudflats, Cape eelgrass beds and / or salt marsh vegetation due to e.g. wake of the vessel / traversing over shallow sandbanks / mudflats.

No-wake channels are areas where all vessels must reduce speed in order to not create a wake which can be damaging to the environment, moored vessels or infrastructure. This overlay generally applies to shallow channels adjacent to sensitive estuarine habitat (mudflats / Cape eelgrass beds that may be subject to erosion or damage due to boating activity) or in areas where there are potential safety issues. Idle speed zones are environmentally sensitive intertidal areas, which are only accessible during high tides and are subject to vessels traversing at reduced speeds to not create a wake which is damaging to the environment. These areas may be subject to erosion or damage due to boating activity. Intertidal areas may be exposed during low tides, resulting in increased risk to vessels. Open water no wake areas are areas outside of the preferred channel that should not be traversed at high speeds due to risk of sediment movement and possible damage to adjacent infrastructure and vessels. Although these channels are deeper than the other no-wake channels, no-wake is prescribed as a safety precaution due to jetties and embankments occurring in these areas.

The preferred channel is the preferred line to follow when traversing the estuary from north to south or south to north. Vessels may travel at speed, provided it is safe to do so, considering other water users and hazards. It consists of deeper portions of the estuary channel deemed to have lowest risk of potential environmental damage and safety risk if used in accordance with relevant regulations and safety guidelines.

Proposed habitat reserves

In addition to the above, the GRNP Management Plan (SANParks 2020) proposes the establishment of two additional habitat reserves in the middle and upper estuary whilst modifying the boundaries of the existing bait reserve (Appendix 1, Map 7). The additional areas that have been identified contain key habitats, which are sensitive to disturbance. The proposed habitat reserves were spaced along the longitudinal axis of the estuary to ensure that representative habitats, coinciding with reported changes in benthic fauna, were protected. The additional habitat reserves incorporating sandbanks, mud flats and vegetated areas with their associated biota, aims to increase habitat protection in all three hydrographic regions of the estuary.

Motivation for the increase protection is based on the conservation targets listed below as provided by Turpie & Clark (2007) for the respective habitat types in the Knysna Estuary:

- Supratidal salt marsh 30%
- Intertidal salt marsh 40%
- Reeds and sedges 20%
- Sand/mud banks 40%
- Submerged macrophytes 40%
- Channel 30%

Establishing habitat reserves is in line with the recommended extent of protection for the Knysna Estuary by Turpie et al. (2012) (i.e., partial protection) and the call by Whitfield et al. (2020) for establishment estuarine protected areas, where the main aim of these protected areas or habitat reserves would be to conserve habitat and associated biota. A study by Barnes and Claassens (2020) also showed that subtidal areas of the Knysna Estuary host different microbenthic assemblages than adjacent intertidal areas and may



therefore not protect harvested species. The current proposed reserves cover both intertidal and subtidal habitats.

Systematic conservation planning involves locating, configuring, implementing, and maintaining areas that are managed to promote the representation and persistence of biodiversity and other natural values (Margules & Pressey, 2000; Pressey & Botrill, 2009). Information is required to identify the best areas to protect whilst also taking cognisance of human use patterns. Information incorporated into the decision-making process to determine the placement of the additional reserves and the adjustment to the existing reserve is provided below. However, we acknowledge that in many instances information is dated and as new information becomes available the exact placement of these habitat reserves may need to be revisited. For example, incomplete studies on juvenile fish indicate that Belvedere may be an important nursery area, but further work is required to confirm this and evaluate consistency over years.

Spatial patterns in bait harvesting and fishing over a seven-year period
Monitoring of patterns in fishing and bait harvesting effort have indicated that, although pressure occurs throughout the estuary, certain areas consistently receive more effort than others. One such area is along the Ashmead channel and in particular along the eastern shoreline from the Leisure Island split towards Lourie Park. Much of this area falls within the existing bait reserve and law enforcement patrols have been unable to decrease the amount of illegal bait harvesting occurring across years. The area is used extensively due to its ease of access. Amendments to the current bait reserve borders are proposed that would remove this section enabling resource-use to legally occur (bait harvesting compliant with the MLRA).

In terms of the proposed new habitat reserves, trends indicate that these areas consistently experienced lower fishing and baiting effort than other sections in the estuary. Within the upper habitat reserve a section of shoreline around the “old bridge buttress” is a popular fishing spot and has been excluded from the habitat reserve to enable shore-fishing access.

Historic mudprawn densities
Based on data by Hodgson et al. (2000a) the islands above the train bridge, which form part of one of the proposed habitat reserves, have historically held the highest densities of mudprawn (186 per m^2). The high densities may be as a result of the lower harvesting pressure due to the inaccessible nature of the islands.

Giant mud crab
The giant mud crab *Scylla serrata* is a large crab that is harvested for its meat. In recent years there has been an increase in illegal harvesting of the mud crab which is concerning and is a priority for law enforcement. No population assessments have been conducted in Knysna or regionally, but it is susceptible to over-harvesting. The intertidal mud banks above the N2 are prime habitat for mud crabs but are also known illegal harvesting areas and are proposed to be included in the habitat reserves.

Fish
Estuaries are known nursery areas for a wide variety of fish species but there is surprisingly little published work on Knysna Estuary where fish communities have been assessed throughout the estuary. Work by Le Quesne (2000) indicated that the marsh areas and intertidal creeks found between the N2 and Red Bridge are important feeding and predator refuge areas for juveniles of a wide variety of species. Pollard et al. (2017) have also shown at that eelgrass beds and bare substrate harboured different fish communities with fewer species (mainly mullet) found over bare sand. A recent spatial analysis of fish assemblages within the Knysna Estuary over a seven-year period (Meiklejohn,2020) indicated variability between estuarine guilds but that the region between the railway bridge and the N2 were important for a range of different species including marine estuarine-dependent species such as the white steenbras. Telemetry work on

white steenbras indicates that they are highly resident and show strong site fidelity to a particular area within an estuary (Bennett et al., 2011). The bigger the estuary, the larger the home range (Bennett et al., 2011).

Birds

Although the Knysna Estuary supports a large number of birds, the densities are not as high as on other important bird estuaries, which may be due in part to recreational disturbance (Martin et al., 2000). The intertidal and salt marsh areas are important for invertebrate feeding birds, in particular the areas around the Ashmead channel. Zonation limiting disturbance would be beneficial for both invertebrate feeding waders and piscivorous divers.

Intertidal and subtidal vegetation

The Knysna Estuary is the third largest vegetated estuary in South Africa (Adams et al., 2016). Intertidal salt marsh plants dominate followed by submerged macrophytes and supratidal salt marsh species (Adams et al., 2016). The proposed habitat reserves cover supratidal, intertidal and subtidal vegetation types.

The proposed habitat reserves were included in the GRNP Management Plan revision process and presented for comment at both public and focus group meetings. Similarly, these have been presented during the stakeholder process for the development of this EMP. For further details the relevant stakeholder reports should be consulted. Slight variations have since occurred in the final layout of the habitat reserves and are due in part to comments received during these engagements along with changes aimed at improving ease of identifying the borders of the reserves to facilitate law enforcement and management. The establishment of the habitat reserves forms part of the Action List of this EMP and will be informed by recommendations on the legal process for establishment of the reserves.



Section 7 – Integrated monitoring plan

According to the standards for estuarine management listed in the Protocol, management actions should, wherever possible, be based on sound scientific evidence. Thus, monitoring is a crucial aspect of the adaptive estuarine management planning process as the generated data will be used to inform, assess and update management decisions. However, the collection, processing and interpretation of such data, particularly ecological data, are generally costly, time-consuming, and often require considerable scientific expertise. This integrated monitoring plan will therefore highlight key monitoring programmes needed to collect required environmental and social data, whilst recognising that financial and human capital constraints exist (Appendix 2). Differentiation is made between monitoring programmes to be carried out by the respective management authorities and those that are not currently undertaken but should be considered in the future if priorities and resource availability change. It is hoped that by listing some of the knowledge gaps, institutional partners and stakeholders with sufficient capacity will participate in, or undertake these programmes. Additionally, where funding and / or human capital constraints exist, rotational implementation of certain monitoring programmes, such as detailed assessments of resource utilization, with other estuaries (usually once every 3-5 years) will be undertaken.

In the DFFE guidelines for the development of EMPs it is stated that an integrated monitoring plan should comprise of three broad categories, namely resource monitoring, compliance monitoring and performance monitoring (DEA, 2015). Resource monitoring focusses on specific ecological indicators (including estuarine health and resource-use), compliance monitoring focusses on compliance with relevant laws, whereas performance monitoring focusses on achievement of the relevant management or governance objectives. Aspects of all three types of monitoring are included in the integrated monitoring plan for the Knysna Estuary (Appendix 3). Additionally, baseline monitoring or surveillance programmes, not linked to the three broad categories and/or specific performance targets or thresholds of potential concern (TPCs) are presented in Appendix 4. The aim of baseline or surveillance monitoring programmes is to collect long-term data which is often used as a baseline or reference points against which change can be measured. An important aspect of monitoring programmes is that they may / will be terminated when the objectives for their establishment are met, or their purpose no longer exists. The monitoring programmes in the tables below may therefore be terminated before the end of the duration period of this EMP and monitoring plan, provided valid reasons exist.

The Knysna Estuary is classified as a Category B/C estuary, with a Recommended Ecological Category of Category B in both the NBA 2018 (Van Niekerk et al., 2019) as well as the "Determination of classes of water resources and resource quality objectives for the Breede-Gouritz water management area" (Government Notice No. 1008 of 18 September 2020). As the Knysna Estuary falls within a protected area, it should ideally be classified as Category A (unmodified, natural), but this is impossible given current developments and pressures on the system, hence the Recommended Ecological Category is set as Best Attainable State (i.e. Category B). In order to achieve and retain the desired classification several physical, chemical and biological attributes and processes need to achieve or be retained within limits of natural or near natural variability, with Government Notice No. 1008 of 18 September 2020 providing a set of monitoring indicators proposing such limits (Table 6). These indicators complement some of the existing monitoring initiatives for the estuary and, where financial and human capital permits, will be monitored alongside the monitoring programmes listed in Tables 4 & 5 by or on behalf of the Department responsible for Water Affairs (DWS).

The Knysna Estuary is one of the better researched estuaries in South Africa (see Grindley 1985, Whitfield 2000, Hayes et al., 2022), with 15 active research and/or monitoring projects registered with SANParks in September 2022. There are various environmental pressures and threats to the estuary, including alien species, climate change, exploitation of natural resources, pollution, freshwater flow reduction, land-use change and infrastructure development, with the NBA 2018 (Van Niekerk et al., 2019) listing pollution, fishing effort and alien invasive species as the biggest threats to the estuary. Most of the research in the Knysna Estuary has centred on the

biggest threats to the estuary. Most of the research in the Knysna Estuary has centred on estuarine biota and environmental processes, while less emphasis has historically been placed on socio-ecological processes. Several monitoring programmes aimed at governance objectives have been included in the monitoring programme to address some of these gaps. These include interdisciplinary (studies that draw on and integrate knowledge from across social and natural scientific disciplines) and/or transdisciplinary (studies that incorporate local and practice-based knowledge and involve non-academic stakeholders in a process of co-learning) research.

Inventorisation and monitoring of key species within the estuary will not be captured as explicit monitoring objectives but will form part of the various monitoring programmes of this integrated monitoring plan and research studies. This type of monitoring will also be encouraged as part of ongoing engagement between SANParks and key research partners and includes research on the endangered Knysna seahorse, endangered Cape eelgrass and management of alien invasive species (those currently described and new introductions).

Although significant effort is directed at monitoring programmes within the Knysna Estuary and its catchment, additional, shorter term research projects have been completed which complement existing knowledge and ongoing monitoring programmes. These projects are undertaken by both internal and external researchers, with the following projects currently registered with SANParks:

- Salt marsh elevation and responses to future sea-level rise in the Knysna Estuary, South Africa;
- Dynamics of salt marsh and seagrass in the Knysna Estuary;
- Abundance, habitat use and distribution of the Knysna seahorse *Hippocampus capensis* (Boulenger 1900) in the Knysna Estuary, with notes on the implications of an invasive red seaweed *Asparagopsis taxiformis* on available habitat;
- Ecology And Biodiversity Of Knysna's Seagrass Beds;
- Acoustic Tracking Array Platform (ATAP) Receiver Infrastructure;
- Investigating site fidelity and habitat use of endemic blue stingrays *Dasyatis chrysonota* in the Knysna Estuary, a potentially important breeding aggregation site;
- Spatial and temporal analysis of fish assemblages within the Knysna Estuary;
- Seagrass blue carbon stocks and associated microbial communities along the cool-warm gradient: a South African study;
- Top-down control by sesarmid crabs in South African estuarine salt marshes;
- Ecological role, reproduction and life history patterns of a non-indigenous *Diopatra* species in the Knysna Estuary;
- Characterising underwater soundscapes in the Knysna Estuary: Sound sources, soundscape contribution and temporal variability;
- A re-assessment of the standing stock and population structure of *Upogebia africana* (Crustacea: Thalassinidae) in the Knysna Estuary;
- Recreational and subsistence fisheries monitoring within the Garden Route National Park;
- Linking physiological, genomic, and ecological functioning in the seagrass, *Zostera capensis;* and
- Water quality monitoring by SANParks & SAEON.

Although desirable, these additional monitoring and research actions were considered unfeasible given the number of estuaries (40) within South African National Parks and limited capacity (human and financial) to carry out extensive monitoring and research in each system. The following knowledge gaps therefore exist and research to address these gaps are encouraged:

- Updated bathymetric surveys and sediment assessments would be helpful to evaluate changes in the quantity and spatial distribution of sediments. Mapping the extent and spatial distribution of sediment movement and settlement, as well as the likely origin of the sediment;
- Monitoring the quantity and composition of fats and oils that enter the estuary through the stormwater system;
- Monitoring the spread of known alien invasive species within the Knysna Estuary;
- Early identification of new alien invasive species and their likely pathways into the Knysna Estuary;
- Subtidal habitat destruction associated with mooring platforms;



- Social-ecological research on the Knysna Estuary;
- Understanding the range of ecosystem services (tangible and intangible) derived from the Knysna Estuary, who the beneficiaries are, how services are mobilised and appropriated, and where possible thresholds and conflicts might arise;
- During 2021/22, eight indicators of adaptive governance have been co-developed with stakeholders of the Knysna Estuary. These indicators relate to the polycentricity of the governance system, the degree of collaboration among role players, quality of social learning that is taking place, and acknowledging the complexity of the estuarine social-ecological system in its management. Stakeholders also rated the current (2021/22) performance of the governance system against these indicators. It is proposed that the eight narrative indicators represent heuristics, or a people's theory of change, for achieving a state of governance that would better support effective management of the Knysna Estuary. These indicators should not be viewed as precise statements against which performance should or could be accurately measured and audited. Rather, these emergent heuristics should serve to facilitate ongoing dialogue, remain open to modification and possible expansion as and when the evolving collective thinking deems such updates necessary, and promote "reflexivity" among stakeholders;
- A current consideration is to have a regular (e.g. annual) survey among stakeholders to reflect the state of, and possible trends in, general governance 'climate'. A relatively simple survey could address stakeholders' sense of place, sense of co-responsibility, and sense of being part of a bigger learning system, all in relation to the Knysna Estuary; and
- Develop a methodology to assess carrying capacity of various recreational uses (including boating) in open access systems.

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Section 8 – Institutional arrangements

All estuary related issues are currently being discussed on three platforms:

Estuary Authority Pollution Committee
SANParks is the secretariat. Officials from the Knysna Municipality (Infrastructure as well as Environment); the Garden Route District Municipality (Health Department); and the Breede Gouritz Catchment Management Agency form part of the committee.

Knysna Park Forum
The Knysna Park Forum meet on a quarterly basis and consist of the following members:

- SANParks
- Knysna Municipality
- Lakes Bird Club
- Boat Clubs
- Commercial Operators
- Knysna Catchment Management Forum
- Thesen Islands Homeowners Association
- Thesen Islands Commercial Owners Association
- Lakes Birds Club
- WESSA
- CapeNature
- DEA&DP
- Garden Route Environmental Forum

Various estuary forums
A number of Estuary Forums are active and meet on a quarterly basis:

- Municipal Coastal Committee
- Garden Route Estuary Forum
- Western Cape Estuary Task Team & Forum
- Coastal Erosion Task Team

Proposed institutional arrangements

It is proposed that an Estuarine Management Committee be established. This committee will be a sub-committee of the Knysna Park Forum and will consist of the following members:

- SANParks (Chair)
- Knysna Municipality (Infrastructure and Environment)
- Garden Route District Health Department
- Breede Gouritz Catchment Management Agency
- Knysna Catchment Management Agency
- Knysna Basin Project
- South African Environmental Observation Network (SAEON)
- Western Cape Province Coastal Management
- Garden Route Municipal Coastal Committee
- Subsistence users' forum
- DFFE
- DWS

Feedback to Interested and Affected Parties will be in the form of an annual report back on the implementation of the of the Estuary Management Plan. This will be an open public meeting.

The following Forums and committees will still remain:

- Knysna Park Forum
- Action Estuary Pollution Committee
- Various Estuarine Forums (Western Cape Estuary Task Team; Garden Route Estuary Task Team; Garden Route District Municipal Coastal Committee (MCC))



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Appendix 1 - Maps

Map 1: Regional context

Map 2: Geographical boundaries of the Knysna Estuary and its EFZ

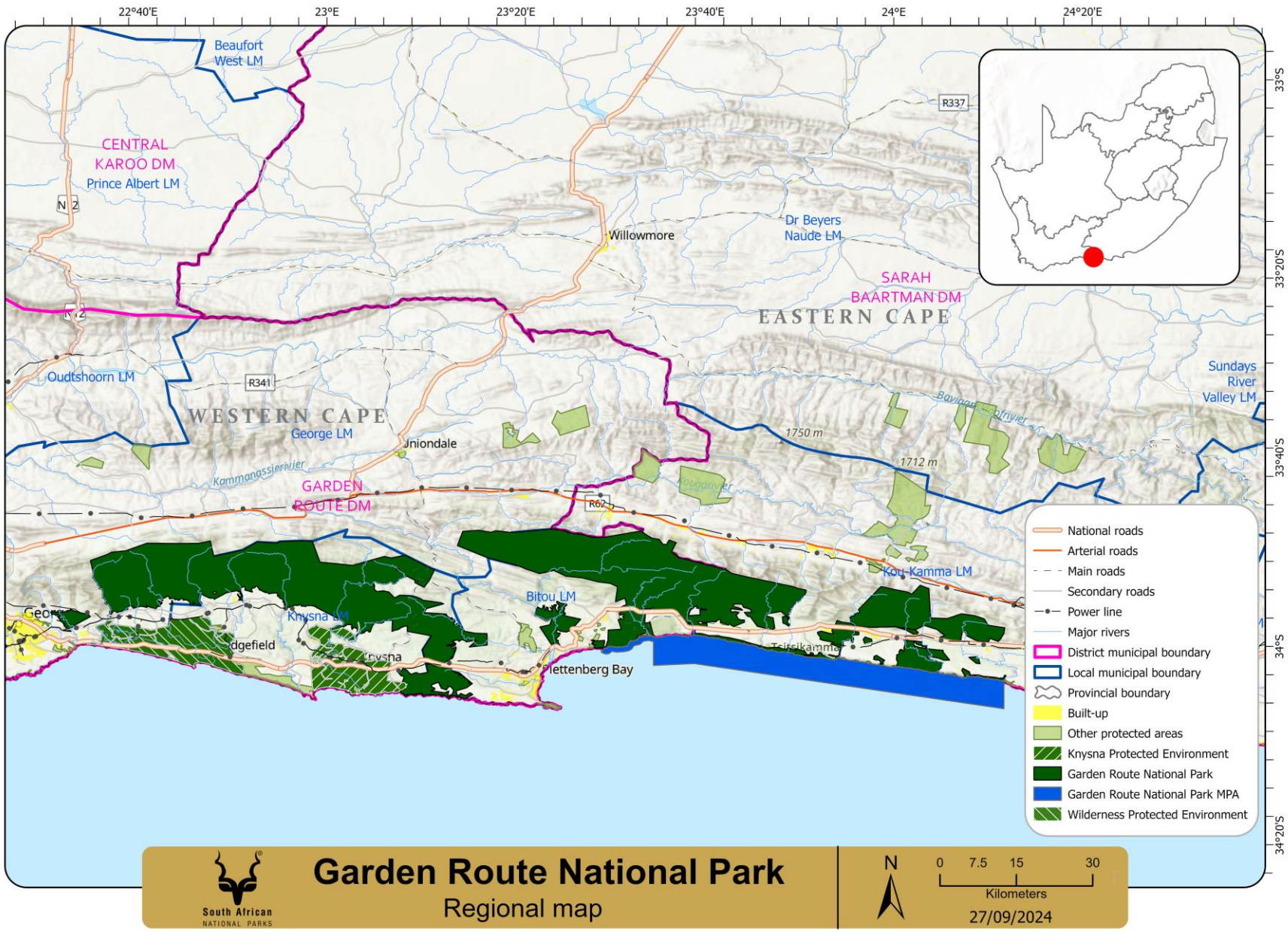
Map 3: Geographical boundary of the Knysna Estuary, catchment and contributing rivers

Map 4: The Knysna protected environment, including the biodiversity control area and development control area

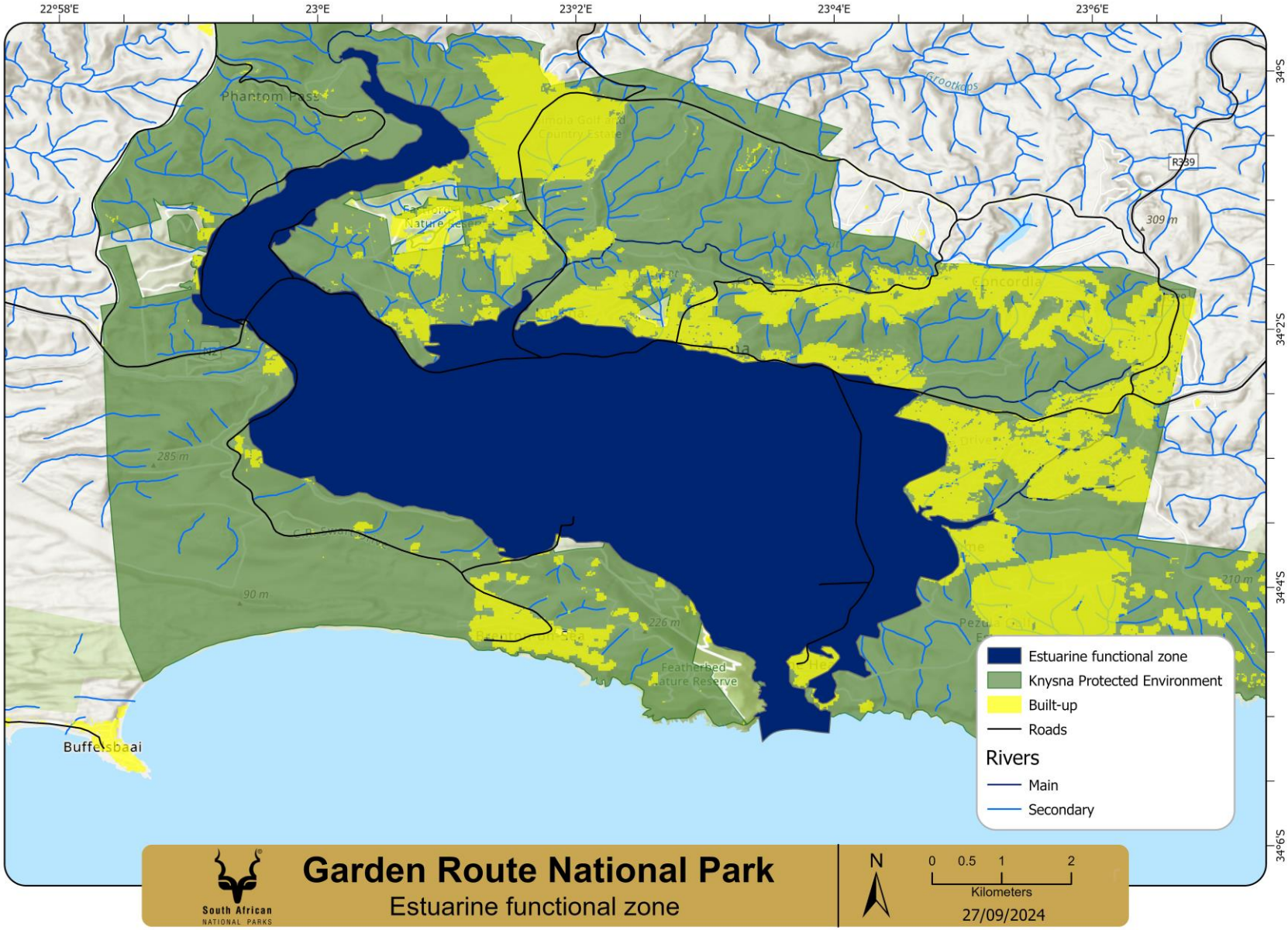
Map 5: Use zones for the Knysna Estuary

Map 6: Special management overlays

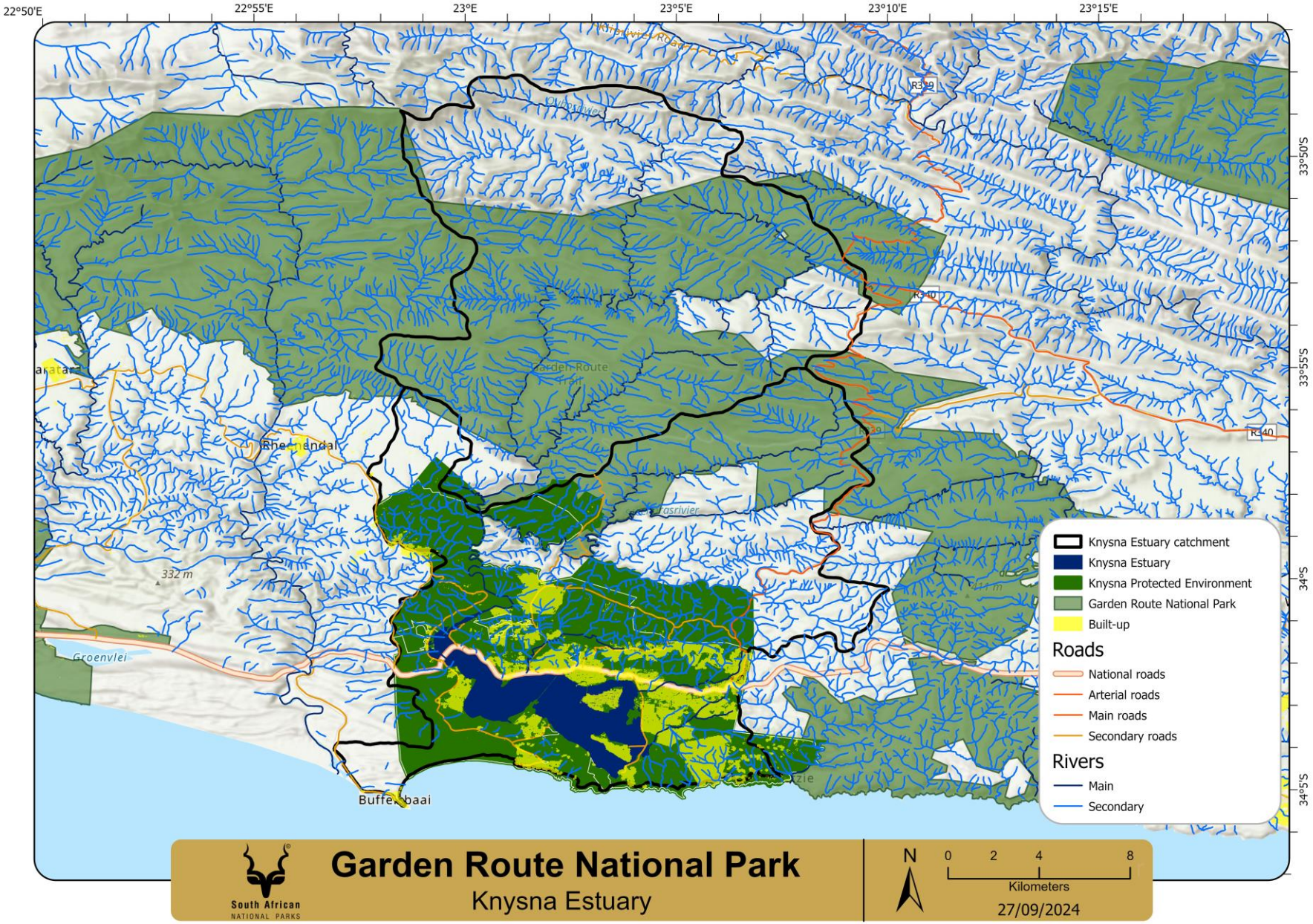
Map 7: Proposed habitat reserves for the Knysna Estuary



Map 1: Regional context



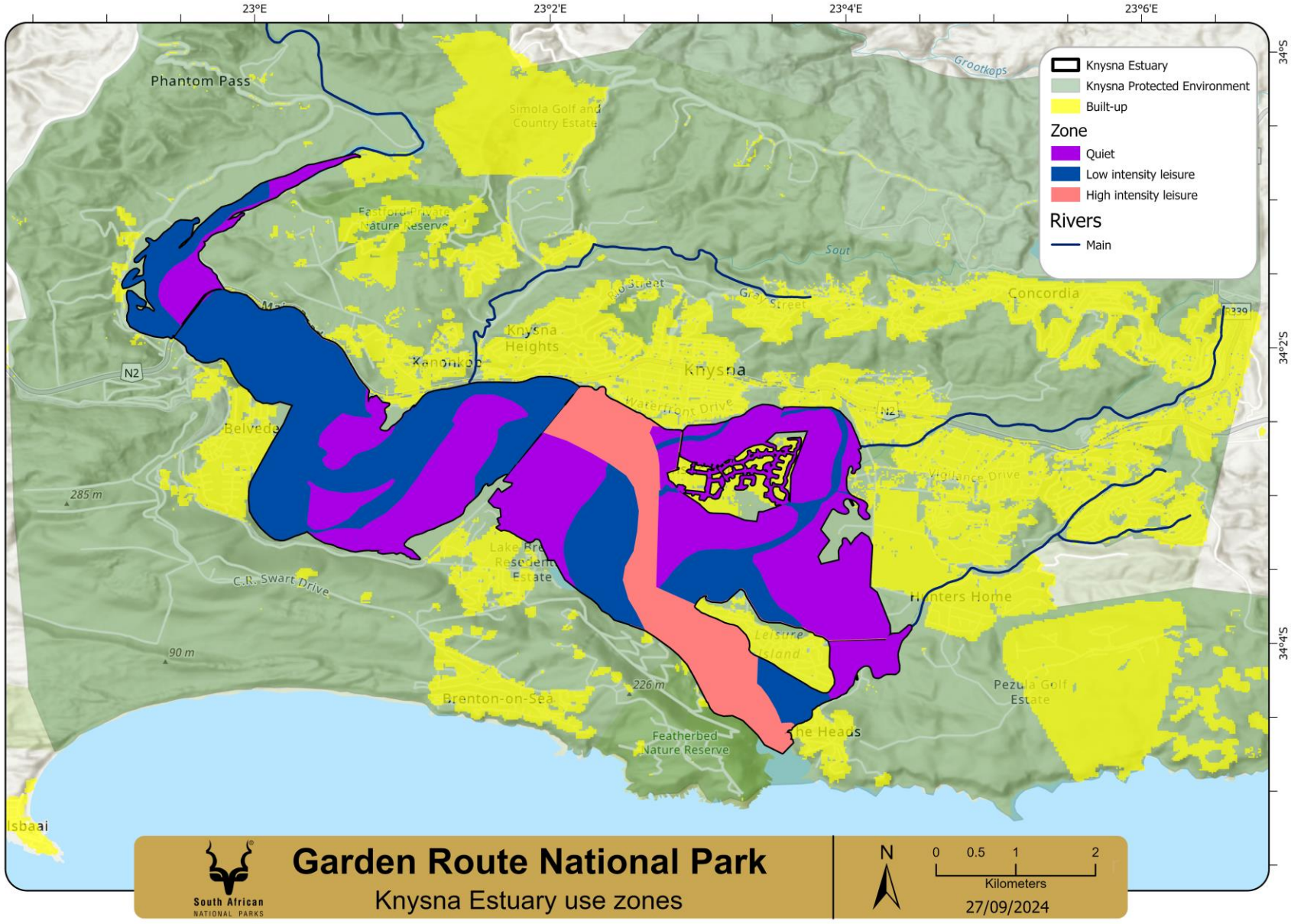
Map 2: Geographical boundaries of the Knysna Estuary and its EFZ based on the 5 m amsl contour (http://bgis.sanbi.org/SpatialDataset/Detail/2689)



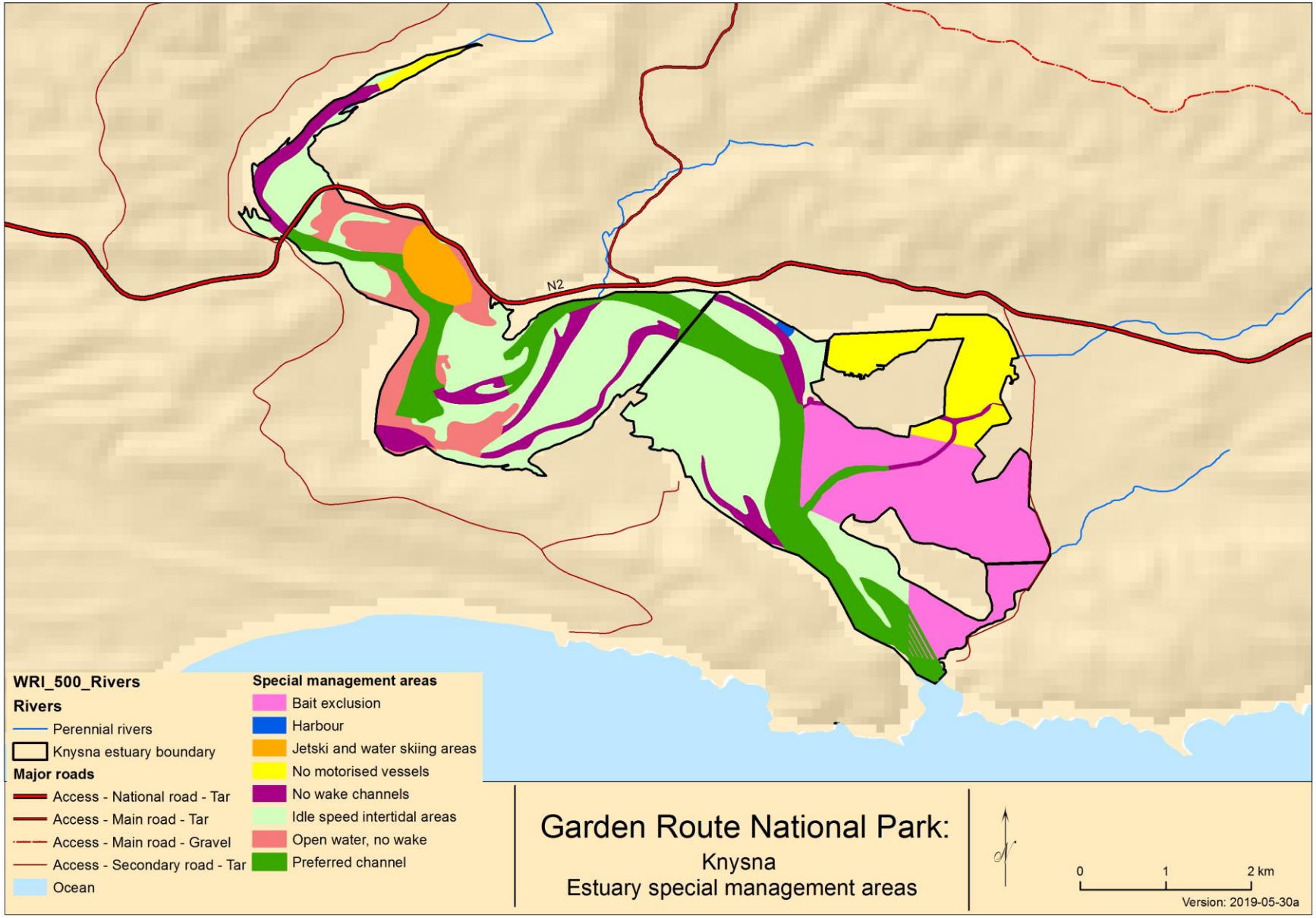
Map 3: Geographical boundary of the Knysna Estuary, catchment and contributing rivers, as well as the boundary of the GRNP.



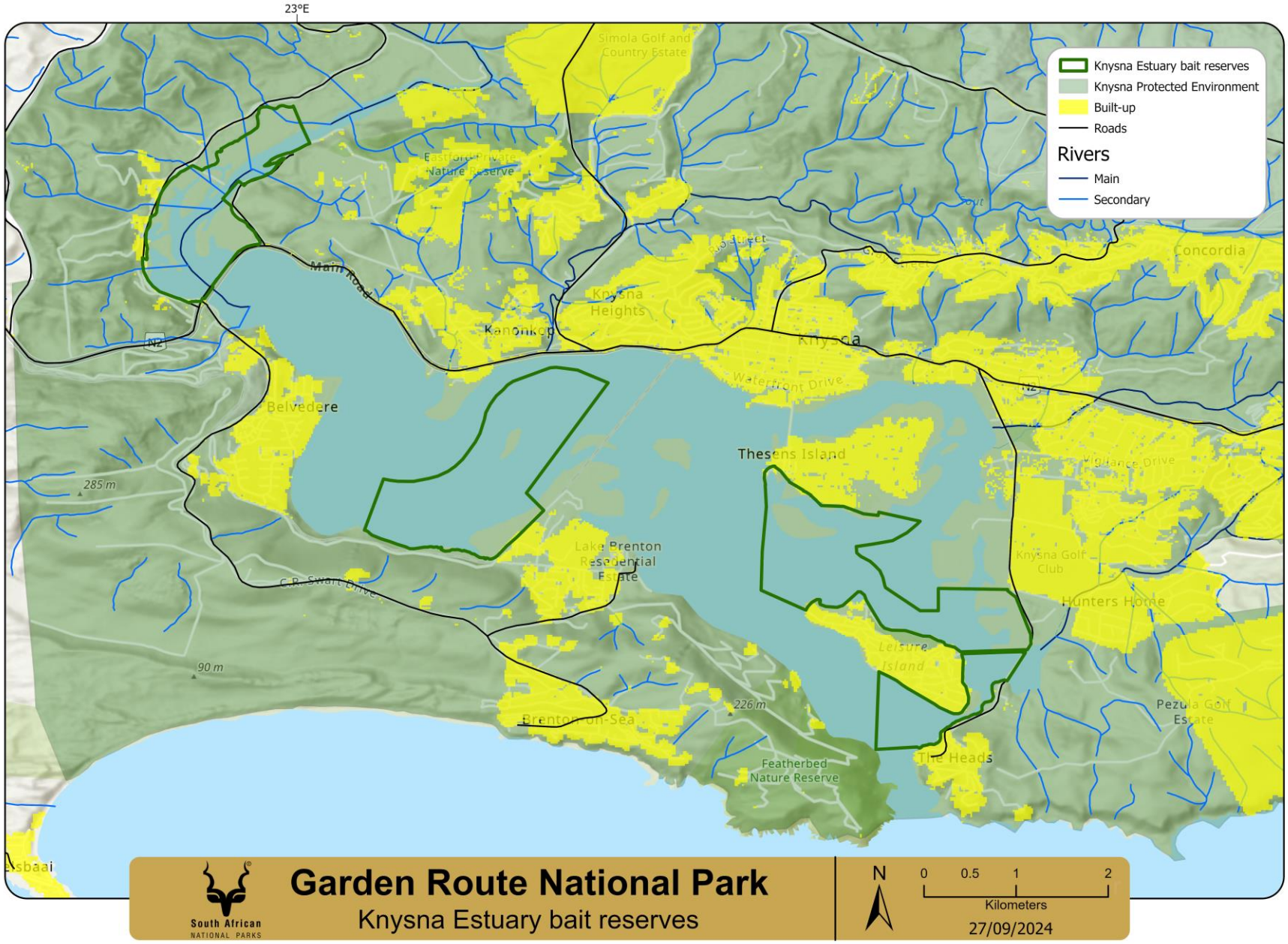
Map 4: The Knysna protected environment, showing the biodiversity control area (water body) as well as the development control area (50 m buffer area around the water body).



Map 5: Use zones for the Knysna Estuary showing high sensitivity areas within the quiet zone (Source: Garden Route National Park Management Plan 2020).



Map 6: Special management overlays showing resource-use management areas for the Knysna Estuary (Source: Garden Route National Park Management Plan 2020).



Map 7: Proposed habitat reserves for the Knysna Estuary (Adapted from: Garden Route National Park Management Plan 2020).

Appendix 2 - Integrated monitoring plan for the Knysna Estuary

Use / Activity	Indicator / linked objective	Temporal scale / parameters	Spatial Scale	Target / limit	Priority	Type of monitoring	Responsible authority
Biodiversity monitoring	Juvenile fish community structure Objective 1	At least once every 5 years	Sampling throughout the estuary	Persistence of estuarine dependent juvenile fish species commonly found in the estuary		Resource	SANParks SS
	Record areas where alien invasive terrestrial plants have been cleared in catchment and estuarine functional zone as well as priority areas for future clearing Objective 7	Annually	Catchment and estuarine functional zone within protected area boundary	Reduce spread of alien invasive terrestrial plant species		Resource	SANParks SS / WfW / BSP
	Bird communities (CWAC) Objective 1	Annually	Sampling throughout the estuary	Long-term variability in abundance		Resource	Lakes Bird Club
Living and non-living resource utilisation	To assess trends in amount of resource-use occurring (Estimated total effort, total catch and catch-per-unit-effort), assess angler awareness and knowledge of regulations through roving creel surveys and structured interviews. Objective 2	At least one year every five years, sampled at minimum, on a monthly basis	Sampling throughout the estuary	As per Marine Living Resources Act Regulations Where needed, changes in user behaviour to ensure sustainable use of estuarine biota		Resource	SANParks SS
	Fisheries regulations, including records of illegal activities Objective 2	Ongoing	Throughout the estuary	As per Marine Living Resources Act Regulations		Compliance	SANParks PM DFFE
	Vessels using the estuary Objective 6	Ongoing	Entire estuarine extent	Accurate knowledge of vessel numbers, types, seasonality and areas of use and transgressions		Resource	SANParks PM

Use / Activity	Indicator / linked objective	Temporal scale / parameters	Spatial Scale	Target / limit	Priority	Type of monitoring	Responsible authority
	Habitat reserve restrictions Objective 1	Ongoing	Within boundaries of habitat reserves	100% compliance to habitat reserve restrictions		Compliance	SANParks SS & PM
	Level of protection provided by the habitat reserve to key species Objective 1	At least once every 10 years	Within boundaries of habitat reserves	Purpose of establishment of habitat reserve advanced		Resource	SANParks SS DFFE
Water abstraction from rivers in the Knysna Estuary catchment	Water licenses issued to private individuals and volume of water abstracted Objective 7	Continuous	As per Government Notice No. 1008 of 18 September 2020 or subsequent legislation as well as authorisation requirements	As per Government Notice No. 1008 of 18 September 2020 or subsequent legislation		Compliance	DWS / BGCMA
	Water abstraction by Municipality Objective 7					Compliance	
	Frequency at which limits are exceeded, volumes extracted not reported/authorised or illegal connections removed Objective 7	Continuous	All abstraction points	0% non-compliance or 100% success rate of correction of transgressions		Compliance	DWS / BGCMA
Water quality and volume in the Knysna Estuary	Effluent constituents and volume of wastewater discharged from the Wastewater Treatment Works Objective 5	As per authorisation *E. Coli*, Nitrate, Nitrite, Ammonium, Phosphorous	At Wastewater Treatment Works and as per authorisation	As per authorisation, including key nutrients (nitrates, nitrites, ammonia, orthophosphate), suspended solids and pathogens		Compliance	KM

Use / Activity	Indicator / linked objective	Temporal scale / parameters	Spatial Scale	Target / limit	Priority	Type of monitoring	Responsible authority
	Water quality within the estuary Objective 5	Quarterly SANParks: Salinity, temp, pH, clarity, dissolved oxygen SAEON: Salinity, temp, pH, clarity, dissolved oxygen, nutrients (orthophosphate, nitrate, nitrite, ammonium, silica), chlorophyll a, light penetration	Main channel along the length of the estuary	Water quality within limits determined by Recreational Use Guidelines, National standards for aquatic ecosystems (freshwater and marine) and Resource Quality Objectives		Compliance	SANParks / SAEON
		E..coli	Within main channel (14 sample localities)				KM
			At / near inlets (14 sample localities)				GRDM
	Water volume entering the estuary Objective 7	Continuous	Station K5H002 (Millwood Forest Reserve)	Base flows as per Government Notice No. 1008 of 18 September 2020 or subsequent legislation		Compliance	DWS / BGCMA
			Charlesford Weir				

Appendix 3 - Baseline monitoring of the Knysna Estuary

Use / Activity	Indicator	Temporal scale	Spatial Scale	Target / limit	Priority	Responsible authority
Meteorology	To record climatic data at stations in the Garden Route	Daily	Measurement of rainfall at various stations in catchments, and 2nd order station at Thesen Islands.	Continuous record of climatic data		SANParks PM & SS
Living and non-living resource utilisation	Establish trends in estuarine use by extractive resource users and estimate dependency of users on living resources	At least one year every five years, sampled at minimum, on a monthly basis	Sampling throughout the estuary			SANParks SS
	Vessel users' activities through boat counts					
Development within the EFZ	To record illegal structures (numbers and area coverage) (including those with *post hoc* approvals)	As activities occur (reported annually)	Throughout the EFZ	Record of all illegal structures developed within the EFZ		KM DEA&DP DFFE SANParks PM
	To record the number of new development approvals (numbers and area coverage) within the EFZ			Record of loss of salt marsh habitat, including potential habitat given sea-level rise predictions		
Water level	To record the water level in the Knysna River	Continuous	Station K5H002 (Millwood Forest Reserve)	Continuous record of water level		DWS

Appendix 4 - Resource quality objectives for the Knysna Estuary

Component	Sub-component	Indicator	RQO Narrative	RQO Numeric													
Quantity	Flow	MMR / MAR (% Nat)	Maintain flow regime as close to natural as possible	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	88.3	Sep	Annual
				MMR/MAR (% Nat)	87.5	87.6	82.7	83.9	86.1	82.5	84.7	87.1	87.5	86.8	87.5	90.5	86.8
Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	DIN not >100 µg/L once-off													
		DIP		DIP not >20 µg/L once-off													
	Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae														
	System variables	Turbidity	System variables not to exceed TPCs for biota	Turbidity >10 NTU in low flow													
		Dissolved oxygen		>5 milligrams/litre in estuary													
	Pathogens	*Enterococci*	Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation	≤185 *Enterococci*/100 ml) (90th percentile)													
		Escherichia coli		≤500 *E. coli*/100 ml (90th percentile)													
Habitat	Hydrodynamics	Mouth state	Maintain connectivity with marine environment at a level that ensures water quality and habitat remains suitable for biota typically found in the estuary	Estuary mouth permanently open													
		Tidal variation		Average tidal amplitude near the mouth during low flows (summer) must not change by >10% from established baseline													
	Sediment	Sediment characteristics, Channel shape/size	Flood regime is sufficient to maintain natural bathymetry and sediment characteristics	Channel shape/size, sediment grain size and organic matter must not change by >30% from established baseline													
Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Maintain the composition and richness of phytoplankton and benthic microalgae groups and medium-low biomass	Maintain low/median phytoplankton/benthic microalgae biomass: phytoplankton not to exceed 3.5 µg/ℓ (median), phytoplankton not to exceed 20 µg/ℓ and/or cell density not to exceed 10 000 cells/ml (once-off); benthic microalgae not to exceed 23 mg/m^2 (median); prevent formation of phytoplankton blooms														
	Macrophytes	Extent,	No further loss to extent, distribution	No further loss to the present area (2014) covered by the macrophyte habitats; no further loss													

Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
		distribution and richness of macrophytes	and richness of macrophyte groups, limit colonisation/spread of the EFZ by alien species	to the distribution of sensitive macrophyte habitats (e.g. salt marsh, submerged macrophytes); control/eliminate invasive plants
	Invertebrates	Macrofauna community composition, abundance and richness	Maintain composition, richness and abundance of different groups of benthic macrofauna and zooplankton	Maintain rich populations of the mudprawn *Upogebia africana* on mudbanks in the middle estuary (Zones A and B); mudprawn density should not deviate from average baseline levels by more than 25% in each season; maintain rich invertebrate communities associated with the REI zone in the upper estuary (zooplankton and benthos); the dominant species in the zone (zooplankton and benthos) should not deviate from average baseline levels by more than 40% in each season
	Fish	Fish community composition, abundance and richness	Maintain composition, richness and abundance of different groups of fish, prevent colonisation/increase of alien species	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference (see 2015 EWR report); numerically assemblage should comprise: Ia estuarine residents (50-80% of total abundance), Ib marine and estuarine breeders (10-20%), IIa obligate estuarine dependent (10-20%), IIb estuarine associated species (5-15%), IIc marine opportunists (20-80%), III marine vagrants (not more than 5%), IV indigenous fish (1-5%), V catadromous species (1- 5%); Category Ia species should contain viable populations of at least 4 species ; Category IIa obligate dependents should be well represented by large exploited species; REI species dominated by both *Maxus capensis* and *G. aestuaria*
	Birds	Avifauna community composition, abundance and richness	Maintain composition, richness and abundance of different avifauna groups	Estuary should contain a diverse avifaunal community that includes representatives of all the original groups. Saltmarsh/wetlands in the floodplain should be rich in birdlife. Intertidal areas should have a good density and diversity of both larger and smaller waders; numbers of waterbirds on the entire system should not drop below 35 species or below 2000 birds for three consecutive counts