C.A.P.E. REGIONAL ESTUARIES MANAGEMENT PROGRAMME

PLANNING GUIDELINES FOR THE MANAGEMENT OF THE KNYSNA ESTUARY: DRAFT FOR SANPARKS REVIEW

Prepared for:

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ABBREVIATIONS AND ACRONYMS

C.A.P.E.	Cape Action for the People and the Environment
Cape Nature	Western Cape Nature Conservation Board
CARA	Conservation of Agricultural Resources Act (Act 43 of 1983)
CBO	Community Based Organisation
CFR	Cape Floristic Region
CMA	Catchment Management Agency
CMF	Catchment Management Forum
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
DA	Department of Agriculture
DEA-DP	Department of Environmental Affairs and Development Planning
DEAT	Department of Environmental Affairs & Tourism
DWAF	Department of Water Affairs & Forestry
CES	Coastal & Environmental Services
CPUE	Catch-per-unit-effort
EIA	Environmental Impact Assessment
EMF	Estuarine Management Forum
EMI	Estuarine Management Institution (comprising the EMF and executive)
EMP	Estuarine Management Plan
EZP	Estuarine Zonation Plan
ICMB	Integrated Coastal Management Bill
IAP	Interested & Affected Party
IEM	Integrated Environmental Management
IDP	Integrated Development Plan
KEPMAP	Knysna Estuary Pollution Management Action Plan
KMOSS	Knysna Municipality Open Space System
KOC	Knysna Oyster Company
MAP	Management Action Plan
MCM	Branch: Marine and Coastal Management (DEAT)
MLRA	Marine Living Resources Act (Act 18 of 1998)
MSL	Mean Sea Level
NEMA	National Environmental Management Act (Act 107 of 1998)
NEMP	National Estuarine Management Protocol
NEMPAA	National Environmental Management: Protected Areas Act
NFA	National Forests Act (Act 84 of 1998)
NGO	Non-governmental Organisation
NHRA	National Heritage Resources Act (Act 25 of 1999)
NRF	National Research Foundation
NWA	National Water Act (Act 36 of 1998)
NWRS	National Water Resources Strategy
PDC	Previously Disadvantaged Community
RDM	Resource Directed Measures
ROD	Record of Decision
RQO	Resource Quality Objectives
SA	Seashore Act (Act 21 of 1935; Amended 1993)
SAEON	South African Environmental Observation Network
SAIAB	South African Institute for Aquatic Biodiversity
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SSC	Species of Special Concern
TPC	Threshold of Potential Concern
WUA	Water User Association

1 INTRODUCTION

Estuarine ecosystems are not isolated systems. They form an interface between marine and freshwater systems and are part of regional, national and global ecosystems, either directly via water flows or indirectly through the movement of fauna. In addition to the biota that these estuaries support, they provide a range of goods and services (uses) to the inhabitants of the various regions. Disturbances in one estuary can influence a wide variety of habitats and organisms in the broader freshwater or marine ecosystem. Thus, the interaction between the systems and users creates a delicate balance, the sustainability of which needs to be addressed by a management plan.

In order to address this balance in a consistent manner in the Cape Floristic Region (CFR), the Cape Action for People and the Environment (C.A.P.E.) Estuaries Management Programme has developed a holistic and inclusive management process representative of all stakeholders. The programme is governed by a Task Team comprising officials from C.A.P.E., Cape Nature, Marine and Coastal Management (MCM), the Department of Water Affairs and Forestry (DWAF), the and the Council for Scientific and Industrial Research (CSIR).

The urgent need for Estuary Management Plans (EMPs) became apparent during the development of the new Integrated Coastal Management Bill (ICMB). Estuaries and their management have not been adequately addressed by past marine, freshwater and biodiversity conservation Acts. Estuaries and estuaries management have been marginalised due to the fact that they do not fit the ambit of any one government department. Estuaries and their management now form an integral part of the new ICMB, which outlines a National Estuarine Management Protocol (NEMP). The protocol identifies the need for the development of EMPs, as these would help to align and coordinate estuary management at a local level.

The Knysna Estuary, however, forms part of the Knysna National Lake Area (Figure 1-1), which was originally proclaimed as a national lake area under the Lake Areas Development Act on 13 December 1985. The National Environmental Management: Protected Areas Act No. 57 of 2003 (as amended) (NEMPAA) repealed the Lake Areas Development Act with effect from 1 November 2005, after which date the Knysna National Lake Area was converted into a protected environment and classified as a protected environment under the NEMPAA. The area, however, has retained the name 'Knysna National Lake Area'. The area covered by the Knysna Estuary, (area defined in section 5.1.1 of this document) within the Knysna National Lake Area is due to be awarded National Park status, with the proclamation of the Garden Route National Park. Subsequent to the proclamation of the Garden Route National Park, the Knysna Estuary will be managed according to the Garden Route National Park Management Plan by the designated management authority, South African National Parks (SANParks) as referred to in section 57 of the NEMPAA. A set of 'Regulations for the Proper Administration of the Knysna National Lake Area Issued in terms of Section 86(1) of the National Environmental Management: Protected Areas Act, 2003' have been drafted, outlining SANParks' authority within the Knysna National Lake Area. These regulations have been incorporated into this document.

Coastal & Environmental Services (CES) has been contracted by CapeNature to address the development and implementation of the Knysna Estuary Management Plan (EMP). As the Knysna Estuary will be managed by SANParks, the designated management authority in terms of section 57 of NEMPAA under the Garden Route National Park Managed Plan, which has yet to be developed, this document serves to inform that plan, and is therefore titled 'Planning Guidelines for the Management of the Knysna Estuary'. This document is structured on the Generic EMP Framework (van Niekerk and Taljaard, 2007) and in effect fulfils the requirement of Objective 2 of the C.A.P.E. Regional Estuaries Management Programme, that is, the development of a Management Plan for the Knysna Estuary.

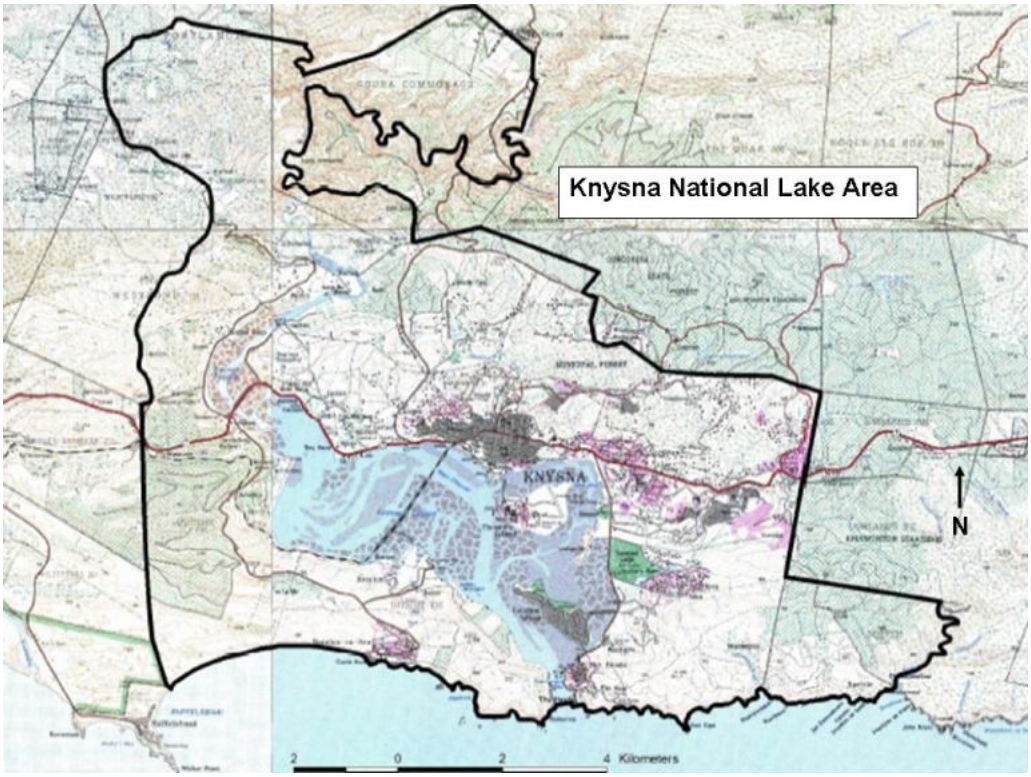

Figure 1-1: Knysna National Lake Area boundary

2 GENERIC EMP FRAMEWORK

The key components that need to be addressed, and which form the basis of the Generic EMP Framework, are illustrated in Figure 2-1. It is essential to understand that the EMP developed within this framework is not carved in stone but will instead become a living document that can be adapted according to the changing requirements of the system itself and its users. A feedback system involving a regulated monitoring programme and a detailed situation assessment once every five years will allow for changes to be made through the working groups responsible for each sector.

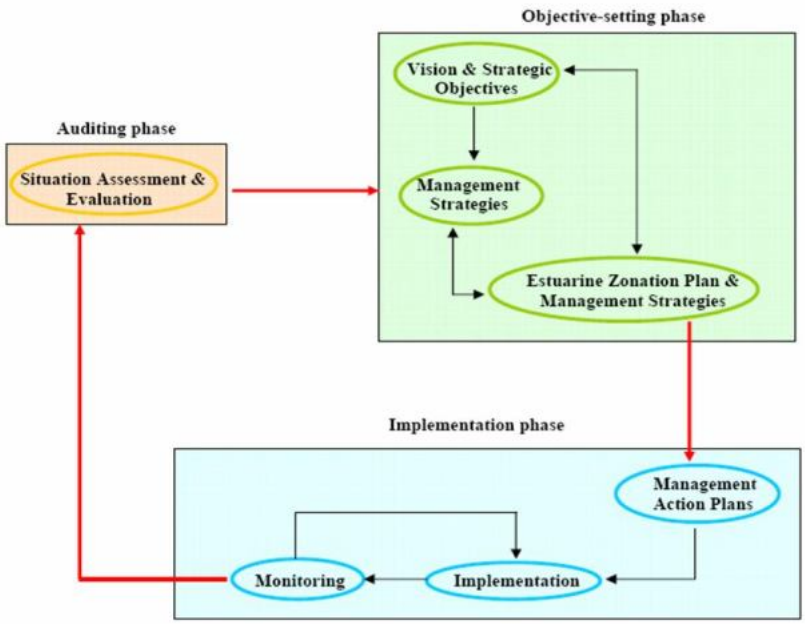

Figure 2-1: Generic framework for the development and implementation of an EMP (from Van Niekerk and Taljaard 2007)

3 VISION AND STRATEGIC OBJECTIVES

The Situation Assessment Report (CES, 2007) provided a sound basis from which to set a realistic and achievable Vision, as well as Strategic Objectives for the Knysna Estuary. It also ensured that, at the time of the stakeholder workshop, expectations were aligned with the opportunities and constraints of the ecological and socio-economic environments prevailing at the time. The developed Vision and Strategic Objectives should not conflict with that developed for the CFR, and Strategic Objectives are listed in priority order to guide subsequent management decisions. The Strategic Objectives form the foundation for quantitative, Operational Objectives.

3.1 Vision

According to the Generic Framework, the Vision should be inspirational, representing a higher level statement of strategic intent, and should take into account the overall Vision set for estuaries within the greater CFR.

> ***Vision for Estuaries in the CFR:*** *Our estuaries are beautiful, rich in plants and animals, they attract visitors, sustain our livelihoods and uplift our spirits.*

The Vision for the Knysna Estuary is as follows:

> ***Vision for Knysna Estuary:*** *Through active participation we will strive towards realising a Knysna Estuary that supports acceptable ecological processes to ensure the long-term survival of this unique system and its biodiversity and the use of living resources in a sustainable manner, for the well-being and enjoyment of all.*

3.2 Strategic Objectives

Strategic Objectives are generally qualitative statements of the values defined in the Vision and should be statements of outcomes rather than means of achievement. The following sectors need to be specifically addressed in terms of Strategic Objectives:

- Living Resources and Conservation
- Water Quality and Quantity

} Collectively Ecosystem Function & Services

- Land Use and Infrastructure Planning
- Institutional and Management Structures
- Education and Awareness
- Non-consumptive Use
- Sustainable Livelihoods

} Social issues

The Strategic Objectives for the sectors mentioned above are as follows:

3.2.1 Living Resources and Conservation

Achieve a sustainable balance between conservation and use of living resources, including implementing effective measures to ensure the protection of habitats and the survival of all species.

3.2.2 Water Quality and Quantity

River and Estuarine Reserves and Resource Quality Objectives must be determined and implemented to ensure that all ecological processes, livelihoods and public health are sustained and enhanced.

3.2.3 Land Use and Infrastructure Planning

All urban and rural developments shall comply with all relevant (local, regional and national) legislation and should conform to development guidelines / policies / frameworks to support the Ecosystem Function and Services objectives stated above.

3.2.4 Institutional and Management Structures

A functional local Estuary Management Forum should be established with representatives from all the relevant authorities and civil society stakeholder groups, that actively promotes open and transparent communication and delegates responsibility that ensures cohesive and effective management of the Knysna Estuary.

3.2.5 Education and Awareness

Through education and awareness programmes it should be ensured that local government officials, residents and visitors are:

1. *Aware of the value of the system and take personal responsibility in the management and conservation of the Knysna Estuary, and*
2. *Aware of the laws that apply to the estuary and their implications.*

3.2.6 Non-consumptive Use

Residents and visitors who use and enjoy the Knysna Estuary must accept the need for environmentally responsible use as well as social density and zonation restrictions on non-consumptive uses of the estuary and comply with these restrictions.

3.2.7 Sustainable Livelihoods

Existing estuary-based livelihoods should be assessed and managed to ensure compliance with legislation and sustainability, and additional sustainable livelihood opportunities should be identified and created.

4 MANAGEMENT STRATEGIES

The Vision and Strategic Objectives may be achievable through various Management Strategies and these should be investigated and evaluated so as to optimally utilise financial and human resources that are detailed in the Management Action Plans. The following Management Strategies are available for achieving the Strategic Objectives for the various sectors detailed in Section 3 (specific reference to relevant sections of legislation may be found in Tables 6.1 to 6.6):

4.1 Living Resources and Conservation

- Sanctuary Areas proclaimed in terms of the National Environmental Management (NEM): Protected Areas Act (Act 57 of 2003) that incorporate a variety of habitats (wetland, saltmarsh, sandbanks, mudbanks, open channel and surf zone adjacent to the estuary mouth) and species, and which would be closed to most forms of human disturbance.
- Conservation Areas in which local by-laws may be applied to protect habitats or resources, such as rotating bait collection areas to allow for recovery and which also allows for changes in intertidal characteristics due to flooding or low water levels, restriction of bait collection to daylight hours to avoid trampling of substrate when larval release and postlarval settlement are at a peak, and wake-free zones to reduce erosion and disturbance of bird populations.
- Enforce existing legislation in terms of the Marine Living Resources Act (Act 18 of 1998; MLRA); this includes bag limits, closed seasons, size limits, collection methods for both fish and invertebrate species, licences, and selling of fish.

- Control the number and format of fishing competitions, for instance, no more than one competition per month; manage all competitions on a measure and release basis - no weighing of fish prior to release; and no dead fish to be considered for prizes or points.
- An Estuarine Zonation Plan (EZP) that permits certain activities within certain zones, for example sanctuary areas, and fishing and bait collecting zones.
- Promote alternatives to consumptive exploitation, such as low-impact, non-consumptive activities such as hiking, bird watching and canoeing.
- Retain the recreational and subsistence fisheries as the only forms of consumptive use; no commercial fishing enterprises, with the exception of the existing mariculture operation should be considered.
- Subsistence fishers must be licensed and their activities regulated to include a strictly controlled bait selling operation.
- Impose and enforce strict environmental standards on the oyster mariculture operation.
- Enforce existing legislation that pertains to activities that impact on estuary ecosystems and their functioning, for instance the National Environmental Management Act (Act 107 of 1998; NEMA) and the Environmental Impact Assessment (EIA) Regulations; Integrated Coastal Management Bill (ICMB); and the Conservation of Agricultural Resources Act (Act 43 of 1983; CARA).

4.2 Water Quality and Quantity

- Enforce existing legislation in terms of the National Water Act (Act 36 of 1998; NWA) with respect to water use (Chapter 4, Parts 1 to 6), catchment management (Chapter 2, Part 2) and water quality (Chapter 3, Part 4).
- The National Water Resource Strategy (NWRS; NWA Chapter 2, Part 1)) provides a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole and within defined water management areas such as specific catchments. This strategy is given effect by water management institutions such as Catchment Management Agencies (CMA) or Water User Associations (WUA) – the Knysna Catchment Management Agency was formed in January 2008, but has yet to develop a Catchment Management Strategy (CMS).
- A CMS developed by the CMA in accordance with the NWA (Chapter 2, Part 2) for the protection, use, development, conservation, management and control of water resources within its water management area. Specifically this will include the classification of the water resource and the resource quality objectives (RQOs; NWA Chapter 3, Parts 1 & 2) aligned with that particular classification. The Knysna Estuary Reserve Determination Study is on-going at present, with a workshop due to be held in July 2008, a Resource Directed Measures (RDM) Report due for September 2008, and the Knysna Estuary Monitoring Programme as an outcome of the Reserve Determination Study due for release January 2009.
- A Knysna Estuary Pollution Management Action Plan (KEPMAP) has been developed by the Knysna Municipality. Responsibility for implementing and running this plan has previously fallen to the Estuary Pollution Prevention Committee, comprising representatives of the Knysna Municipality, the Eden District Municipality, SANParks and several specialists. However, due to lack of human capacity the plan has not been initiated to date. The Estuarine Management Institution (Section 4.4) should take responsibility for implementing the plan.

4.3 Land Use and Infrastructure

- An Estuarine Zonation Plan that restricts land use and development within the terrestrial portion of the designated estuarine area.
- Enforce existing legislation that pertains to activities that impact on estuary ecosystems and their functioning, e.g. NEMA and the EIA Regulations; ICMB; and CARA.
- A draft Spatial Development Framework (SDF) has been developed for incorporation into the Integrated Development Plan (IDP) which specifically recognises the Knysna estuarine

area and regulates land-use within that area in accordance with the recommendations of the EMP. The key points of the SDF, pertaining to the Knysna Estuary and the regulation of land-use, have been summarised below:

Land use and subsequent development such as the installation of services is governed largely by economic drivers. In the case of the Knysna Municipality these drivers include residential and commercial development based largely on the tourism and recreational potential of the region.

It is now a requirement for municipalities to produce an SDF, which is then incorporated into an IDP. The IDP then establishes the development capability for the area based on financially sound and sustainable plans such as an SDF. Furthermore, the SDF also synthesises concepts and strategies contained in documents such as the Open Space Plan, Settlement and Services Frameworks and the Economic Development Framework. The Knysna Municipality is currently in the process of formalising the latest SDF, of which certain portions have been included into this report due to the SDFs consideration of the boundary it shares with the Knysna National Lake Area.

An SDF is based on four main growth areas or concepts, which are contained in the documents listed above. These four concepts are thus in line with development needs of the municipal area, represented spatially.

The fours growth area or SDF Concepts, as shown in Figure 4-1 are (Knysna SDF, 2007):

1 - Open Spaces
Open spaces are those areas containing open vegetation (natural or cultivated) or water bodies (lagoons, wetlands or lakes) proposed and are protected from urban development. This also ensures that these areas remain productive from environmental, recreational and social perspectives (Knysna SDF, 2007). Open space planning such as the KMOSS (Knysna Municipality Open Space System) has taken these areas into consideration, within the context of indentifying and maintaining important ecological corridors.

2 - Major towns and Central Business Districts (CBDs)
The economic, social and recreational importance of existing town centres are recognised, given the current trend for growth to be directed to new nodal developments, in particular new shopping malls on the edge of towns that are only accessible by private transport. The Growth Potential in Towns Study undertaken by the Provincial Government of the Western Cape (PGWC) has provided a basis for establishing a hierarchy of settlements, although this is adjusted for the specific context of the Knysna Municipal Area.

3 - Activity streets and Nodes
This focuses on key road linkages and cluster developments that encourage mixed-use activities (job creation and community facilities) along its route and that create connectivity with the existing town centres. This is aimed at incorporating previously separated developments into mainstay economic activity and increasing the viability of employment generating opportunities in these areas. The idea is to concentrate areas of economic activity in order to promote scales of economy, rather than allowing the dispersal of businesses which creates a number of negative side effects.

4 – Urban Edges
Urban edges are geographical boundaries, which identify the limits of development for the next three to five years, to encourage infill development and densification. These are based on provincial guidelines and are revised as additional information is presented.

The Knysna Municipality SDF draft has also included the respective Densification and Settlement Upgrading Frameworks. These two aspects relate to increasing the density of existing residential / commercial developments in the areas within the Urban Edge, thus making the most of the current infrastructure, thereby limiting further impact on the remaining natural areas. The Upgrading Framework relates to issues with developing the capacity of the infrastructure to adequately serve the social and economic needs of the region and is also incorporated into the SDF.

Key components of the SDF, which are based on the Knysna Open Space System (KMOSS) (Figure 4-1) are discussed in further detail in Sections 5.1.5 and 5.2.4 of this report, as these relate directly to future land use planning and the required provisions and development guidelines.

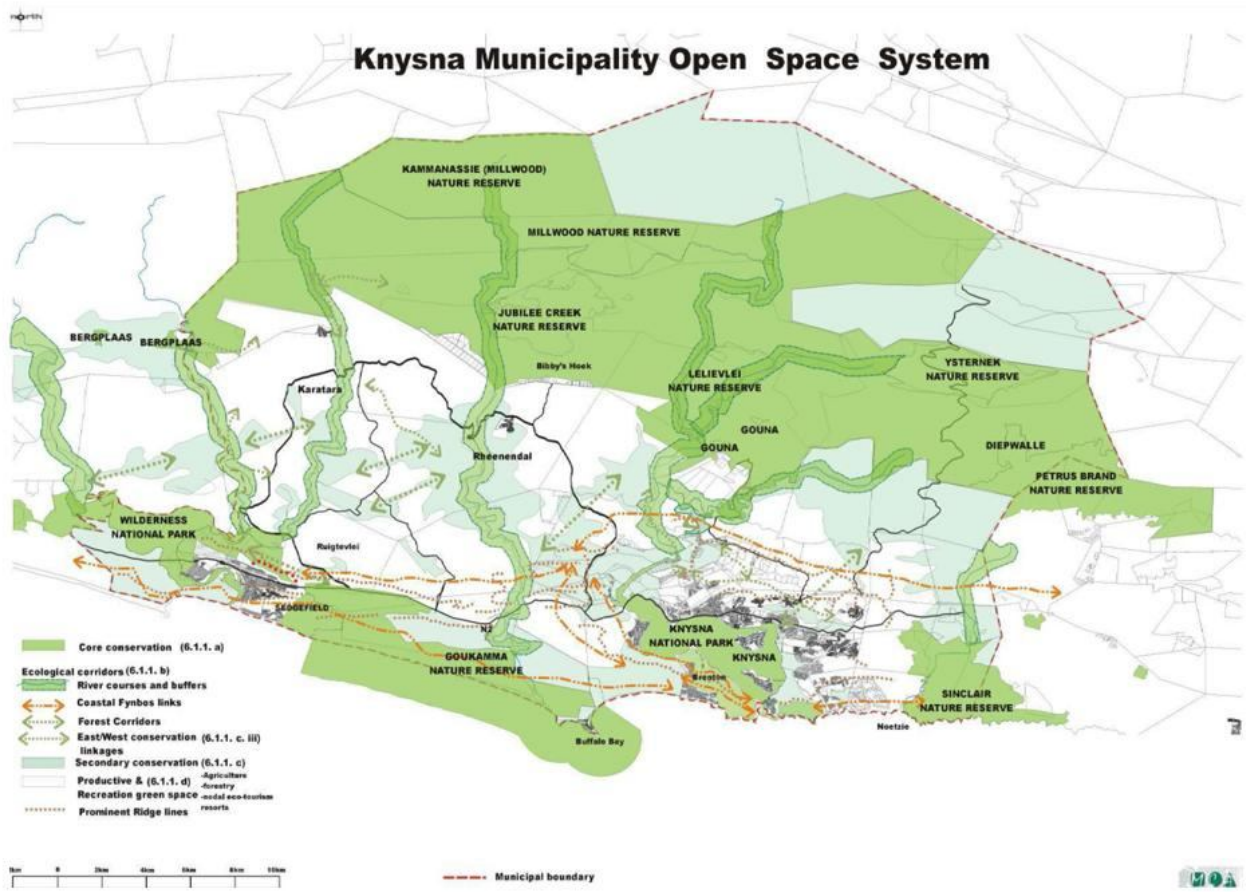

Figure 4-1: The proposed Knysna Municipality Open Space System (SDF 2007 Draft, 2007)

4.4 Institutional and Management Structures

- A local Estuarine Management Institution (EMI), representative of all relevant spheres of government and civil society, is formed to ensure the implementation of the EMP; this includes ensuring that relevant government departments fulfil their obligations (for instance the Department of Environmental Affairs and Tourism (DEAT), and the Department of Water Affairs and Forestry (DWAF) assisted by a CMA and WUAs), and that the ideals of the EMP are captured within all relevant management and planning documents, such as the SDF and IDP, and a CMS that includes the setting of RQOs. The relationship with the SANParks Park Forum will need to be established, and perhaps should be incorporated into the EMI.

4.5 Education and Awareness

- Educational workshops for local authorities, in particular town planners and municipal managers, about the ecological, social and economic value of estuaries, the EMP and its context within the SDF and IDP, the ICMB, and the consequences of irresponsible development within the estuarine area.
- Training courses for estuarine managers, municipal authorities, estuarine management forum members, catchment management agencies and water user association members; DWAF's Resource Directed Measures: Estuarine Reserve Training Course; and higher degrees for those managers who already possess a degree or diploma.
- Public awareness campaign (estuary value / natural heritage, biodiversity, threats and conservation efforts) via pamphlets, refurbishment of notice boards, particularly those demarcating the Invertebrate Reserves (and erection of notice boards at each Invertebrate Reserve marker points), school tour groups, illustrated talks given by research scientists and members of the forum technical working groups and transfer of research findings / monitoring plan results on a regular basis into publicly available, easily understandable documents (in, for instance, local newspapers and popular science articles). SANParks have an existing People and Conservation Programme, which provides environmental education programmes such as:
    - Khula Nam programme
    - "Take a girl child to work" programme
    - Weedbuster week
    - Eco-schools
    - Earthnotes film festival
    - Morula kids
    - International beach clean-up
    - Oyster festival activities
    - Arbour week
    - SANParks week
    - Kids in Parks Programme

  The table below summarises the SANParks People and Conservation Programme environmental education and youth outreach activities in the Knysna National Lake Area for 2007/2008:

Table 4-1: SANParks People and Conservation Programme environmental education and youth outreach activities

PROGRAMME	YEAR TOTAL (12 mths)
Knysna National Lake Area	
Guided Theme Excursions (Schools)	381
Khula Nam Excursions	140
Kids in Parks camp programmes	0
Holiday programmes	128
Eco-schools workshops	6
Eco-schools Meetings	24
Total No of Children (schools)	**649**
Total No of Adults (schools and Groups)	**64**

- Empower catch monitors and local conservation officers through an education initiative involving relevant national and regional legislation, zoning of the estuary and general knowledge of fauna and flora within the estuarine area.
- Research projects aimed at enhancing our knowledge of the Knysna system and thus the efficacy of the EMP through amended Management Action Plans (MAPs) and monitoring programmes.

4.6 Non-consumptive Use

- Research existing non-consumptive uses and assess the extent to which they comply with existing regulations with a view to identifying problem areas.
- In consultation with users, review and update existing regulations with regard to non-consumptive uses and develop sustainable social density and zonation restrictions that are incorporated into the EMP.
- Ensure compliance of all existing non-consumptive uses with regulations and social density and zonation restrictions.

4.7 Sustainable Livelihoods

- Research and report on the nature and distribution of existing livelihoods linked to the estuary and assess the environmental sustainability of these.
- Assess and report on the distribution of impacts that compliance with all existing legislation and management plans would have on the range of existing livelihoods linked to the estuary and identify potential strategies to mitigate these impacts.
- Through an inclusive consultative process, make decisions about what level of consumptive and non-consumptive use of the estuary and it living resources will be supported and permitted and incorporate these into the EMP.
- Ensure compliance of all existing livelihood activities with legislation and management plans that regulate against potential impacts on the estuarine area, its inhabitants and users.
- Explore and promote the development of new initiatives that will benefit previously disadvantaged communities and that will comply with legislation and management plans that regulate against potential impacts on the estuarine area, its inhabitants and users.

5 ESTUARINE ZONATION PLAN AND OPERATIONAL OBJECTIVES

Management Strategies need to be translated into an Estuarine Zonation Plan (EZP) and Operational Objectives. However this is not applicable to all Management Strategies, as clearly the EZP cannot include the strategies for water quantity and quality, institutional and management structures, sustainable livelihoods, and education and awareness programmes. Instead the EZP reflects the strategies devised for living resources and conservation, and land use and infrastructure.

5.1 Estuarine Zonation Plan

The EZP for the Knysna Estuary is represented visually in Figures 5-1 to 5-5 and comprises the following:

5.1.1 Geographical boundary

The C.A.P.E. Estuaries Programme considers the NWA definition of an estuary as the most appropriate. It reads as follows; “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.” For the purposes of determining the Resource Directed Measures (RDM), DWAF defines the geographical boundaries of an estuary as follows; “the seaward boundary is the estuary mouth and the upper boundary the full extent of tidal influence or saline intrusion, whichever is furthest upstream, with the five metre above mean sea level (MSL) contour defined as the lateral boundaries.”

The geographical boundaries of the Knysna Estuary have also been defined within these parameters although the five metre above MSL contour is seen more as a guideline and it is more likely that local topography will determine the lateral extent of the estuarine area. The five metre

contour has, however, been included for consideration. The Knysna Estuary can broadly be divided into three distinct regimes (Largier *et al.*, 2000):

- **Upper estuary regime** (from White Bridge (N2 road bridge) to the Charlesford Weir), which is strongly influenced by the inflow of freshwater from the Knysna River and demonstrates strong vertical stratification in salinity and water temperature.
- **Lagoon regime** (from White Bridge (N2 road bridge) to the railway bridge), which is characterised by aged salty water with little direct influence from freshwater. The lagoon is considered as a transition zone between the estuary and the marine embayment.
- **Large marine embayment regime** (from the railway bridge to the Knysna Heads), which is flushed by tidal flows and exhibits temperatures and salinities similar to the ocean

The boundaries of these three regimes demonstrate a high degree of temporal variability reflecting amongst others, the magnitude of freshwater inflow from the Knysna River into the estuary and the inflow of marine waters through the heads (Largier *et al* 2000). For the purposes of this document, and from an ease of management perspective, the Knysna Estuary will represent all three regimes. The Core (Domain) Boundaries, or Core 1 region boundaries, are therefore from the Knysna Heads to the Charlesford Weir, and up to 100m inland from the high water mark (Figure 5-1). The 100m inland mark has been included as a no development riparian buffer zone as many activities for which a environmental approval (either an Environmental Impact Assessment (EIA), or Basic Assessment (BA)) is required have been defined in relation to this set-back line (see NEMA, Government Notices R386 & R387). In addition, the coastal buffer zone defined by the ICMB (Section 16) is 100 m for certain land-uses and it is regarded as an effective buffer against human interference with the estuary and its sensitive riparian areas.

The Knysna National Lake Area defines the Secondary (Planning) Boundary, or Core 2 (Figure 5-1).

5.1.2 Sanctuary and conservation zones

Sanctuary Zones
The existing Invertebrate Reserve must be retained. This area prevents the collection of invertebrate species within the designated boundaries, and is thus a form of a sanctuary zone. This area provides protection for a host of habitat types including sandbank, mudbank, open channel and sandy beach zones and their associated fauna and flora. The saltmarshes are important habitat types in their own right and, apart from their unique floral composition, also provide a vital habitat for invertebrate and vertebrate organisms, act as natural flood control areas and provide a vital source of materials within the estuarine food web.

Based on the findings of the Situation Assessment (CES, 2007), and the current demographics, use and value and range of habitats provided by the Knysna Estuary, no further sanctuary zones are proposed. This is assuming that existing legislation is enforced in the conservation zones of the remainder of the estuary, such as enforcing fish size and bag limits.

Conservation Zones
Conservation zones are defined by Turpie and Clark (2007) as the remaining regions of the estuary, including terrestrial margins, not declared sanctuary areas and zoned in a particular way depending on the Vision and requirements for the estuary. The remainder of the Knysna Estuary water body, its associated habitats and the riparian buffer area to a distance of 100 metres back from the high water mark have been proposed as conservation areas and would thus be managed by SANParks, the designated management authority, and administered either by them or a designated institution such as the local EMI. Activities within the conservation zones would be controlled through the administration of the NEMPAA as well as by other national legislation, which includes but is not limited to the Seashore Act (SA; Act 21 of 1935; amended 1993; until repealed by the ICMB), NEMA and the associated EIA regulations, CARA and ICMB when it is promulgated.

A proposed zonation plan has been indicated in Figure 5-2. This is based on previous SANParks

management plans, as it has proved to be successful in the past. Zones included are:

1. High intensity recreational use – boating (power), skiing, sailing, fishing, ferry trips in the main Knysna channel.
2. Low intensity use – limited boat use and activities (area incorporates the Invertebrate Reserve).
3. Low intensity recreational use – birding, fishing, house-boating.
4. Low intensity use – birding, fishing (the option of a no-wake zone should be explored, as well as a restriction on motor size above 'Red bridge', as is imposed at present).

The Garden Route National Park Management Plan, however, will be drafted under the DEAT management plan guidelines for protected areas, therefore the zones may have to be aligned to those used in the DEAT guidelines. The intensities of use of recreational activities, however, should be retained. Further, carrying capacities and social densities (see section 5.2.1) will need to be established by SANParks and the EMI.

5.1.3 Important bio-physical features and recreational activities

The EZP demarcates important bio-physical features such as major habitat types (sandbanks, saltmarshes, open channels and fresh water wetlands) and Knysna erven (Figure 5-3) as well as regions of resource use and recreational activities, drainage channels and drainage points of entry into the Knysna Estuary (Figure 5-4).

5.1.4 Rehabilitation zones

No specific areas requiring rehabilitation were identified in the Situation Assessment of the Knysna Estuary (CES, 2007), and no areas have been shown on the EZP maps. A lack of circulation / water movement, however, has the potential to degrade the saltmarsh vegetation of certain areas of the estuary, which require regular inundation. Such areas include the saltmarsh stands along Ashmead Channel and in the Point region.

5.1.5 Land-use, planning provisions and infrastructure

A variety of land-use patterns and zones are found along the edge of the Knysna Estuary (Figure 5-5). These are predominately residential, recreational, commercial zones and protected areas. These are clearly defined in the draft Knysna Spatial Development Framework (Knysna SDF, 2007).

The majority of land uses within the Knysna Municipal area have some form of impact on the estuary and as a result, together with the estuary being a protected environment, the Knysna Municipality Open Space System (KMOSS) (Figure 4-1) has taken cognisance of the surrounding land use and has provided for a system of interconnected open spaces areas and buffer zones. More importantly, the estuary has been included into the KMOSS, with planning provisions being that the Knysna Estuary be treated as a Core Conservation Area. The Knysna River is also included in the KMOSS as a River Course and Buffer, and therefore receives a lower degree of protection than the estuary.

Core conservation areas perform the role of protecting the physical and biophysical functioning of the important natural ecosystems. The core conservation category is further divided into two parts. Firstly, proclaimed or recognised nature reserves and national parks, which already have guidelines in place which control and manage the land-use. The second category is proposed nature reserves, which have been identified by the Municipality. The KMOSS study identified the following, together with a set of suitable planning provisions:

1 – Existing Nature Reserves and Protected Environments in the Knysna municipal area (Figure 4-1). These are: Kammanassie/Millwood; Jubilee Creek; Lielievlei; Gouna; Ysternek; Diepwalle; Pertrus Brand; Sinclair, Pledge and Goukamma Nature Reserves; Goukamma Marine Reserve; as well as Wilderness and Knysna Lake Area.

2 – Proposed Nature Reserves include the Sparrebosch and Salt River valley indigenous forests on Municipal land have been included in this area, as both have been recommended for nature reserve status.

The KMOSS has provided the following land-use management guidelines as part of future planning provisions within state or municipal conservation areas:

- Only non-consumptive activities should be permitted in core conservation areas. These include:
  - Passive recreation and related activities;
  - Tourism;
  - Research activities;
  - Environmental education.
- No development, urban or agricultural, should be permitted in these areas.
- No development should occur outside of the urban edge, as defined in Figure 5-5.

Land-use management guidelines on private land are slightly different. Unless such land is acquired by conservation authorities, land use should be restricted to low visual and low environmental impact dwellings, sited in a position that would minimise environmental impact of both the home and the access route. This must be to the satisfaction of the Municipality, in consultation with environmental authorities. The size, finishes and colour of the structures must also blend with the surrounding environment to the satisfaction of the authorities listed above. The proposed SDF (2007) does make a significant contribution in terms of proposing several building designs, colour schemes and layout plans for future developments, to meet the standards noted above.

Additional non-consumptive activities such as those mentioned for state or municipal owned conservation areas should also be considered where appropriate for privately owned areas. The size of the properties, the proximity to other facilities and transport routes should be taken into account, while the formation of conservancies and conservation areas between neighbouring landowners must also be promoted (Knysna SDF 2007).

The success of the proposed KMOSS hinges on the necessity to co-ordinate the numerous stakeholders who have jurisdiction within the area. The key stakeholders include the Municipality, Cape Nature Conservation, South African National Parks (SANParks), the Department of Water Affairs and Forestry (DWAF), South African Forestry Corporation Limited (SAFCOL), South African National Roads Agency Limited (SANRAL), Provincial Roads, owners of private nature reserves and members of conservancies (SDF 2007).

Figure 5-1: Geographical boundaries of the EMP showing the Core (Domain) Zone i.e. water area from the mouth to Charlesfod weir, and a 100m terrestrial buffer, and the Secondary (Planning) Zone i.e. Knysna National Lake Area

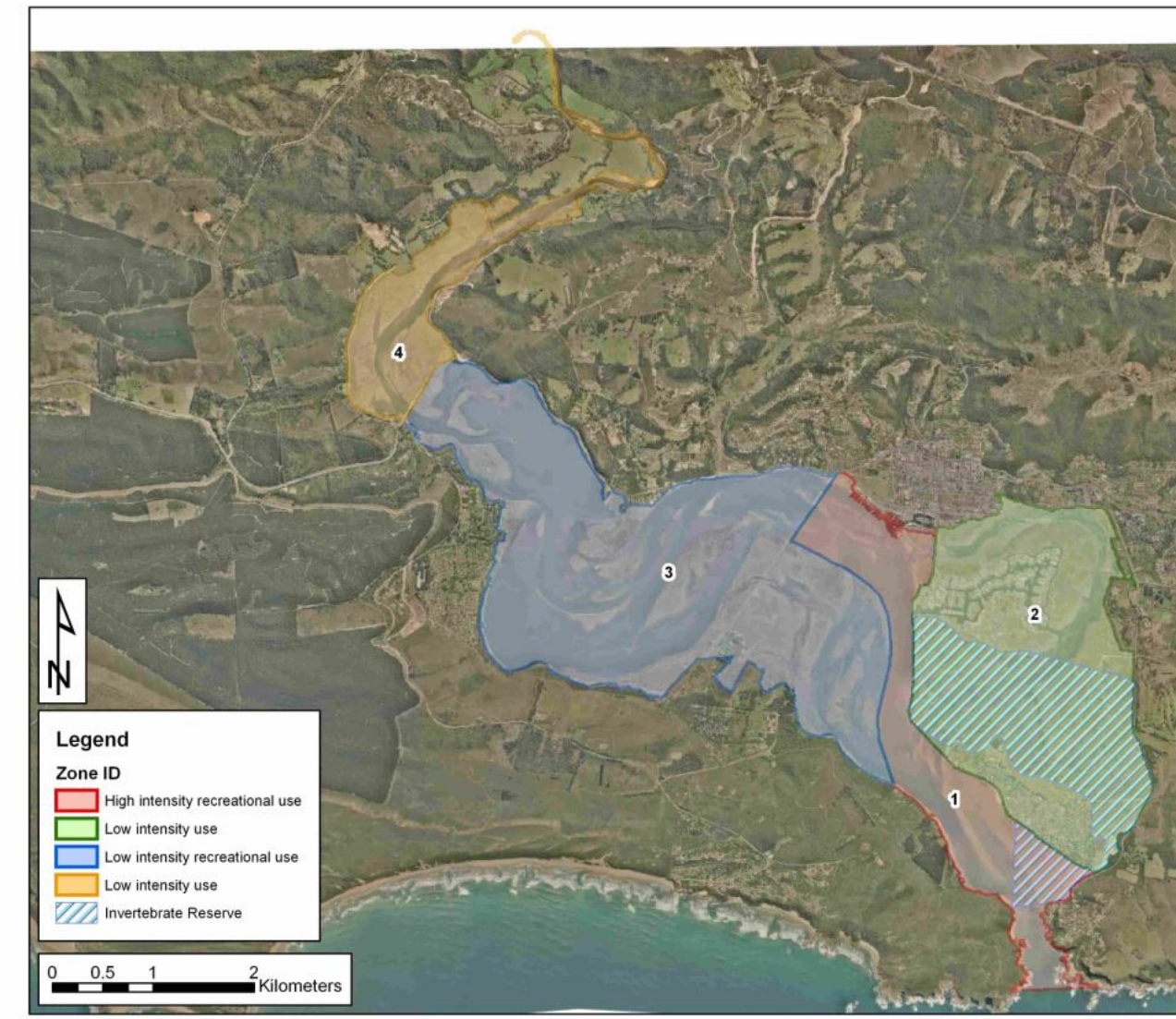

Figure 5-2: Proposed zoning of the Knysna Estuary

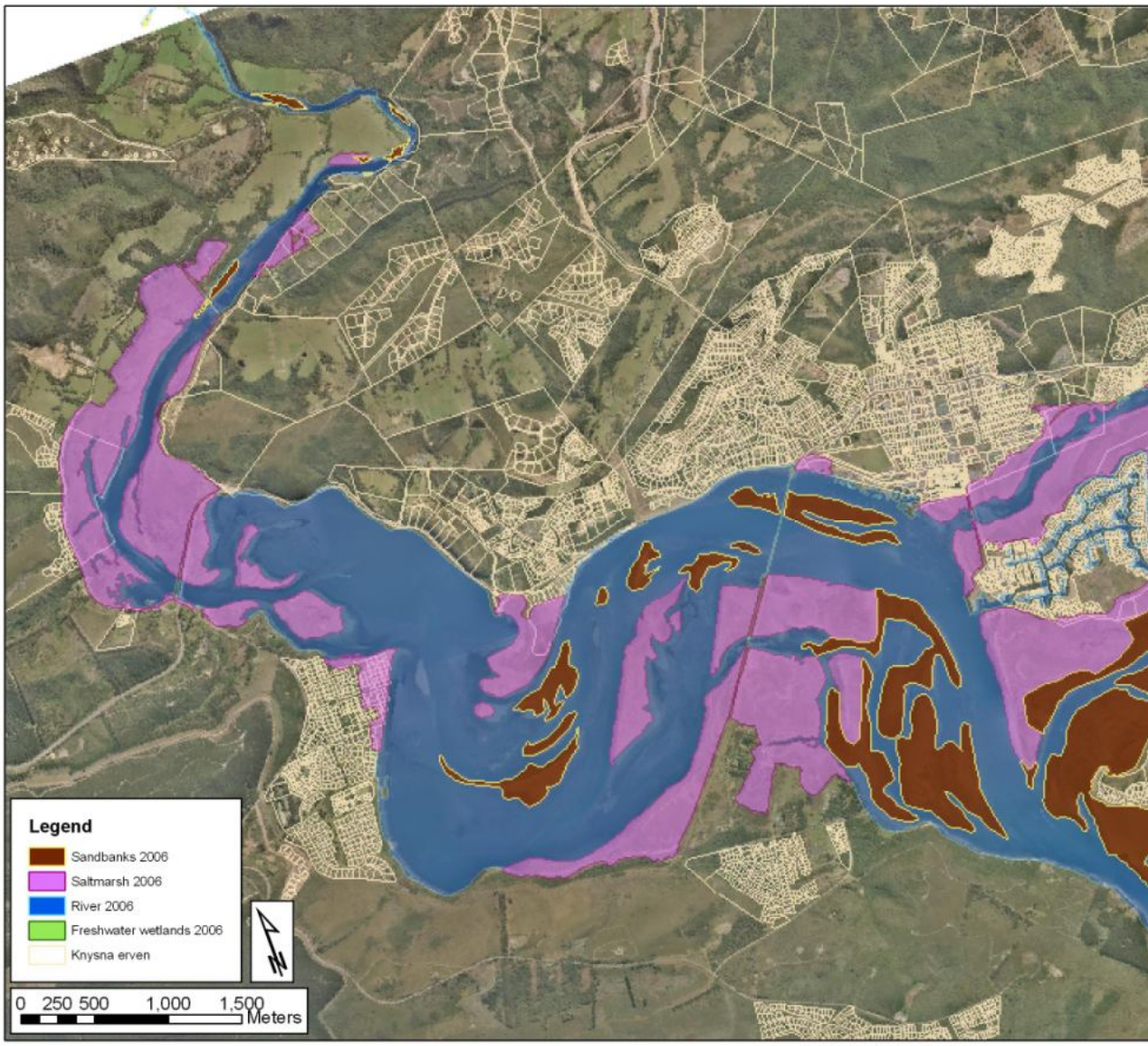

Figure 5-3: Important bio-physical features of the Knysna Estuary

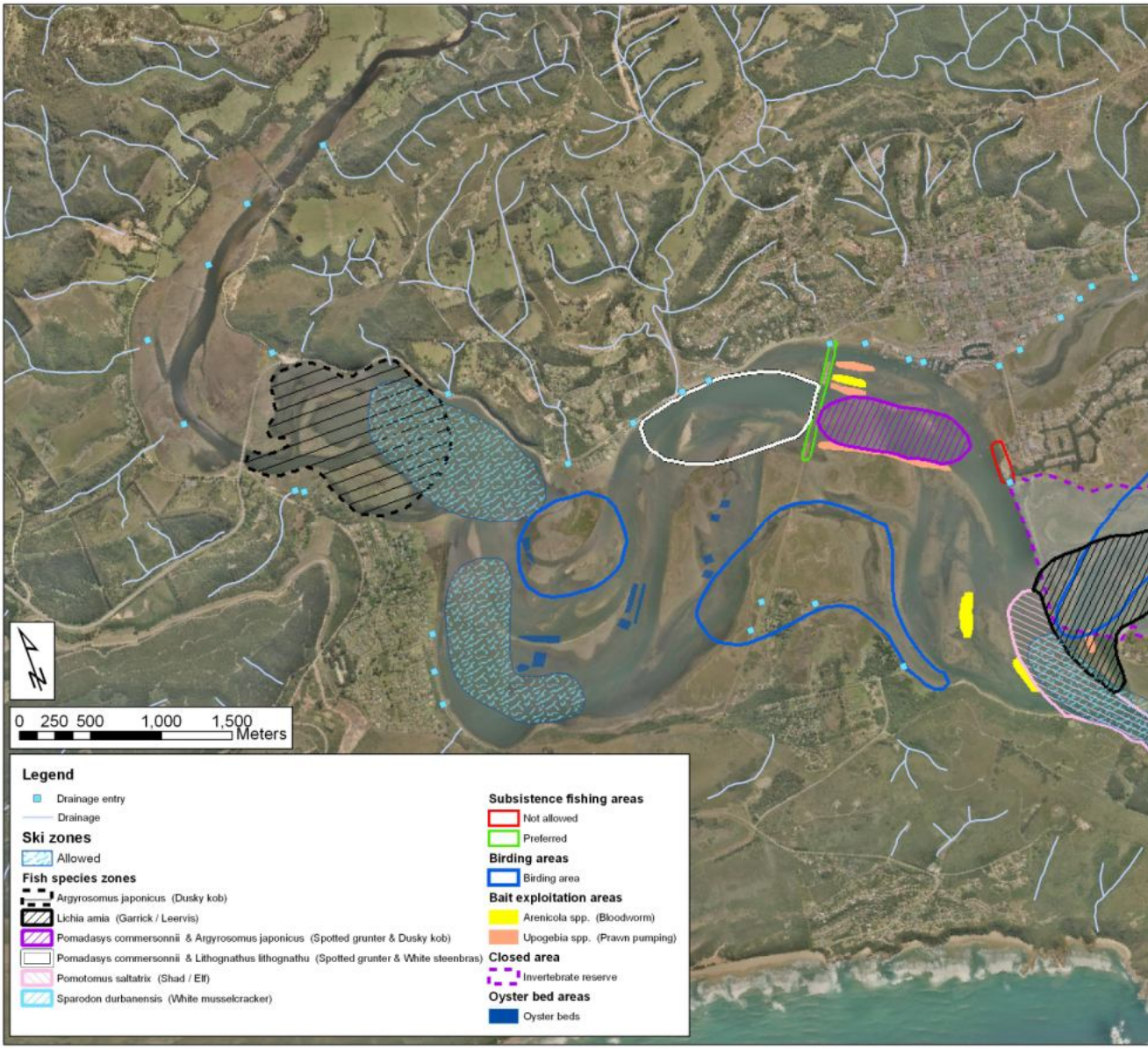

Figure 5-4: Regions of resource use and recreational activities, drainage channels and drainage points

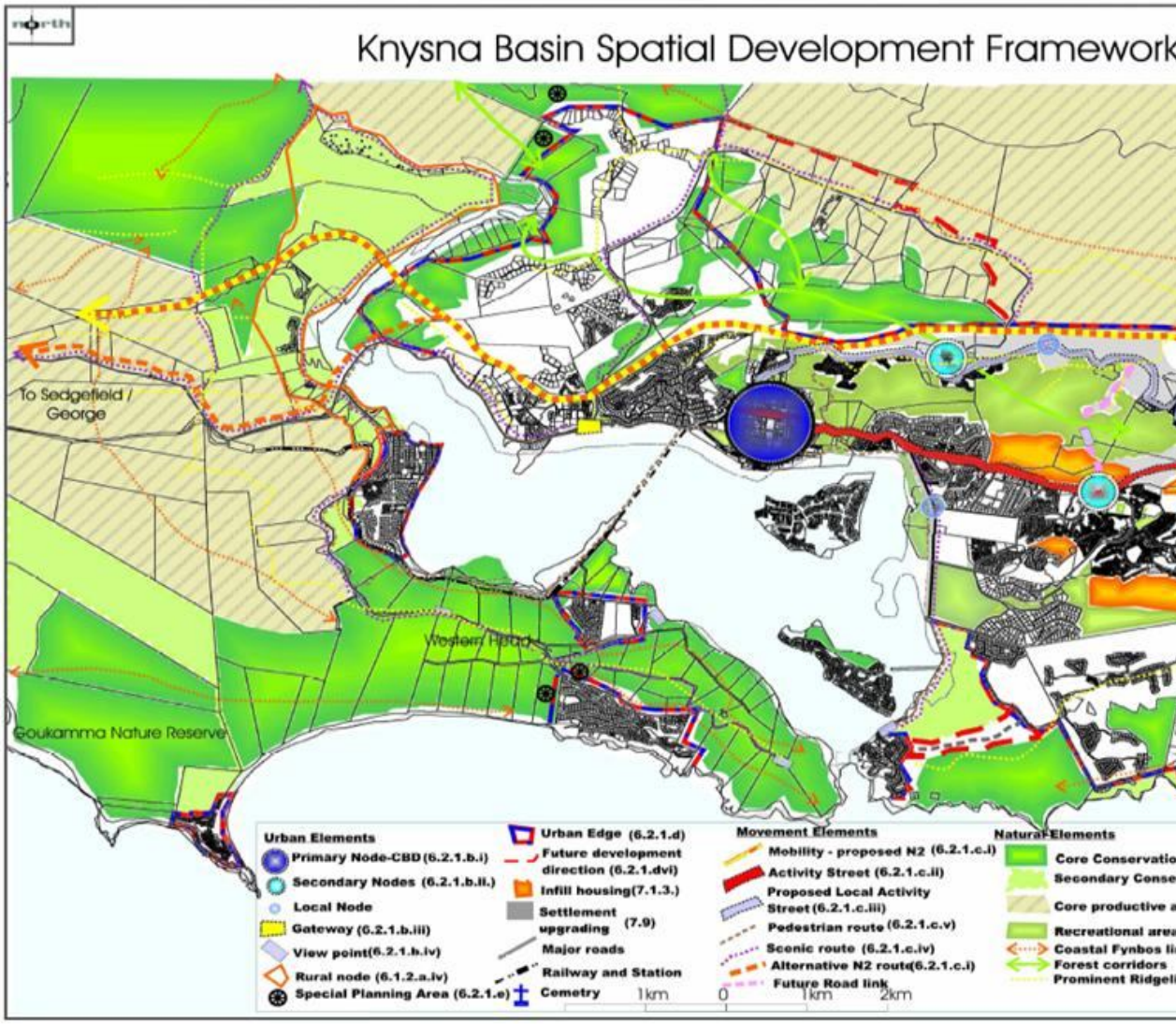

Figure 5-5: Knysna Municipality SDF map showing conservation areas, lagoon edge and urban edge

5.2 Operational Objectives

The Operational Objectives specify quantitative, measurable standards, target values, limits or Thresholds of Potential Concern (TPCs) for indicators relevant to the different zones and activities in accordance with the EZP. These need to take into account any existing standards, regulations, operational policies or guidelines that have relevance to estuaries, as well as available resources. TPCs are defined as measurable end-points related to specific indicators that, if reached, prompt management intervention. In essence, TPC end-points should be defined in such a way that they provide early warning signals of potential non-compliance with Operational Objectives (Taljaard and Van Niekerk 2007a). Generic indicators and recommended TPCs for many of the Operational Objectives are available in (McGwynne and Adams 2004) but, for the purposes of this document, TPCs will not be suggested for conservation and living resources Operational Objectives, but derived at a later stage in consultation with SANParks: Scientific Services.

5.2.1 Conservation

Operational Objectives for conservation purposes should be targeted at protecting biodiversity within the Knysna Estuary by ensuring that the diversity, distribution and abundance of plant, bird, fish and benthic invertebrate communities is maintained or restored. These objectives should be defined in terms of TPCs for a range of indicators that, firstly reflect aspects of biodiversity itself, secondly are aimed at controlling human activities that may impact on habitats and living resources, and thirdly deal with enforcement issues.

Biodiversity

- Presence and extent of plant communities, including submerged macrophytes, benthic microalgae, saltmarshes and emergent reeds. The recommended TPC will need to be established, but conservation of a range of habitat types, in particular submerged beds of *Zostera capensis* and the sandy substrate need to be conserved, as these provide habitat for the critically endangered species of special concern (SSC) including the Knysna seahorse (*Hippocampus capensis*), the pulmonate limpet (*Siphonaria compressa)*, and the pansy shell (*Echinodiscus bisperforatus*).
- Infestation of riparian areas by alien vegetation. The TPC will need to be established. Baseline and reference data can be obtained from aerial photographs and on-site line transects.
- Densities of intertidal invertebrate species such as mudprawn, sandprawn and bloodworm. The TPC will need to be established. Baseline data can be obtained from regular seasonal counts of burrows using random quadrats over an initial two-year period.
- Waterbird counts that include red-data species, those that are highly or partially dependent on estuaries, breeding aggregations or activity and the presence of nests. Since rare or specialised birds are usually the first to be affected by change, the TPC for species richness should be the loss of one or two species over a short period of time. The TPC for species diversity will need to be established. Baseline data should be collected from twice-yearly bird counts over a spring low tide and outside of peak disturbance periods, and from locally available sources such as the Lake Bird Club and the Knysna Basin Project.
- Fish abundance as measured by catch-per-unit-effort (cpue); this indicator and its associated TPC is also relevant to the Operational Objectives for exploitation of living resources. There are currently no recommended TPCs for *cpue* probably because catch data is not widely available for individual estuaries. TPCs for the decrease in numbers of all species need to be derived, with dusky kob and white steenbras requiring more stringent TPCs then the remaining species. It is important to note, however, that a decline in *cpue* for any species may not be the result of exploitation on the Knysna Estuary alone, that is, it may be a national trend as the resource is widely distributed, and it may also be due to other factors such as water quality or a decrease in food availability. Baseline data can be obtained from a fishery survey conducted for an initial period of two years.
- Extent of natural area remaining per habitat type and the degree of habitat fragmentation. The TPC will have to be established. Baseline data on habitat type coverage can be obtained from aerial photographs and existing GIS data.

- Location and proportion of estuary habitat type under formal protection (sanctuary area). TPCs and baseline data for this objective are not available but the recommendation from Turpie and Clark (2007) is that half the system be formally protected. This is unrealistic given the user dynamics and land-use of the Knysna estuary, but the current Invertebrate Reserve cover a total area of 323.16Ha or approximately 16% of the total water area (1976.09Ha). A preliminary TPC would be any decrease in the total sanctuary area taking into account the level of habitat protection in other estuaries.

Human activities

- Number of persons visiting the estuary and their activity, that is, carrying capacity. The physical, social (includes cultural and psychological aspects) and ecological carrying capacities (together grouped as recreational carrying capacity) have not been calculated for the Knysna Estuary and a comprehensive study is required to determine these values; once calculated the TPCs for each would be any value in excess of that capacity. Baseline data can be collected during a survey that records the different types of activities and the respective number of participants on the water and on the bank and the number of registered and unregistered boats on the water. Carrying capacity can be calculated according to a DWAF model but may also be regulated by estuary stakeholders in line with the estuary Vision.
- Bait collecting, including number of collectors, collecting methods, rate of removal, number of licensed operators and adherence to bag limits. The TPC for a decline in bait organisms due to collecting activities which include legal methods (pumps are not recommended for mudprawn as they cause too much damage to the consolidated sediment), digging and trampling of habitats will need to be established. The TPC for licensed operators or compliance should be very high - one person operating outside the law should be cause for concern. Baseline data can be collected as part of a more detailed fishery survey and should include numbers of collectors, collecting sites, methods used, number of bait organisms taken and bait collecting licences. This aspect is also dealt with under Operational Objectives for living resource exploitation.
- Number of fishing competitions. There is no defined TPC for this indicator as a reduction in fish and bait organism populations may not be as a result of fishing competitions alone. However, given the national status of many target fish species, a TPC should be any increase above the baseline in the number of competitions or else the number of participants. Baseline data can be collected over a period of a year where the number of competitions and participants are recorded.
- Litter (solid waste) accumulation. Each estuary is different and the sources of litter vary considerably. Sources on the Knysna are both residents (riparian landowners and resorts), visitors including competition anglers and other recreational users, and the commercial areas including the Central Business District and Thesen's Island. There should be a zero tolerance for litter, so the TPC should be any visible increase in the volume of solid waste in or adjacent to the estuary when compared to baseline data. Baseline data can be collected for the first year and should be measured as volume collected in standard garbage bags after certain activities or times, such as fishing competitions and peak holidays.

Law enforcement

- Number of law enforcement officers assigned to an estuary, the frequency of patrols and number of offences, arrests and convictions in terms of the MLRA. Effective patrolling and adequate numbers of enforcement officers should act as a deterrent to illegal activities and promote compliance. Competent enforcement should also ensure a high conviction rate for offenders. The TPCs for this objective should therefore be the incidence of offenders, with a designated number per month or per patrol being set as the threshold and the rate of convictions in relation to arrests made. The aim would be to reduce the number of offenders to zero such that the TPC would be a single offender at any given time and to achieve a higher conviction rate than that which exists at present. Baseline data would be in the form of existing arrest and conviction rates housed at the SANParks office, frequency

of patrols, aspects that are enforced and the number of offenders. This aspect is also dealt with under Operational Objectives for living resource exploitation.

- Enforcement and monitoring of conditions in terms of records of decision (ROD) for developments as the result of the EIA process. Due to the sensitive nature of estuarine systems, all developments will have a negative impact on their functioning, irrespective of intentions. The TPC for this objective must be very high and even a single offence must be seen as unacceptable. Baseline data is set out in the form of recommendations as a part of the conditions of the ROD; these recommendations must be complied with in order to reduce impacts.

5.2.2 Exploitation of living resources

Operational Objectives for the exploitation of living resources should be targeted at enforcing a sanctuary area which is designed to protect a variety of habitats and species, SANParks enforcement of NEMPAA regulations to protect habitat or resources within designated conservation zones, existing legislation detailed in the MLRA, regulating the activities associated with competition angling, and strict conditions for the running of the oyster mariculture operation.

Sanctuary Area

- All forms of exploitation are prohibited in the designated sanctuary area (Invertebrate Reserve). Baseline information regarding the existing levels of exploitation in the reserve can be obtained from SANParks and Thesen's Island Homeowners Association. The TPC for compliance to this regulation should be very high - one person operating outside the law should be cause for concern.

Exploitation of bait organisms

- Maintenance of bait organism populations through compliance with regulations stipulated in the MLRA (bag limits, collection methods and licences), the sanctuary area management plan and any estuary specific by-laws within the conservation areas. The TPC for compliance should be very high – one person operating outside the law should be cause for concern - while the TPC for populations of bait organisms needs to be established based on baseline density values (reductions may, however also be due to other activities or aspects not related to exploitation). Baseline population density data can be obtained from regular seasonal counts of burrows using random quadrats over an initial two-year period or can be sourced from tertiary and research institutions or published works.

Exploitation of fish

- All fishermen (artisanal and recreational) must be in possession of valid licenses and adhere to all regulations specified in the MLRA. The TPC for compliance to these regulations should be very high – one person operating outside the law should be cause for concern.
- Maintenance of linefish populations or fish abundance, measured as *cpue*, through compliance with MLRA regulations (bag limits, size limits, closed seasons and licenses). The TPC for compliance should be very high - one person operating outside the law should be cause for concern. There are currently no recommended TPCs for *cpue* probably because catch data is not widely available for individual estuaries. TPCs for the decrease in numbers of all species need to be derived, with dusky kob and white steenbras requiring more stringent TPCs then the remaining species. It is important to note, however, that a decline in *cpue* for any species may not be the result of exploitation on the Knysna Estuary alone, that is, it may be a national trend as the resource is widely distributed, and it may also be due to other factors such as water quality or a decrease in food availability. Baseline data can be obtained from a fishery survey conducted for an initial period of two years.

Fishing competitions

- Angling competitions contribute greatly toward the decline of fish and bait organism populations due to the concentration of effort over a short period of time and the above-

average skill of the participants. In order to reduce this impact on fish and bait populations the objective would be to regulate the number of competitions and participants and to adopt a no-kill policy for threatened linefish species. There is no defined TPC for this indicator as fishing competitions alone are unlikely to be the direct cause of the reduction in fish and bait organism populations on a National scale. However, the TPC for compliance to the MLRA and estuary specific regulations during competitions should be very high – one person operating outside the law or competition format should be cause for concern.

Mariculture

The Knysna Oyster Company (KOC) operation should comply with all legislation and conditions (monitoring requirements) relevant to its mariculture activities. Baseline data can be obtained from the company itself, the Municipality, the authority responsible for issuing the authorisation (DEAT: MCM) and institutions involved with research and monitoring in the system. TPCs for several indicators associated with mariculture operations will need to be established (these may vary depending on dilution rates, tidal flushing and currents):

- Chlorophyll-a levels due to potential micro-algal blooms as a result of elevated nutrient levels
- Excessive macrophyte growth due to elevated nutrient levels.
- Dissolved oxygen
- The presence of dead or live culture organisms outside of the concession area.
- Activities related to the culture operation outside of the concession area.
- The visual impact of the operation and the presence of disused oyster racks
- Compliance with aspects of the Record of Decision issued by DEA-DP not covered above.

5.2.3 Water quality and quantity

The NWRS, which provides for the development of a catchment management strategy by a CMA or WUA, will ensure both the classification of the water resource (Knysna system) and the required RQOs. The RQOs for a catchment and its associated riverine and estuarine systems relate to the following aspects:

- The water quantity of fresh water inflow into the estuary (Ecological Reserve); and
- the water quality of fresh water inflow at the head of the estuary and water quality within the estuary.

More specifically, the following components, listed in Chapter 3 (Section 13) of the NWA, form the basis of all RQO determinations:

- The Ecological Reserve (human needs and ecological requirements);
- the instream flow;
- the water level;
- the presence and concentration of particular substances in the water;
- the characteristics and quality of the water resource and the instream and riparian habitat;
- the characteristics and distribution of aquatic biota;
- the regulation or prohibition of instream or land-based activities which may affect the quantity of water or quality of the water resource; and
- any other characteristic of the water resource in question.

These components will in effect form the basis of the Operational Objectives. However, the quantitative, measurable standards, target values and TPCs required for defining these Operational Objectives will only be available for the Knysna system in late 2008 / early 2009. In terms of water quantity, the target values would be in the form of mean monthly flows measured in m^3/sec. Water quality TPCs for both fresh water inflow and estuarine water (due to marine influences) would be expressed in appropriate units for physical/chemical variables (salinity, temperature, pH, dissolved oxygen and turbidity); inorganic nutrients (dissolved inorganic nitrogen

and reactive phosphate); and toxic substances (e.g. total ammonia, arsenic, cadmium, lead, mercury and insecticides).

5.2.4 Land-use and infrastructure

The Knysna SDF contains a number of guidelines related to the future use of available areas within the Municipality. These relate to all aspects of town planning such as the creation of nodes, provision of access and suitable services. The SDF also highlights a number of possible developments and guidelines along the lagoon edge (Knysna SDF, 2007).

The draft SDF has provided the following guidelines for inclusion in the Knysna Lagoon Edge Management Guidelines (Knysna SDF, 2007).

These are as follows:

- *"Low impact eco-tourism facilities and education-related uses could be considered in areas of low sensitivity. Low impact resorts and education-related uses may be acceptable in areas that are not environmentally sensitive;*
- *Where private property falls within areas identified as Core Conservation Areas, unless such land is acquired by conservation authorities, land use is restricted to a low visual and environmental impact dwelling house (and normally associated outbuildings), sited in a position that will minimise environmental impact of both the dwelling house and the access route thereto, to the satisfaction of the Council, in consultation with environmental authorities. Size, finishes and colours of the structures must blend with the surrounding environment to the satisfaction of the above authorities;*
- *A high degree of soft landscaping (soft edges) should be used along the Lagoon edge;*
- *Mobility corridors, such as cycle ways and pedestrian paths should be formalised and encouraged, such as those proposed by SANRAL along Lagoon Road; and*
- *All future developments must adhere to the proposed Urban Edge as shown in the SDF 2007.*

Other potential projects listed in the draft SDF (2007) include the following two which are of importance in relation to the Knysna Estuary. Operational Objectives for this future land use have been provided:

Knysna Lagoon Edge Project which has included the following statements (Knysna SDF 2007):

i) The proposals and policy guidelines include:
- *promoting public access and use of the lagoon edge as an important part of experiencing the key place-making element of Knysna Basin;*
- *promoting public recreation areas at parts of edge where public access exists for the greatest number of residents (public parks, viewpoints, public walking and cycle trails) and that focus on views of the lagoon.*

ii) The proposed planning and design projects include:
- *proceeding with detailed design and construction of Western gateway;*
- *commissioning detailed design for Knysna Multi-purpose Urban Park (public park, picnicking and braai areas, botanical gardens, ablution facilities etc);*
- *commissioning detailed design and construction of the pedestrian / cycle route along the lagoon edge; and*
- *proceeding with incremental development of viewpoints proposed in the SDF;*
- *the proposal to formalise the informal trading site(s) along the lagoon road into Knysna should be pursued.*

iii) The key actions and pilot projects include:

Liaising with potential key role players to be involved in design and construction of walk / cycle way (South African National Roads Agency Ltd, Knysna Municipality, Rotary, etc.);

- *completing the section of the pedestrian / cycle walkway from the Eastern Head to the existing boardwalk (close to the N2);*
- *developing the viewpoints at the end of George Rex Drive and the Western Head road, Northern Areas viewpoints; and*
- *implementing landscaping, public space and trading spaces at the Western Gateway.*

iv) Assessment of development applications:

- *Private development along the edge should not be detrimental to public access to the lagoon. Further applications should be assessed in terms of their ability to increase the extent of the public walkway along the edge of the lagoon.*
- *High and unattractive fencing obscuring views of the public walkways (and thereby increasing its vulnerability for crime) should not be allowed. The River Club is an excellent example of a private resort that has a positive interface with the public walkway, yet retains its private usage for visitors.*

Eastern Lagoon Edge Multi-purpose Park and Pedestrian / Cycle Way

- *Maintain the existing public lagoon edge as public;*
- *Develop the undeveloped elements of Knysna Lagoon Edge Multi-purpose Park:*
  - *Knysna Municipal Sports Complex;*
  - *Braai and picnic area;*
  - *Pedestrian walkway;*
  - *Botanical garden;*
- *Maintain an active interface along George Rex Drive, south of proposed sports complex:*
  - *Ensure public edge (urban / green interface);*
  - *Ensure strong edge definition.*
- *Develop the pedestrian / cycleway between the Eastern Head and the existing path at the northern edge portion of George Rex Drive;*
- *Promote rehabilitation of land south of sewage works for mixed-use development and residential development;*
- *Should the land become available, develop a range of higher density housing on the Municipal Golf Course.*

The above principals or projects discuss guidelines and objectives pertaining to town planning and strategic development. In the interests of this report, it is also important to highlight operational guidelines based on the requirements of the natural ecosystems. The following section deals with proposed Operational Objections that should considered within the Knysna Estuary Management Plan.

The nature and extent of land use and infrastructure associated with the estuary and catchment should be guided by the following:

- Planning should allow for the maintenance of a riparian zone along the length of the estuary; the proposed width of this zone is 100m, or wider of necessary to include sensitive habitats such as supratidal saltmarshes.
- No additional development on the floodplain for safety reasons (floodlines) and sense of place.
- Developments and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary cycles.
- Development proposals should be evaluated through the EIA procedure and guided by the EMP specifically and the broader catchment management plan.

Baseline data would be in the form of town planning schemes or development frameworks (SDF and IDP, for instance) that would need to be compared to a visual display (map) of all activities and infrastructure within the defined estuarine area to ascertain compliance and conformity with the estuary Vision.

- The number of applications for new development and/or rezoning of land associated with the estuary will need careful monitoring. There is currently no quantitative value defining a TPC for this objective's indicator, but any increase in the number of applications compared to the last five years should be cause for concern. It is recommended that all applications be subject to the EIA process and, in addition to the Municipality, all applications should be considered by the local EMI prior to their submission to the authorities. SANParks have been give the authority to review and reject authorisation of developments through the Regulations for the Proper Administration of the Knysna National Lake Area Issued in terms of Section 86(1) of the National Environmental Management: Protected Areas Act, 2003, and will have an important role to play in seeing that the EMP is adhered to. Should applications receive a favourable ROD, the development should be assessed by an independent environmental auditor approved by both the Department of Environmental Affairs and Development Planning (DEA-DP) and the local EMI to ensure compliance. Any deviations from the ROD conditions should be regarded as unacceptable. Baseline data in the form of development/rezoning applications can be obtained from the local municipality; ideally the numbers of applications should decrease as the Vision of the estuary becomes a reality.
- All planning and management tools such as EMPs, SDFs, IDPs, Strategic Environmental Assessment (SEA) and Integrated Environmental Management (IEM) plans in the form of EIAs to guide planning and development. The TPC for this objective indicator would be if estuaries were not considered at all in planning and management documents. The functioning and value of the Knysna system need to be reflected in any regional SEA that is conducted and must be represented in the SDF and IDP in the form of an EMP, and should be a significant factor in any EIA assessment. All decisions regarding development and planning in the estuarine area need to be guided by these planning and management tools. Baseline data is available in the form of current SDF and IDP documents; this EMP; and records showing the extent to which development and planning in the estuarine area have been guided by these tools in the past. A regional SEA is as yet not available.

5.2.5 Institutional and management structures

- Establishment of local EMI to engage government (at all levels) on planning and management issues. Ideally local EMIs should be established at all estuaries where human activities and development impact on the system and should serve in an advisory capacity on issues threatening the integrity of the estuary. The TPC for the Knysna Estuary EMI would clearly be the absence of such a local EMI. Any such EMI needs to reflect the needs and aspirations of all stakeholders and should be represented by all stakeholder groups including local, regional and national government institutions where applicable. The relationship with SANParks Park Forum will need to be established, and perhaps should be incorporated into the EMI.
- Establishment of a CMA, WUA and catchment forum to manage water resources and water related activities in the catchment. Essentially CMAs develop and implement strategies for water resource use according to the NWRS; this would include the RQOs needed to manage water quantity and quality aspects of the EMP. The WUA falls under the CMA and comprises a management committee whose role it is to effectively manage water resource activities on behalf of its members. A catchment forum fulfils a similar function to a local EMI and should ideally be incorporated into the EMI hierarchy within the water use working group. The TPC for the Knysna catchment would be the absence of any such institutions or bodies. Any such agency or association needs to reflect the needs and aspirations of all stakeholders and should be represented by all stakeholder groups including local, regional and national government institutions where applicable.
- Degree of interaction and cooperation between the management of estuaries and the management of catchments. The TPC for this objective would be if the local EMI and the

CMA, WUA and catchment forum did not interact to ensure the management of the catchment and estuarine area as a single ecological entity. Once these institutions have been formed a record needs to be kept of the number and type of projects or initiatives that require cooperation; the more cooperative ventures there are, the more successful this objective will be.

5.2.6 Education and awareness

- Educational workshops hosted by the local EMI or municipality should be organised at least once a year in order to educate local authorities, in particular town planners and municipal managers, and estuarine managers about the value of estuaries, the EMP and its context within planning strategies, the ICMB, and the consequences of irresponsible development within the estuarine area. Potential TPCs would be no workshops, poor attendance at workshops and ongoing poor decision making with regards issues affecting estuaries. A simple questionnaire for local authorities would provide baseline data as to their current awareness level with regards estuarine management.
- The People and Conservation initiatives run by SANParks should continue, and be expanded to public awareness campaigns aimed at all user groups and age groups. The TPCs would be a lack of easily accessible information (pamphlets, sign boards or the continued poor state of some sign boards, particularly around the Invertebrate Reserve), a decline in participation by school groups and a general poor level of understanding of estuaries by the general public. Baseline data should comprise the extent of visual aids within the estuarine area and any public interaction with the local EMI or estuary managers.
- Tertiary and research institutions as well as government departments (such as DWAF and DEAT: MCM) need to be involved in research projects that will address specific management concerns, monitoring requirements and gaps in knowledge. The TPCs would either be a lack of research, a decrease in the number of research projects or the continued lack of data required by monitoring programmes. Baseline data should comprise the number of tertiary institutions involved in research, the areas of research and the aspects that need to be addressed through directed research.

5.2.7 Non-consumptive Use

- Research existing non-consumptive uses and assess the extent to which they comply with existing regulations with a view to identifying problem areas. The TCP would be the research report.
- In consultation with users, review and update existing regulations with regard to non-consumptive uses and develop sustainable social density and zonation restrictions that are incorporated into the EMP. The TCP would be the minutes of the consultative meetings and the decisions made that are incorporated into the EMP.
- Ensure compliance of all existing non-consumptive uses with regulations and social density and zonation restrictions. The TPC would be activities that do not comply with legislation, management plans or planning documents. Baseline data would need to be acquired from a variety of sources including DEA-DP (for ROD on developments), local municipality (for land-use authorisations, conformity with the SDF and IDP, tourism ventures and infringements of estuarine by-laws), DWAF (water quality) and DEAT: MCM (catch monitors and aspects pertaining to living resources). An audit of all activities and developments should be conducted by an independent assessor to determine compliance and the need for corrective measures.

5.2.8 Sustainable livelihoods

- Research and report on a) the nature and distribution of existing livelihoods linked to the estuary, b) the environmental sustainability of these activities, c) assess the significance of the impacts that compliance with all existing legislation and management plans would have on the range of existing livelihoods linked to the estuary and d) identify potential strategies to mitigate these impacts. The TCP would be the research and assessment report.

- Through an inclusive consultative process with all the key stakeholders and user groups, make decisions about what level of consumptive and non-consumptive use of the estuary and its living resources will be supported and permitted and incorporate these into the EMP. The TCP would be the minutes of the consultative meetings and the decisions made that are incorporated into the EMP.
- Ensure compliance of all existing livelihood activities with legislation and management plans that regulate against potential impacts on the estuarine area, its inhabitants and users. The TCP would be activities that do not comply with legislation, management plans or planning documents. Baseline data would need to be acquired from a variety of sources including DEA-DP (for ROD on developments), local municipality (for land-use authorisations, conformity with the SDF and IDP, tourism ventures and infringements of estuarine by-laws), DWAF (water quality) and DEAT: MCM (catch monitors and aspects pertaining to living resources). An audit of all activities and developments should be conducted by an independent assessor to determine compliance and the need for corrective measures.
- Explore and promote the development of new non-consumptive initiatives (including canoe trails, bird watching, hiking trails, tours of historical and cultural interest) that will benefit previously disadvantaged communities (PDCs) and that will comply with legislation and management plans that regulate against potential impacts on the estuarine area, its inhabitants and users. The TPCs would be if no activities involving PDCs were initiated and if those that were initiated failed to comply with legislation, management plans or planning documents. The local EMI would need to involve communities in combination with the municipality, civic based organisations and the tourism industry.

6 MANAGEMENT ACTION PLANS

A full range of management actions have been identified in order to facilitate the achievement of the Operational Objectives within the sectors of ecosystem function and services (exploitation of living resources and conservation, water quantity and quality), land-use and infrastructure, institutional and management structures and social issues (education and awareness, non-consumptive use, and sustainable livelihoods).

Within each of these sectors, the management actions plans (MAPs) include:

- A prioritised list of management actions required;
- All related legal, policy and/or best practice requirements of relevance to specific management actions;
- Monitoring plans to measure effectiveness of actions. If TPCs are brought under control then management actions can be considered effective. However if they continue to be exceeded then changes need to be made to management actions, the EZP or Operational Objectives;
- A work plan identifying when each action should be initiated and by whom; and
- A resource plan detailing the human resources and the sources of funding or finances required to carry out the above.

The MAPs for conservation, living resources, land-use and infrastructure, institutional and management structures, education and awareness, non-consumptive use, and sustainable livelihoods and are detailed in Tables 6-1 to 6-6. Water quantity and quality is dealt with in Section 6.1 below.

Table 6-1 Management Action Plans for Conservation (Biodiversity, Human Activities and Law Enforcement) Strategic Objectives

CONSERVATION (Biodiversity)				
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**	**Resource plan**
Operational Objective B1: Plant communities; TPC will need to be established				
Water quality - determine type and source of problem and initiate steps to alleviate.	NWA (Sections 19 & 21); ICMB (Chapter 8, Section 74), CARA (Sections 6, 8 & 12)	Water quality of river inflow and estuary; toxic substances (from agriculture) in sediment; recovery period (aerial and reference photographs).	As soon as TPC is attained. DWAF responsible for water and sediment quality; DEAT responsible for ICMB; DA responsible for agricultural pollution; EMF or tertiary institutions.	**Human** - DWAF, DEAT & DA personnel; forum members from conservation working group; research students. **Financial** - national government; C.A.P.E.; independent research funds.
Episodic events - none required as nature must be allowed to take its course.	None	Recovery period and shifts in location of plant communities and habitat (aerial and reference photographs).	As soon as episodic event has passed; EMF or tertiary and research institutions.	**Human** - forum members from conservation working group; research students. **Financial** - C.A.P.E.; independent research funds.
Human disturbance - enforce by-laws and EZP to reduce trampling; enforce national legislation to prevent clearing of forests and riparian vegetation.	Municipal by-laws (for EZP); NEMA (Chapters 1 & 5; EIA Regulations); Seashore Act (Sections 3 & 10); NFA (Chapter 3, Section 1); NEM: Biodiversity Act (Chapter 4, Part 1).	Compliance w.r.t. by-laws and national legislation; recovery period (aerial and reference photographs).	As soon as TPC is attained. Responsible agents are DWAF, DEA-DP, DA, DEAT and local authority; EMF or tertiary institutions.	**Human** - National & provincial government personnel; municipal departments; forum members from conservation working group; research students. **Financial** - national & provincial government; municipal; C.A.P.E.; independent research funds.
Operational Objective B2: Alien vegetation infestation; TPC will need to be established				
Initiate clearing of vegetation in affected areas.	NWA (Section 21); NEM: Biodiversity Act Chapter 5, Part 2); NEMA; CARA (Sections 6 & 8)	Ensure eradication of alien vegetation to levels below the TPC (aerial photographs and transects).	As soon as TPC is attained; DWAF, DEAT & DA responsible for alien eradication.	**Human** - DWAF, DEAT & DA personnel (or land owners). **Financial** - national government.
Operational Objective B3: Intertidal invertebrate species; TPC will need to be established				
Water quality - determine type and source of problem and initiate steps to alleviate.	NWA (Sections 19 & 21); ICMB (Chapter 8 Section 74), CARA (Sections 6, 8 & 12)	Water quality of river inflow and estuary; toxic substances (from agriculture) in sediment; recovery period (quadrat counts).	As soon as TPC is attained. DWAF responsible for water and sediment quality; DA responsible for agricultural pollution; EMF or tertiary institutions.	**Human** - DWAF & DA personnel; forum members from conservation working group; research students. **Financial** - national government; C.A.P.E.; independent research funds.
Episodic events - none required as nature must be allowed to take its course.	None	Recovery period and shifts in location of invertebrate communities and habitat (reference photographs and quadrat counts).	As soon as episodic event has passed; EMF or tertiary institutions.	**Human** - forum members from conservation working group; research students. **Financial** - municipal; C.A.P.E.; independent research funds.
Human disturbance - enforce by-laws and EZP to reduce trampling; enforce national legislation to limit bait collection according to quotas.	Municipal by-laws; MLRA (Chapter 3, Section 14).	Compliance w.r.t. by-laws and national legislation; recovery period (quadrat counts).	As soon as TPC is attained. Responsible agents are DEAT:MCM and local authority; EMF or tertiary institutions.	**Human** - national government personnel; municipal departments; forum members from conservation working group; research students. **Financial** - national government; municipal; C.A.P.E.; independent research funds.

Table 6-1 continued

Operational Objective B4: Waterbirds partially or highly dependent on estuaries; TPC for species richness is one species; TPC for loss in div established			
Loss of habitat and food source due to human interference - enforce legislation and by-laws pertaining to EZP and human activities.	MLRA (Sections 14 & 43); NEM: Protected Areas Act (Chapter 4); NEM: Biodiversity Act (Chapter 4, Part 1); Sea Birds and Seals Protection Act (Act 46 of 1973; Section 3b); NEMA (Chapters 1 & 5; EIA Regulations); municipal by-laws (pertaining to EZP); SDF/IDP.	Compliance with national legislation, SDF/IDP and municipal by-laws; recovery of populations (bi-annual bird counts)	As soon as any Responsible auth and municipal; E Lakes Bird Club
Water quality - determine type and source of problem and initiate steps to alleviate.	NWA (Sections 19 & 21); ICMB (Chapter 8, Section 74).	Water quality of river inflow and estuary; toxic substances (from agriculture) in sediment; recovery of populations (bi-annual bird counts).	As soon as any DWAF responsibl quality; EMF, tert Bird Club
Operational Objective B5: Fish abundance; TPC for dusky kob and white steenbras, as well as other species ne			
Address levels of fishing effort, bag limits and extent and location of sanctuary areas.	MLRA (Sections 14 & 43); NEM: Biodiversity Act (Chapter 4, Part 2); NEM: Protected Areas Act (Chapter 3 Section 28).	Compliance with legislation; levels of effort and cpue to be measured (catch monitors and fishery survey).	Continuous from DEAT:MCM is res tertiary institutions
Operational Objective B6: Extent of habitat types and habitat loss; TPC will need to be establis			
Episodic events - none required as nature must be allowed to take its course.	None	Recovery period and shifts in location and extent of habitat types (aerial and reference photographs).	As soon as episod or tertiary institutio
Human interference - ensure compliance with EZP and associated by-laws governing human activities and national legislation; consider additional sanctuary areas to protect habitats.	Municipal by-laws pertaining to EZP; IDP; NEMA (Chapters 1 & 5; EIA Regulations); NEM: Biodiversity Act (Chapter 4, Part 1); NEM: Protected Areas Act (Chapter 3, Section 28; Chapter 4); MLRA (Section 43); CARA (Section 6); Seashore Act (sections 3 & 10); NFA (Chapter 3, Sections 1 & 2).	Compliance w.r.t. by-laws, IDP and national legislation; recovery period and efficacy of sanctuary areas (aerial and reference photographs).	As soon as TPC agents are DWAF and local auth institutions.
Operational Objective B7: Extent and location of formally protected estuarine habitat; TPC is the decline in terms of surf			
Enforce legislation pertaining to protected areas; ensure compliance with EZP and other legislation pertaining to human activities.	NEM: Protected Areas Act (Chapter 3, Section 28; Chapter 4); NEM: Biodiversity Act (Chapter 4, Part 1); MLRA (Section 43); ICMB (Chapter 2, Sections 23 & 24); NEMA (Chapters 1 & 5; EIA Regulations); NFA (Chapter 3, Section 2).	Compliance with relevant legislation to ensure sanctity of protected areas (aerial photographs and active patrols)	Continuous from DEAT and DEA-D authority; EMF can a daily basis to mo

Table 6-1 continued

Management actions	Legal requirements	Monitoring plans	W
CONSERVATION (Human Activities)			
Operational Objective HA1: Carrying capacity (to be determined by EMF based on DWAF models); TPC is when numbe			
Regulate number of boats launching or taking part in a specific activity (e.g. angling competitions).	Operational Policy for Recreational Water Use (DWAF; August 2004)	Visual counts of boats on the water or at each launch site; counts of numbers of users engaged in recreational activities.	Number of users s time; restrictions carrying capacity i at launch sites managers are resp
Operational Objective HA2: Bait collecting; TPC for decrease in population size of any bait organism will nee			
Enforce MLRA regulations to ensure compliance.	MLRA (Section 14; Chapter 6)	Fishery survey to include collectors; random quadrats for population density; inspections of bait collectors catch.	Ongoing from responsible auth compliance; tertia survey with help fr
Police sanctuary areas and no-take zones in the conservation area in accordance with the EZP.	NEM: Protected Areas Act (Chapter 4); MLRA (Chapter 6); Municipal by-laws pertaining to EZP.		
Consider larger no-take areas or control collection times (e.g. daytime only).	NEM: Protected Areas Act (Chapter 3, Section 28); NEM: Biodiversity Act (Chapter 4, Part 1); MLRA (Section 43); Municipal by-laws pertaining to EZP.		
Operational Objective HA3: Number of fishing competitions and participants; TPC is an increase from current number of			
Regulate number of fishing competitions and participants.	Municipal by-laws (regulating recreational activities on estuary); policies of EMF and angling clubs.	Monitor number of competitions and count number of participants.	Use records from municipal nature launch site control
Operational Objective HA4: Litter accumulation; TPC is an increase in volume from baseline va			
Initiate clean-up operations on a regular basis; all boats to return to launch site with litter in plastic bags; and consider implementing punitive measures for responsible individuals or organisations.	NEMA (Chapter 1); NWA (Section 19)	Monitor volume of litter collected by the number of standard garbage bags filled.	Ongoing from tim peak periods, duri competitions; ins DEAT:MCM catch municipality, ge members; clean-u club members combination of inf residents at other
CONSERVATION (Law Enforcement)			
Operational Objective LE1: Law enforcement capacity; TPCs are non-compliant users and a low conv			
Increase presence of law enforcement personnel on estuary; education and awareness programmes for enforcement officers and users.	MLRA (Chapter 6); White Paper for Sustainable Coastal Development (Section C, Chapter 10); ICMB (Chapter 5, Section 37).	Monitor number of patrols and non-compliant users; survey to assess effectiveness of education and awareness programme.	Ongoing from DEAT:MCM is the help from conservation an awareness).
Operational Objective LE2: Enforce and monitor developments in the context of their RODs; TPC is any non-complian			
Enforce compliance with ROD conditions and report any infringements.	All legislation referred to in ROD - this will vary according to nature of development or activity.	Inspections of all sites where activities or developments are taking place; ensure independent environmental control officer is appointed.	Regular (weekly) f development is authority is mostly other government independent envi general public

Table 6-2: Management Action Plans for Exploitation of Living Resources and Mariculture Strategic Obj

EXPLOITATION OF LIVING RESOURCES			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective E1: Protection of marine living resources in sanctuary area; TPC is non-compliance			
Enforce legislation pertaining to the sanctuary area.	NEM: Protected Areas Act; MLRA	Compliance with relevant legislation and management frameworks to ensure sanctity of protected areas; record instances of non-compliance.	Continuous from implementation of E Parks are responsible national autho enforcement personnel to operate o compliance; EMF members and ge reporting incidents of non-compliance
Operational Objective E2: Protection of bait organisms; TPC for any bait organism to be establi			
Enforce legislation and by-laws pertaining to bait collection (closed or rotational areas, bag limits, collection methods, collection times and licenses).	MLRA; NEM: Protected Areas Act; Municipal by-laws.	Inspection of activities and collectors to ensure compliance with MLRA regulations, sanctuary areas and by-laws; record instances of non-compliance.	Continuous from implementation of E Parks are responsible nationa environmental division are responsib appointed enforcement personnel ar staff to operate on a daily basis to active patrols and point access ch general public can assist by rep compliance.
Operational Objective E3: Protection of fish populations; TPCs are non-compliance by user groups; % decline from baseline cpue values for as for all other species			
Enforce MLRA regulations (bag limits, size limits, closed season, licenses and collection methods).	MLRA.	Inspection of activities and fishermen to ensure compliance with MLRA regulations; record number of incidents of non-compliance; measure cpue.	Continuous from implementation responsible authority in conjunction Parks staff. All MLRA appointed operate on a daily basis to monitor patrols and point access checks; rese include compliance monitoring and cp members and general public can ass non-compliance.
Operational Objective E4: Regulate number and format of fishing competitions. TPCs are an increase in competitions and participants and			
Maintain a limited and predetermined number of well structured, regulated fishing competitions.	None except EMP guidelines and angling club policies.	Number of competitions to be determined and monitored; participants to be assessed for compliance with competition rules; record incidents of non-compliance.	Continuous from implementation of responsible authority with help from appointed specialists to recommend assist in measure and release efforts.

Table 6-2 continued

MARICULTURE			
Operational Objective M1: Ensure compliance by Knysna Osyer Company (KOC) with operational requirements; management actions an			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Ensure compliance with regards water quality (nutrients and disolved oxygen) and ininitiate remedial measures if TPCs are exceeded.	Seashore Act; NEMA; ICBM.	Chlorophyll-a levels, macrophyte growth and dissolved oxygen to be monitored.	Weekly water samples taken by KO period; include aditional samples as quantity sampling regime by DWA macrophyte growth (area of coverag (plant community) assessment by EM
Presence of dead or alive culture organisms outside of concession area will require removal.	NEMA; NEM: Biodiversity Act.	Visual assesment of substrate up and downstream of concession area and intertidal areas where debris colects; record frequency of ocurrence and numbers.	Monthly visual surveys by KOC sta officer; *ad hoc* visual surveys durting by SANParks and municipal environm
Prevent culture-related activities from taking place outside of concession area.	MLRA; NEMA; Seashore Act; NEM: Biodiversity Act.	Visual assessment of KOC activitiers to ensure they only take place inside demarcated concession area; record any incidents of non-compliance.	Environmental site officer, SA environmental personnel can monito daily responsibilities; general public c of non-compliance.
Reduce visual impact of culture operation to acceptable levels.	NEMA; Seashore Act.	Record number of complaints from other estuarine users; monitor response from KOC.	Visual impacts are subjective but publ incidents that affect them beyond the SAN Parks or environmental site off complaints and relay to KOC for actio
Ensure compliance with all other aspect of the Record of Decision.	NEMA; Seashore Act.	Regular review of activities to check for compliance with ROD conditions; monitor rehabilitation actions as required.	Environmental site officer appointed assess all ROD conditions on a mo non-compliance to be reported to DI KOC to initiate mitigation actions.

Table 6-3: Management Action Plans for Land-use and Infrastructure and Institutional and Management

LAND-USE and INFRASTRUCTURE			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective LU1: Nature and extent of land-use and infrastructure; TPCs are broad statements of inten			
Maintenance of a riparian zone along the length of the estuary - enforce a zone that is 100 m wide or inclusive of sensitive habitats.	NEM:Biodiversity Act (Chapter 4, Part 1); NEMA (Chapter 5; EIA Regulations); ICMB (Chapter 2 Section 16); SDF/IDP; NEMPAA – SANParks authority section 86(1))	Compliance with legislation restricting activities in this zone; monitor applications for activities within the zone.	Initiate as soon as EMP is implemen DEA-DP and municipality and p responsible; EMF can monitor infringe in any applications.
No additional development on the floodplain - enforce recommendations in planning frameworks; difficult to implement due to size of area and demand for developments..	NEM:Biodiversity Act (Chapter 4, Part 1); NEMA (Chapter 5; EIA Regulations); ICMB (Chapter 2, Section 16; Chapter 3, Section 28); SDF/IDP; CARA (Section 6); NEMPAA – SANParks authority section 86(1))	Compliance with legislation restricting activities in this zone; monitor applications for activities within the floodplain.	Initiate as soon as EMP is implemen DEA-DP, DA and municipality and responsible; EMF can monitor infringe in any applications.
Developments and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary cycles - ensure all developments do not impact negatively on water quality by enforcing relevant legislation.	NWA (Sections 19 & 21); NEMA (Chapter 5; EIA Regulations); CARA (Sections 6 & 12); SDF/IDP; NEMPAA – SANParks authority section 86(1))	Monitor EIA process to ensure all impacts are adequately mitigated; ensure compliance with ROD conditions; monitor water quality parameters according to RQOs; ensure compliance with legislation and planning frameworks.	Initiate as soon as EMP is implemen DEA-DP, DWAF, DA and municipali department of agriculture; EMF, CM infringements and register as IAPs in
Development proposals should be evaluated through the EIA procedure and guided by the EMP specifically and the broader catchment management plan - register as IAP for all development applications and ensure compliance with all legislation.	All legislation controlling aspects of development within the EIA process - this will vary according to nature of development or activity but will include aspects covered by the NWA (Section 19; Chapter 4), NFA (Chapter 3, Section 1), NEMA (Chapter 5; EIA Regulations), CARA (Sections 6 & 12), NHRA (Chapter 2, Parts 1&2), ICMB (Chapter 2, Section 16; Chapter 3, Section 28) & SDF/IDP; Knysna Municipality Open Space System (KMOSS); NEMPAA – SANParks authority section 86(1))	Monitor the EIA process for each application and ensure compliance with all legal requirements.	Initiate immediately - for all new a applications currently under cons municipality are responsible for ensu EIA procedures.
Operational Objective LU2: Number of applications for development and/or rezoning of land within estuarine area; there are no quantitative cause for concern.			
Register as IAP for all development and rezoning applications and ensure compliance with all legislation and planning frameworks.	All legislation controlling aspects of development within the EIA process - this will vary according to nature of development or activity but will include the NWA (Section 19 & Chapter 4), NFA (Chapter 3, Section 1), NEMA (Chapter 5; EIA Regulations), CARA (Sections 6 & 12), NHRA (Chapter 2, Parts 1&2) & SDF/IDP; NEMPAA – SANParks authority section 86(1)).	Record numbers of new applications for comparison to recent years; monitor the EIA process for each application to ensure it fulfills legal requirements.	Register as IAP for all new applica records for compliance regarding olde municipality are responsible for ensu followed.
Operational Objective LU3: Use of planning and management tools to guide development; TPC would be the exclusion of estu			
Ensure that the estuarine area is specifically addressed in all planning and management frameworks.	ICMB (Chapter 4); SDF/IDP (in the form of specific management plans such as EMP and CMS); regional SEAs; NEMPAA – SANParks authority section 86(1)).	Review of all existing planning and management frameworks; monitor progress of all new management and planning documents through direct participation.	Initiate immediately and register EMF organisations that must be consulte input; planning and management co municipality are responsible for ado frameworks.

Table 6-3 continued

INSTITUTIONAL and MANAGEMENT STRUCTURES			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective IMS1: Establishment of a local EMI (forum); TPC would be the absence of such an			
Form a local EMI in the guise of an Estuarine Management Forum	ICMB (Chapter 4)	Monitor progress of EMF and ensure it fulfills its obligations.	Initiate immediately - assemble memb appoint technical working groups; mandate and responsibilities. C.A.P together with specialist consultants.
Operational Objective IMS2: Establishment of CMA, WUA and catchment forum; TPC would be the absence of a			
Form CMA and WUA and associated forum and integrate with the EMF.	NWA (Chapter 2, Part 2; Chapter 8); ICMB (Chapter 4)	Monitor progress of CMA, WUA and forum and ensure they fulfill their obligations; ensure their integration within the EMF.	Initiate immediately - assemble all int (WUA already exists); set mandate a responsible authority together with consultants.
Operational Objective IMS3: Interaction between EMF, CMA, WUA and catchment forum; TPC would be if no integration and interac			
Integrate CMA, WUA and catchment forum representatives with EMF and host regular meetings.	NWA (Chapter 2, Part 2; Chapter 8); ICMB (Chapter 4)	Ensure integration and keep record of number and types of projects or management scenarios that are resolved or addressed cooperatively.	Initiate immediately; integrate CMA, representatives within the EMF (w working group) and identify opportun are themselves responsible for integra

Table 6-4: Management Action Plans for Education and Awareness, Non-consumptive Use and Objectives

EDUCATION and AWARENESS			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective EA1: Educational workshops on value of estuaries, their context within planning frameworks and legislation and conse no workshops, poor attendance or continued poor decision making that affects estuaries.			
Initiate series of workshops (with help from C.A.P.E. and DEAT) and get buy-in from municipality to ensure attendance. Continuation of SANParks People and Conservation Programme	White Paper for Sustainable Coastal Development (Section C, Chapter 10); ICMB (Chapter 5, Section 37).	Keep record of number of workshops and attendance by municipal staff and managers participants to submit to a questionnaire to test awareness, understanding and effectiveness of workshop.	Initiate immediately. DEAT (C responsible for education on a nation can be hosted by C.A.P.E. or the EM group members or specialists fr institutions and to give presentations.
Operational Objective EA2: Interactive public awareness campaign; TPCs would be no visual aids, lack of public interest and poor level of ur govern their well-being.			
Ensure that visual aids (notice boards) are erected at key points (launch sites and resorts, around Invertebrate Reserve); host school groups for interactive tours of the estuary, i.e. continuation of SANParks People and Conservation Programme	White Paper for Sustainable Coastal Development (Section C, Chapter 10); ICMB (Chapter 5, Section 37).	Monitor placing of notice boards and ensure their content is relevant to the Knysna scenario; provide school groups and general public with a questionnaire to determine effectiveness of the programme.	Initiate immediately. DEAT (Co responsible for education on a nation the visual material; EMF or municipal can host school groups and make us research institutions on occasions to g
Operational Objective EA3: Research projects by tertiary and research institutions and government departments; TPCs would be no research required for monitoring programmes.			
Identify key areas where research efforts should be concentrated (e.g. water quality and quantity; fishery survey; and faunal composition and distribution); actively engage government and tertiary and research institutions to initiate projects.	None	Monitor progress of all research activities concerned with the Knysna and ensure that outcomes are practical and effectively used in long term monitoring programmes that will guide the implementation of the EMP.	Initiate immediately; EMF can inte tertiary and research institutions. Gov as DWAF and DEAT may initiate institutions such as CSIR and SAEC term monitoring projects.

Table 6-4 continued

NON-CONSUMPTIVE USES			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective NC1: Research existing non-consumptive uses and assess the extent to which they comply with existing regulatio			
Secure funding for assessment and engage the services of professional researchers/assessors to investigate this issue and report on it.	None	Management to guide, monitor and review activities and outputs of researchers.	Develop proposal, secure funds researchers, and conduct researc report.
Operational Objective NC2: In consultation with users, review and update existing regulations with regard to non-consumptive uses and de restrictions that are incorporated into the EMP			
Consult with stakeholders and decision making	None but should be an inclusive, transparent and open consultation process.	Monitor consultation and decision making process to ensure that they are inclusive, transparent and open.	Initiate on completion of Operationa and hold consultative meetings/ worl Write up comments and views rece for decision making and develop these draft regulations to be review the public before being finalised and
Operational Objective NC3: Ensure compliance of all existing non-consumptive uses with regulations and social densit			
Engage relevant government authorities to address activities that do not comply with legislation and planning frameworks.	Applicable legislation is contained in the NWA (Sections 19 & 21); NEMA (Chapter 5; EIA Regulations); NFA (Chapter 3, Sections 1&2); ICMB (Chapter 2, Section16; Chapter 3, Section 28); CARA (Section 6); NHRA (Chapter 2, Parts 1&2); NEM: Biodiversity Act (Chapter 4); NEM: Protected Areas Act (Chapter 4); SDF/IDP; municipal by-laws and local management plans.	Review all existing activities for compliance with legislation and planning frameworks; monitor all proposed new activities for compliance; monitor reparation where applicable.	Initiate on completion of Operationa of EMF to engage municipality industry and government departm DWAF, DA and DEAT to enforce planning frameworks.

Table 6-4 continued

SUSTAINABLE LIVELIHOODS			
Management actions	**Legal requirements**	**Monitoring plans**	**Work plan**
Operational Objective SL 1: Assess and report on the distribution of impacts that compliance with all existing legislation and manageme livelihoods linked to the estuary and identify potential strategies to mitigate these impacts			
Secure funding for assessment and engage the services of professional researchers/assessors to investigate this issue and report on it.	None	Management to guide, monitor and review activities and outputs of researchers.	Develop proposal, secure funds researchers, and conduct researc report.
Operational Objective SL 2: Through an inclusive consultative process, make decisions about what level and distribution of consumptive and resources will be supported and permitted and incorporate these into the EMP			
Consult with stakeholders and decision making	None but should be an inclusive, transparent and open consultation process.	Monitor consultation and decision making process to ensure that they are inclusive, transparent and open.	Initiate on completion of Operationa and hold consultative meetings/ wor Write up comments and views rece for decision making and develop these draft regulations to be review the public before being finalised and
Operational Objective SL 3: • Ensure compliance of all livelihood activities with legislation and management plans that regulate against poten and users.			
Engage relevant government authorities to address activities that do not comply with legislation and planning frameworks.	Applicable legislation is contained in the NWA (Sections 19 & 21); NEMA (Chapter 5; EIA Regulations); NFA (Chapter 3, Sections 1&2); ICMB (Chapter 2, Section16; Chapter 3, Section 28); CARA (Section 6); NHRA (Chapter 2, Parts 1&2); NEM: Biodiversity Act (Chapter 4); NEM: Protected Areas Act (Chapter 4); SDF/IDP; municipal by-laws and local management plans.	Review all existing activities for compliance with legislation and planning frameworks; monitor all proposed new activities for compliance; monitor reparation where applicable.	Initiate on completion of Operationa of EMF to engage municipality industry and government departm DWAF, DA and DEAT to enforce planning frameworks.
Operational Objective SL 4: • Explore and promote the development of new initiatives that will benefit previously disadvantaged commun management plans that regulate against potential impacts on the estuarine area, its inhabitants and			
Engage community representatives, municipality, civic organisations, tourism industry and other key stakeholders to identify opportunities and ensure they are compliant with all forms of regulation.	Applicable legislation is contained in the NWA (Sections 19 & 21); NEMA (Chapter 5; EIA Regulations); NFA (Chapter 3, Sections 1&2); ICMB (Chapter 2, Section 16; Chapter 3, Section 28); CARA (Section 6); NHRA (Chapter 2, Parts 1&2); NEM: Biodiversity Act (Chapter 4); NEM: Protected Areas Act (Chapter 4); SDF/IDP; municipal by-laws and local management plans.	Monitor progress with regards initiation of new activities and their compliance with regulations; monitor reparation where applicable.	Initiate on completion of Operationa of EMF to engage all stakeholders and draft operational frameworks to

6.1 Water Quantity and Quality

As the Knysna Estuary Reserve Determination Study is not yet complete, the Operational Objectives for water quantity and quality cannot be clearly defined at this moment (see Section 5.2.1). MAPs together with implementation and monitoring plans therefore cannot be formulated at this stage. As a result of the Reserve study, a monitoring programme for the estuary will be drafted, from which the Operational Objectives and implementation plans for the EMP should be drawn. Implementation of the monitoring programme will primarily be the responsibility of DWAF. At this stage, the monitoring programme report is due for release in January 2009.

Typically the indicators, for which TPCs would be set in a water quality and quantity monitoring programme would include the following (McGwynne and Adams 2004; Taljaard and Van Niekerk 2007b):

- River (freshwater) inflow measured at gauging weirs above the head of the estuary;
- Continuous water-level recording at the estuary mouth;
- Frequency and duration of episodic events;
- Sedimentation and changes in bathymetry;
- Concentrations of water quality parameters in river inflow;
- Concentrations of constituents that determine water quality;
- Concentrations of toxic substances;
- Salinity distribution patterns under different river-flow ranges;
- Turbidity; and
- Frequency of occurrence and location of:
    - fish and invertebrate mortalities
    - macro- and microalgal blooms
    - pollution (solid waste) and surface contaminants
    - areas with bad smells

In time, when all aspects of the RQOs for the Knysna Estuary become available either through DWAF initiatives or specific research programmes run through tertiary institutions, the water quantity and quality components of the EMP can be addressed in detail.

7 IMPLEMENTATION

The implementation of the EMP itself is not the responsibility of government *per se* (although government agencies must be involved), but is instead the responsibility of the local EMI in the form of a forum of all stakeholders headed by an elected chairperson and guided by working groups representing the major management aspects, namely living resources and conservation, water quantity and quality, land-use and infrastructure, institutional and management structures, and social and cultural (education and awareness, non-consumptive use, sustainable livelihoods). The EMI serves to keep all stakeholders informed of the progress and effectiveness of the EMP, identifies areas of concern and makes management recommendations that may need to be incorporated into the EMP, liaises with government departments to ensure they fulfil their legal obligations, and interacts with tertiary and research institutions to help coordinate research programmes. The EMI and its members may also be directly involved with monitoring programmes by collecting data (physical measurements or visual observations) and can act as the eyes and ears for law enforcement authorities. All members of the EMI must be provided with a list of contact numbers to be called in the event that they observe anyone who fails to comply with the EMP requirements. In fulfilling its obligations within this project, CES is essentially undertaking the role that should be played by a properly constituted local estuarine management institution (EMI).

Guidelines for the establishment of an EMI are summarised in the section following (from Van Niekerk and Taljaard 2007).

7.1 Establishment of a Local Estuarine Management Institution

The process of establishing a local EMI is initiated by a competent local authority or NGO who should organise a meeting of all relevant government authorities and interest groups who have a direct stake in the well-being of the estuary. In the case of the Knysna Estuary it is recommended that as the authorised management authority, SANParks should organise the meeting and insure that the following institutions and interest groups are included:

- The national DEAT (MCM);
- The provincial Department of Environmental Affairs (DEA-DP);
- The Catchment Management Agency (CMA);
- The regional DWAF;
- The Department of Agriculture;
- The local municipal authority (Knysna Municipality);
- The district municipal authority (Eden Municipality);
- Municipal Nature Conservation Services (CapeNature, SANParks);
- The local Tourism Body;
- The local Heritage Association;
- The Knysna Catchment Management Forum;
- The local estuarine concern groups (Wildlife Environmental Society of Southern Africa, Knysna Environmental Forum);
- The Ratepayers' Association;
- Local developers and industries;
- Local landowners or resort managers;
- Local angling or fishing groups (Knysna Angling and Diving Association);
- Non-governmental organisations (NGOs);
- Community-based organisations (CBOs); and
- Ecological, social and resource-economic specialists (Knysna Basin Project).

The role of SANParks Park Forum should be reviewed and incorporated in to the EMI. The local EMI that is to be established at the meeting must consist of the following:

1. An **Estuarine Management Forum** (EMF) comprising representatives of all the above institutions and interest groups. Existing institutions such as CMAs, WUAs or catchment forums and conservancies may be used instead of establishing a new separate forum, but these would need to be expanded to include representatives from all interest groups.
2. A **chairperson** elected by the forum who will take the lead in the development and implementation of the EMP.
3. **Technical working groups** (with a group leader to coordinate activities) for each of the following sectors:
   a. Conservation;
   b. Social (and cultural) issues;
   c. Land-use and infrastructure development;
   d. Water quantity and quality; and
   e. The exploitation of living resources.

Each of these working groups should have representatives from the relevant government departments who have executive powers in terms of legislation that is specific to each sector, for instnace living resources should be represented by DEAT:MCM; conservation by DEA-DP; land-use and infrastructure by Department of Agriculture and the Municipality; and water quantity and quality by DWAF. These working groups will be responsible for addressing issues specific to their responsible sectors that have been raised by the forum. The leaders of each working group may also be used as an intermediary between forum members or members of the public who wish to report incidents and the chairperson who can then liaise with relevant authorities to address the specific concern.

Although members of the CES project team will be available on an advisory basis during the initial implementation of the EMP, the management plan's long-term implementation will become the responsibility of the local EMI.

7.2 Responsibilities and Resources

At present the responsibility for managing estuaries lies with SANParks, as referred to in section 57 of the NEMPAA. However, the estuary represents the lowest point in Knysna and runoff and wastewater in its immediate surrounds gravitate towards the estuary. SANParks ability to monitor, manage and control the sources of water / wastewater that enter the estuary is limited due to the scope of its mandate and the shear number and diversity of such sources. The Knysna Municipality thus has a role to play in regulating the discharge of wastewater into the estuary, as does the Eden District Municipality Environmental Health Department, who are charged with ensuring the health of Knysna's citizens and tourists in the area. DWAF is responsible for catchment related issues and water quantity and quality requirements, while a combination of other government agencies are indirectly involved via responsibilities associated with legislation that regulates activities that may impact on the estuarine area and its resources (living and non-living). These include national DEAT: MCM, DEA-DP (NEMA and EIA regulations), Department of Agriculture (CARA), SAHRA (NHRA) and local and district municipalities (SDFs and IDPs). All management actions detailed in the MAPs need to be executed within the legal or policy frameworks that are described by these legal and planning instruments. Some may only be enforced by representatives from the relevant government agency, but others may be enforced by staff appointed in terms of regulations in the Act to act on behalf of a specific agency.

The participation of all levels of government in the management of estuaries is important, but in the context of the Knysna EMP, as the management authority of the Knysna National Lake Area as referred to in Section 57 of the NEMPAA, SANParks will have a major role to play. Constraints on SANParks' ability to manage wastewater discharges into the estuary, and the roles of the local and district municipalities in this respect is referred to above, but the Knysna and Eden Municipalities' environmental conservation and town planning divisions will have key roles, since they can provide guidance and ensure compliance with regards the local SDF and IDP frameworks. SANParks, through the implementation of Regulations for the Proper Administration of the Knysna National Lake Area Issued in terms of Section 86(1) of the National Environmental Management: Protected Areas Act, 2003 (Sections 6(1) – (7), 16(1) – (5), 17(1) – (5)), will have developmental authorisation capacity in the biological control area (area comprising the water area, a water resource and State land within the Knysna National Lake Area). If the EMP is not used to guide the SDF and ultimately incorporated into the IDP then its objectives and vision will never be realised. Although the ICMB provides the legal context for the need for an EMP, it is the responsibility of individual municipalities to ensure they embrace the ideals of the EMP and fulfil their obligation to ensure its successful implementation via the SDF and IDP. Once the EMP is incorporated into the Garden Route National Park Management Plan, it will have further legal context through the NEMPAA.

SANParks have recently appointed more park rangers, and this will assist in the implementation of the NEMPAA regulations, as well as those of the MLRA. Whether further rangers and capacity is required will have to be determined by the EMI and SANParks. There is no reason to believe that town planning within the Knysna Municipality requires additional personnel to deal with the EMP recommendations with regards land-use and infrastructure. The guidelines are clear and all that is required is that the existing personnel exercise their mandates within the legal framework governing land-use. The environmental division, however, needs to build its capacity. The KEPMAP project was devised but never implemented due to a lack of capacity, and this needs to be addressed. The finances for this will most likely need to come from municipal funds but, due to the importance of the Knysna Estuary in a national context, effective governance should be a priority. Should this not be the case it needs to be addressed by the EMI. All municipal environmental officers as well as the existing SANParks and DEAT catch monitors need to attend the relevant courses and be appointed in terms of the MLRA regulations to enforce the provisions

of that Act.

7.3 Five-Year Plan

As this report will not be the final EMP produced, but will provide a foundation for the development of the Knysna Estuary Management Plan sector of the Garden Route National Park Management Plan, the timeframes given are general indications for progress after the finalisation of the Garden Route National Park Management Plan. Should sections be omitted from this plan, they will obviously no longer be relevant. It is recommended that the following aspects of the eventual EMP be implemented as a matter of priority **within a year** after finalisation of the Garden Route National Park Management Plan:

- Establish a local EMI that is representative of all stakeholders, interest groups and relevant government departments.
- Ensure that the EMP is accepted by the municipality and incorporated into the SDF and IDP frameworks.
- Establish zoning of the estuary in accordance with the EZP.
- All aspects relating to land-use and infrastructure within the estuarine area.
- Appoint all SANParks field rangers in terms of the MLRA regulations to enable them to enforce the provisions of the Act.
- Identification of monitoring and research requirements, with a detailed fishery survey to be initiated by a research institution.

The following aspects of the EMP should be addressed within the time frames indicated:

- MAP for water quantity and quality - defining the RQOs for the Knysna catchment and estuary is the responsibility of DWAF, and although a project is currently underway it is likely that these will only be available in 2009. Once the RQOs have been defined the MAP can be drafted; this should ideally happen within the next year but may only be possible during the **second year**.
- Investigate the feasibility of using locally generated funds for management and EMI activities, for example boat launching or competition levies used for river patrols or monitoring of fishing activities by the end of the **second year**.
- Initiate all other monitoring programmes and coordinate with research projects where appropriate within the **next three years**.
- All outstanding aspects pertaining to the MAPs for all conservation, living resources and management and institutional arrangements within the **next three years**.
- The education and awareness programmes within the **next three years**.
- Regulation of existing livelihoods and the identification of additional non-consumptive use opportunities involving members of previously disadvantaged communities within the **next four years**.

The EMP in its current form will be reviewed **after five years**. It will be the responsibility of the EMI executive team to produce a State-of-the-Estuary Report, which essentially involves revisiting the Situation Assessment and Evaluation that was performed in Phase I of this project. This will be followed by a round of revision and/or refinements of the Objective-setting and Implementation phases (Figure 2-1) as and where necessary - it may, for example, be necessary to adjust aspects of an MAP or monitoring programme.

8 MONITORING AND EVALUATION

8.1 Monitoring

There are two components to monitoring, namely baseline measurement programmes and long-term monitoring programmes, and it is important to note the difference between them in the context of the EMP framework (Taljaard and van Niekerk 2007b). Baseline measurement programmes usually refer to short-term or once-off, intensive investigations of a wide range of parameters to

obtain a better understanding of ecosystem functioning; they may also involve the investigation of non-ecological data to determine an existing situation with regards to compliance, land-use patterns, institutional and management structures, alternative livelihoods and education and awareness initiatives. These programmes would normally be a part of the Situation Assessment and Evaluation and the Objective-Setting Phases within the framework. In the context of this EMP baseline data is required in order to determine the TPCs for the management actions described in the MAPs.

Long-term monitoring programmes refer to ongoing data-collection programmes that are done to continuously evaluate the effectiveness of Management Strategies and management actions within MAPs that are designed to maintain a desired environmental state. Data from these programmes is used to determine or anticipate when particular TPCs have been or will be exceeded, so that responses to potentially negative impacts, including cumulative effects, can be implemented in good time. Long-term programmes usually involve biotic and abiotic components concerned with the bio-physical aspects such as water quantity and quality, conservation and living resources. However, accumulated data from baseline programmes associated with land-use and infrastructure, management and institutional structures, education and awareness, non-consumptive use and sustainable livelihoods and can be analysed over the long-term as well to ensure that the Vision for the Knysna Estuary is achieved and maintained. Long-term programmes often form part of detailed scientific surveys or research projects conducted by tertiary and research institutions, but they may also take the form of less complex initiatives such as fisheries regulations compliance and activities in the context of the EZP or municipal by-laws.

8.1.1 Baseline programmes

A detailed description of the baseline requirements, spatial and temporal scales, required resources and sampling and analysis techniques with regards the TPCs referred to in the MAPs (Section 6; Tables 6-1 to 6-6) is provided in Tables 8-1 to 8-4 below (see McGwynne and Adams, 2004). Some aspects of these baseline programmes, such as *cpue* and population (invertebrates and birds) monitoring will also form part of long-term programmes (see Section 8.1.2 below).

8.1.2 Long-term monitoring

The long-term monitoring programmes described in this section (Table 8-5 to 8-7) were initially developed to determine the requirements for the Ecological Reserve and then to assess the effectiveness of the prescribed Reserve (see Taljaard and Van Niekerk, 2007b). However, in most instances data from these programmes can also be used as indicators of other management concerns where the Ecological Reserve specifically is not responsible for the observed pattern or scenario. For example, the long-term monitoring of fish could reveal a decline in biodiversity or species richness that could be due to RQO parameters but could equally be due to human activities such as fishing, episodic events causing habitat change, seasonal migrations, national trends in fish populations or large-scale fluctuations in climate.

Unlike many of the baseline programmes where data can be gathered and in many instances analysed by EMF members, long-term monitoring programmes tend to be the responsibility of government departments such as DWAF and DEAT who usually contract the services of tertiary and research institutes such as CSIR, the South African Institute for Aquatic Biodiversity (SAIAB), the South African Environmental Observation Network (SAEON), Knysna Basin Project and Universities. However, at all times the EMF executive should be involved so as to ensure that programmes will be beneficial to the effective implementation of the EMP.

Long-term monitoring programmes for the following components are proposed, namely hydrology, sediment dynamics, hydrodynamics, water and sediment quality, microalgae, macrophytes, invertebrates, fish and birds. The protocols for carrying out these programmes has been taken from Taljaard and Van Niekerk (2007b) and adapted to suit the Knysna scenario where applicable.

Table 8-1: Baseline programmes for Conservation (biodiversity, human activities and law enforcement)

CONSERVATION (BIODIVERSITY)					
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Scale**	**Sampling and Analysis**
B1: Maintenance of plant communities.	Area of cover; TPC relating to reduction in area covered by any plant community type to be defined.	**Human** - members of EMF or municipal environmental officer. **Budget** - cost of aerial and/or reference photographs.	The designated estuarine area; should include sand and mudbanks for sediment distribution patterns.	Aerial photographs every 5 years for Situation Assessment; reference photographs bi-annually for seasonal variation at selected sites.	Aerial photos from Dept. of Surveys and Mapping; reference photos from fixed elevated positions at low tide. Surface area of each community type plotted on a map; habitat type and plant cover at reference sites plotted; XY graphs of plant community area for each season over 5-year period.
B2: Control of alien vegetation.	Area of cover; TPC relating to riparian area infested with alien vegetation to be defined.	**Human** - DWAF. **Budget** - cost of aerial photographs and reference transects.	Riparian region within the designated estuarine area and the greater catchment.	Aerial photographs every 5 years for Situation Assessment; reference transects at disturbed sites annually.	Aerial photos from Dept. of Surveys and Mapping; reference transects at disturbed or cleared sites. Surface area of indigenous and alien vegetation plotted on a map every 5 years; XY graphs of vegetation type against year in disturbed areas to track recovery.
B3: Maintenance of invertebrate populations (mudprawn, sandprawn and bloodworm).	Population densities; TPC to be defined	**Human** - members of EMF; more likely students or staff from tertiary or research institute. **Budget** - research funding from tertiary or research institutions.	Several representative habitats for major invertebrate species, including control sites where human activities are excluded.	Seasonal; recommendation for mudprawn is January, June and September.	Random quadrats above low spring tide level where number of burrows are counted; seasonal sampling to include breeding and recruitment seasons. Baseline data set may be set up after 2 years; plot XY graphs of number of burrows against time of year. Reasons for decrease may not be human induced and could be due to natural variation.
B4: Maintenance of waterbird populations.	Species richness; TPC is loss of a single species. Species diversity; TPC to be defined. Bird numbers; TPC to be defined.	**Human** - members of EMF and Lakes Bird Club; students or staff from tertiary or research institute. **Budget** - research funding from tertiary or research institutions; subsidy from CWAC at UCT.	Reference sites in the prominent bird saltmarshes.	Twice yearly in winter (June-July) and summer (January-February).	Counts to be done over spring low tide period and outside peak disturbance periods and record prevailing conditions; counting areas mapped and representative of a range of estuary habitat types. Plot species richness, diversity and numbers against time of year and habitat type; long-term period (5 to 10 years) is required to allow for detection of natural fluctuations; detailed analysis to be done by CWAC.
B5: Maintenance of fish populations.	CPUE; TPC for dusky kob and white steenbras to be defined as for all other species.	**Human** - DEAT:MCM catch monitors; students or staff from tertiary or research institute. **Budget** - research funding from tertiary or research institutions; funding from DEAT for increased catch monitor capacity.	Water body within the designated estuarine area.	Ongoing for catch monitors; research project comprising fishery survey to be conducted every 5 years.	Boat inspections and shore patrols in the form of roving creel surveys; access point inspections; weekdays, weekends and holidays to be included; catch (number and weight) and time fished is relevant data. CPUE to be plotted against time for each species; analysis of research data and catch monitors data can be combined.
B6: Maintenance of estuarine habitats.	Area of cover and degree of fragmentation; TPC related to reduction in area covered by any habitat type (overlap with B1 as this includes floral habitats) to be defined.	**Human** - members of EMF or municipal environmental officer. **Budget** - cost of aerial and/or reference photographs (already accounted for in B1).	Designated estuarine area.	Aerial photographs every 5 years for Situation Assessment; reference photographs bi-annually for seasonal variation at selected sites.	Use same photos as described for B1. Data is analysed and presented as for B1, i.e. habitat types plotted on map and XY graphs for each habitat type for each season over 5-year period. Loss of habitat may be due to human activities or natural cycles.
B7: Protect estuarine habitats in formally protected areas.	Proportion of various habitat types under protection; TPC would be a reduction in this proportion on a National scale.	**Human** - DEAT:MCM or municipal environmental officer; specialist consultant for analysis. **Budget** - DEAT or C.A.P.E. funding for cost of survey, annotated maps or photos and specialist analysis.	Designated estuarine area and sanctuary areas in other CFR estuaries.	Annotated maps or aerial photographs every 5 years.	Aerial photos from B1 and B6 can be used and annotated with habitat type and extent within formally protected areas. Analysis needs to be done in the context of habitat types protected in other CFR estuaries and should be done by DEAT or C.A.P.E.

Table 8-1 continued

CONSERVATION (Human Activities)				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Scale**
HA1: Ensure carrying capacity of estuary is not exceeded.	Number of recreational users in each sector; TPC is when carrying capacity is exceeded.	**Human** - members of EMF or municipal environmental officer. **Budget** - counts can be done as part of normal daily activities or responsibilities, i.e. no additional cost.	Designated estuarine area; may be limited to specific zones based on type of activity in accordance with the EZP.	Twice a month outside of peak p (weekday and weekend day) and o week during peak holiday periods.
HA2: Control human activities that impact on invertebrate (bait organism) populations.	Population densities; TPC to be defined. Compliance with regulations (bag limits, collecting methods licenses, closed areas); TPC is continued instances of non-compliance.	**Human** - MLRA appointed personnel; members of EMF; students or staff from tertiary or research institute. **Budget** - research funding from tertiary or research institutions.	Designated estuarine area.	Once a week during the neap and s tide cycles for population density daily for compliance.
HA3: Protect linefish and bait organism populations by restricting fishing competitions.	Number of competitions and participants; TPC is an increase in current numbers.	**Human** - members of EMF; DEAT catch monitors; municipal environmental officer; launch site managers; and angling club committees. **Budget** - counts can be done as part of normal daily activities or responsibilities, i.e. no additional cost.	Designated estuarine area, in particular launch sites.	Once a year when applications t competitions are submitted municipality.
HA4: Reduce the amount of litter (solid waste) within the estuarine area.	Volume of litter measured in standard garbage bags.	**Human** - members of EMF; municipal environmental officer. **Budget** - can be done as part of normal daily activities or responsibilities, i.e. no additional cost.	Designated estuarine area, in particular the water body and immediate riparian area.	During or after each organised ev least once a month during peak p and twice during the year outside o periods.
CONSERVATION (Law Enforcement)				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Scale**
LE1: Improve law enforcement capacity.	Incidence of non-compliance and high conviction rate; TPC is an increase in incidents of non-compliance with MLRA and a decrease in conviction rate.	**Human** - MLRA appointed officials. **Budget** - can be done as part of normal daily activities or responsibilities, i.e. no additional cost.	Designated estuarine area.	Once a year.
LE2: Compliance with RODs issued as part of EIA process.	Incidence of non-compliance; TPC is any form of non-compliance.	**Human** - DWAF and DEA-DP officials; independent environmental control officer appointed in terms of the ROD; EMF members as registered IAPs. **Budget** - part of normal responsibilities for government departments; developer pays for environmental control officer.	Designated estuarine area.	Depends on number of developmen RODs issued.

Table 8-2: Baseline programmes for Exploitation of Living Resources (including Mariculture)

EXPLOITATION OF LIVING RESOURCES				
Objective	**Indicator and TPC**	**Resources Required**	**Spatial Scale**	**Temporal Sca**
E1: Ensure sanctity of sanctuary area through compliance monitoring.	Incidence of non-compliance; TPC is any form of non-compliance.	**Human** - DEAT:MCM or SANParks and MLRA appointed personnel; EMF members and general public to report incidents of non-compliance. **Budget** - part of daily responsibilities for SANParks and MLRA appointed personnel.	Designated sanctuary area (invertebrate reserve).	Daily by SANPark MLRA app personnel; i reporting by members and g public is on *ad hoc*
E2: Maintenace of viable bait organism populations.	Population densities; TPC to be decided	**Human** - DEAT:MCM or SANParks and research institute personnel. **Budget** - part of daily responsibilities for DEAT:MCM or SANParks; research funds.	Designated estuarine area.	Population de three times a (January, June September) spring-tide cycles.
E3: Maintenance of fish populations.	CPUE; TPC to be decided	**Human** - DEAT:MCM or SANParks and other MLRA appointed catch monitors; students or staff from tertiary or research institute. **Budget** - part of daily responsibility for DEAT:MCM or SAN Parks; research funding from tertiary or research institutions.	Water body within the designated estuarine area.	Ongoing for SA and and MLRA app staff; research comprising fishery to be conducted e years.
E5: Restrict number of competitions and participants and maintain high level of compliance with MLRA regulations and competition-specific rules.	Number of competitions and participants; TPC is an increase above existing levels. Compliance; TPC would be any incidents of non-compliance with MLRA and competition-specific rules.	**Human** - EMF executive; MLRA appointed personnel; angling club committee members. **Budget** - part of current responsibilities for MLRA appointed staff; any expenses by EMF executive to be covered by competition levies.	Designated estuarine area.	Compliance during competition; num competitions to decided at the s each year.

Table 8-2 continued

MARICULTURE				
Objective	**Indicator and TPC**	**Resources Required**	**Spacial Scale**	**Temporal Sca**
M1: Ensure compliance by the KOC with all aspects relating to ROD and operational requirements.	Indicator for nutrient levels are chlorophyll-a and macrophyte growth; TPCs to be decided	**Human** - Environmental site officer and KOC staff; SANParks and EMF; tertiary and research institutions. **Budget** - KOC; C.A.P.E.; research funding from tertiary or research institutions.		Weekly samples fo chlorophyll-a and dissolved oxygen p additional seasona samples as part of quality monitoring; macrophyte growth assessed once a y part of plant comm monitoring.
	Dissolved oxygen; TPC to be decided			Weekly samples fo dissolved oxygen p additional seasona samples as part of quality monitoring.
	Presence of dead or alive culture organisms outside concession area; TPC is the occurrence of any stray organisms.			Monthly.
	Culture-related activities outside of concession area; TPC is the occurrence of any such activities.			*Ad hoc*.
	Number of reports from other estuarine users with regards visual impacts; TPC is subjective-related but more than one complaint about the same issue should be cause for concern.			Ongoing.
	Compliance record with ROD conditions; TPC is any incident of non-compliance.			Ongoing.

Table 8-3: Baseline programmes for Land-use and Infrastructure and Institutional and Management Stru

LAND-USE and INFRASTRUCTURE				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Sca**
LU1, 2 & 3: Nature and extent of land use and infrastructure and use of management frameworks to guide develo				
Maintenance of riparian zone.	Compliance with legislation and 100 m buffer zone; TPC is any infringements within this zone.	**Human** - DEA-DP, DWAF & DA officials; environmental control officer appointed in terms of the RODs; municipal environmental officer and town planning; members of EMF. **Budget** - part of normal responsibilities for government departments; developer pays for environmental control officer and rehabilitation.	Estuarine waterways and 100 m buffer zone adjacent to banks.	Visual monitoring done on an *ad ho* during normal daily a or responsibilities.
Restrict additional development on the floodplain.	Number of applications for new developments within the floodplain; TPC is any new applications for development.	**Human** - Municipal environmental officer and town planning; members of EMF. **Budget** - part of normal responsibilities or daily activities for municipal departments; C.A.P.E. funding for EMF.	Floodplain within the designated estuarine area measured to the 5 m contour above MSL.	Visual monitoring done on an *ad ho* during normal daily a or responsibilities.
Maintenance of water quality and normal hydrodynamic and sedimentary cycles.	RQO parameters; TPC would be any activity that negatively impacts on the RQOs.	**Human** - DEA-DP and DWAF personnel; environmental control officer appointed in terms of the RODs. **Budget** - part of normal responsibilities for government departments.	Designated estuarine area and catchment.	Bi-annual for DWA form part of more long-term m programme) and ong DEA-DP and E activities are appro ROD issued.
Land-use and development proposals evaluated through EIA procedure and guided by EMP and CMP. Record number of applications for development or rezoning. All proposals should be evaluated in accordance with the SDF and the Knysna Municipality Open Space System (KMOSS).	Compliance with EIA procedure and adherence to EMP and CMP and KMOSS ideals; TPC is non-compliance in this regard and lack of regard for management framework recommendations. Number of applications; TPC is an increase in applications for development or rezoning.	**Human** - DEA-DP, DWAF and DA personnel; representatives of EMF and CMF/WUA. **Budget** - part of normal responsibilities for government departments; costs for IAP registration and participation by EMF and CMA/WUA from C.A.P.E. or levies charged for recreational activities.	Designated estuarine area and catchment.	Ongoing; exact tim depend on applications for activ received by DEA-DP or DA.
INSTITUTIONAL and MANAGEMENT STRUCTURES				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Sca**
IMS1 & 2: establishment of EMF and catchment institutions such as CMA, WUA and catchment forum.	Presence of institutions; TPC would be the absence of such institutions.	**Human** - C.A.P.E. and DWAF personnel. **Budget** - part of normal responsibilities for DWAF C.A.P.E. Estuaries Programme.	Estuarine area for EMF and catchment for CMA, WUA and catchment forum.	Must happen immed
IMS3: Interaction between EMF and catchment institutions.	Integration and interaction between institutions; TPC would be institutions operating in isolation.	**Human** - C.A.P.E. Programme coordinator and institutional representatives (chairpersons). **Budget** - C.A.P.E. Estuaries Programme.	Designated estuarine and catchment area.	Assess once a year.

Table 8-4 Baseline programmes for Education and Awareness, Non-consumptive Use and Sustainable

EDUCATION and AWARENESS				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Sca**
EA1: Increase awareness of estuaries and their value amongst municipal workers and managers.	Attendance at workshops and questionnaire; TPC would be poor workshop attendance and failure to complete questionnaire.	**Human** - DEAT:MCM with assistance from EMF executive and specialists from tertiary and research institutes. SANParks People and Conservation Programme **Budget** - National government (DEAT) and C.A.P.E. SANParks People and Conservation Programme.	Knysna municipality.	Once a year.
EA2: Increased public awareness of estuaries and their value.	Number of public notice boards, number of school groups and questionnaire; TPC would be no visible notice boards, few school tour groups and continued public ignorance.	**Human** - DEAT:MCM with assistance from municipal environmental staff and EMF executive and specialists from tertiary and research institutes. SANParks People and Conservation Programme **Budget** - National government (DEAT) and C.A.P.E. SANParks People and Conservation Programme	Designated estuarine area.	Once a year.
EA3: Research projects initiated that fill knowledge gaps and provide information for monitoring programmes.	Number of research projects; TPCs would be few research projects and continued lack of data for monitoring programmes.	**Human** - EMF executive. **Budget** C.A.P.E.	Designated estuarine and catchment area.	Once a year.
NON-CONSUMPTIVE USE				
NC1: Research existing non-consumptive uses and assess the extent to which they comply with existing regulations with a view to identifying problem areas	Research Report	Need funding from EMF and competent human resources to undertake research and write report	Settlements around the estuary where resource users live and work.	Initiate immediately
NC2: In consultation with users, review and update existing regulations with regard to non-consumptive uses and develop sustainable social density and zonation restrictions that are incorporated into the EMP	Workshop and Decisions made that are incorporated into the EMP.	Need funding from EMF and competent human resources to facilitate consultation process and to write up outcomes and regulations	Settlements around the estuary where resource users live and work.	Initiate on comple Operational Ob SL1.
NC3: Ensure compliance of all existing non-consumptive uses with regulations and social density and zonation restrictions	Compliance with legislation and planning and management frameworks; TPC would be any non-compliance or conformity.	**Human** - Various municipal departments; tourism representatives; resort managers; homeowners association representative; EMF executive. **Budget** - Part of normal responsibilities for municipality, resorts, homeowners and tourism operators; C.A.P.E. for EMF involvement.	Settlements around the estuary where resource users live and work.	Initiate on comple Operational Ob SL2. Ongoing acti

Table 8-4 continued

SUSTAINABLE LIVELIHOODS				
Objective	**Indicator and TPC**	**Resources**	**Spatial Scale**	**Temporal Sca**
SL 1: Assess and report on the distribution of impacts that compliance with all existing legislation and management plans would have on the range of existing livelihoods linked to the estuary and identify potential strategies to mitigate these impacts	Assessment Report	Need funding from EMF and competent human resources to undertake research and write report	Settlements around the estuary where resource users live and work.	Initiate immediately
SL 2: Through an inclusive consultative process, make decisions about what level and distribution of consumptive and non-consumptive use of the estuary and it living resources will be supported and permitted and incorporate these into the EMP	Workshop and Decisions made that are incorporated into the EMP.	Need funding from EMF and competent human resources to facilitate consultation process and to write up outcomes and regulations	Settlements around the estuary where resource users live and work.	Initiate on comple Operational Ob SL1.

Table 8-5: Long-term monitoring programmes for hydrology, sediment dynamics, hydrodynamics and water and sediment quality

SEDIMENT DYNAMICS			
Sediment grabs for particle analysis.	Entire estuary at 1000 m intervals.	Every 5 years and after flood events.	Difference between long-term equilibrium patterns and short term variations need to be determined. Sediment processes are better monitored over the long-term and floods may be infrequent and their effects only recorded in the long-term.
Sediment cores for historical characterisation.	Entire estuary at 1000 m intervals elsewhere.		
Bathymetric surveys for mouth dynamics and cross-sectional profiles.	Entire estuary at 1000 m intervals elsewhere.		
Sediment loads.	Head of the estuary.	Ideally daily records; once per week may suffice.	
HYDRODYNAMICS			
Record river inflow at flow-guaging station.	Head of the estuary.	Continuous.	Construction of flow-guaging weirs must not impede migratory movements of aquatic organisms. Baseline data for inflow and water level are required for initial reserve determination and a minimum 5-year data set is recommended.
Record water level.	Mouth area and four stations along estuary length.		
Aerial photographs.	Entire estuary if possible otherwise mouth area.	Annually.	
WATER and SEDIMENT QUALITY			
River inflow - measure system variables, nutrients and toxic substances.	Head of the estuary.	Monthly.	Water quality parameters depend on riverine and marine waters and biochemical processes. Baseline data for water quality should be obtained from a minimum 5-year data set. Toxic substances accumulate and integrate over time, therefore sediments would provide the best evidence of elevated levels or build-up. Data collection can coincide with biological monitoring programmes to help with interpretation of biotic data.
Nearshore marine environment water quality at the mouth; from literature.	Immediate vicinity of mouth or general nearshore/surf zone conditions.	N/A	
Estuary water quality - measure salinity, temperature, system variables and inorganic nutrients.	Ten stations equally spaced along estuary and one each in river and surf zone.	Seasonal and/or at times during biological surveys.	
Measure parameters at effluent discharge sites.	At discharge site prior to entering estuary.	Weekly.	
Sediment samples for toxic substances (trace metals, hydrocarbons, pesticides and herbicides).	Estuarine area where fine sediments have recently been deposited.	Once every 5 years or after flood events.	

Table 8-6: Long-term monitoring programmes for microalgae, macrophytes and invertebrates

MICROALGAE			
SAMPLING PROCEDURE	**SPATIAL SCALE**	**TEMPORAL SCALE**	**COMMENTS**
Phytoplankton biomass - duplicate samples at surface and 0.5 m depths for chlorophyll-a; cell counts for species composition and distribution.	Ten stations equally spaced from mouth to head of the estuary.	Initially a summer and winter sample two years after EMP implementation; summer and winter samples every three years thereafter.	Combine sampling times when water and sediment quality studies are done; also coincide with invertebrate sampling to help with interpretation of zooplankton data.
Benthic microalgae -intertidal and subtidal samples for chlorophyll-a; determine relative abundance of dominant species.			
Measure salinity, inorganic nutrients, sediment particle size distribution and organic content and light penetration at each site.			
MACROPHYTES			
Aerial photographs - record number of plant community types, area covered by each, historical changes in community distribution and size and extent of anthropogenic impacts.	Entire estuary	Initially a summer survey two years after EMP implementation; summer surveys every three years thereafter. If aerial photographs are available for intermediate period these should be analysed too.	The following plant habitat types are relevant to the Knysna Estuary: open surface water, intertidal sand and mudbanks, submerged macrophyte beds, macroalgae, intertidal and supratidal salt marsh and reed and sedges.
Field data for ground truthing of aerial photographs - record number of plant community types, area covered by each, species list within each community and extent of anthropogenic impacts.			
Permanent transects at reference sites to record changes in plant habitats and quadrats to determine percentage change in species composition within communities. Specific data along transects to include elevation and water level, water salinity and turbidity, sediment salinity, composition and moisture content.	At least two transects each in lower and middle reaches covering dominant habitats, e.g. salt marshes, zostera beds and reeds/sedges. Additional transects as needed where communities sensitive to freshwater flow are located.		
INVERTEBRATES			
SAMPLING PROCEDURE	**SPATIAL SCALE**	**TEMPORAL SCALE**	**COMMENTS**
Zooplankton - quantitative duplicate samples at night during neap tides using net trawls pulled diagonally across the estuary; record species composition and abundance. Collect phytoplankton and benthic microalgae at each site for chlorophyll-a analysis.	One station in the river; other stations within defined salinity zones (0-10ppt, 10-20ppt and 20-35ppt); minimum of ten stations along estuary length. Stations in each zone should include dominant habitats, bird feeding areas and areas vulnerable to changes in river inflow.	Initially a summer and winter sample two years after EMP implementation; summer and winter samples every three years thereafter.	High variability in invertebrate response to flow and rapid changes in community composition and species abundance requires a long-term data set for baseline data. Sampling stations should try overlap macrophyte sites to link invertebrate patterns to habitat types. Coordinate sampling with water and sediment quality surveys for cost-effectiveness and interpretation of patterns.
Benthic invertebrates - subtidal samples collected by grab; intertidal samples using core-sampler or quadrat counts for burrow densities; minimum of five replicates per site. Identify all to species level, record densities and abundance and if *Zostera* is present. Sediment samples at each site to be analysed for particle size and organic content.			
Macrocrustaceans - replicate quantitative benthic sled samples at same stations used for zooplankton at neap tide; can also set prawn/crab traps overnight (difficult to quantify). Identify to species level and record species composition and abundance.			

Table 8-7 Long-term monitoring programmes for fish and birds

FISH			
SAMPLING PROCEDURE	**SPATIAL SCALE**	**TEMPORAL SCALE**	**COMMENTS**
Fish community - sampling gear needs to suit habitat types. Seine and gill nets will be primary gear, but also otter trawls (deep channels), cast nets and Fyke nets (strong flow and dense vegetation). Record species composition, abundance, distribution and length frequencies. Sub-samples may be required for feeding, reproduction and genetic studies.	Stations in the river and at least ten spread over representative salinity zones (0-10ppt, 10-20ppt;20-30ppt and 30-35ppt); stations in each zone must include all major habitats.	Initially a summer and winter sample two years after EMP implementation; summer and winter samples every three years thereafter. Additional sampling after any fish kill and two months later.	Non-destructive sampling to be carried out where possible, i.e. measure and release. Multiple gears are required to ensure entire community is sampled. Sampling should coincide with water quality surveys. Fish are good indicator species and respond rapidly to changes in flow regime but may be more tolerant to substances that are harmful to other organisms (plants and invertebrates) and may also not be as susceptible to pollutants or other toxins as they are mobile and can swim away.
Fish behavior - acoustic tagging studies on the dusky kob may be implemented to determine the movement behavior and residency time of large individuals in the Knysna Estuary.	Estuarine area.	Intensive surveys during period when acoustic tag is active.	Labour intensive but with clear implications for the resource on a National level. Can form part of a network of estuaries where similar tagging studies are being conducted.
BIRDS			
SAMPLING PROCEDURE	**SPATIAL SCALE**	**TEMPORAL SCALE**	**COMMENTS**
Divide estuary into sections based on habitat type and within each section at low tide record species and abundance (special note of rare or endangered species), state of habitat, level of human activity/disturbance, breeding activity and nesting sites.	Estuarine area and floodplain including surf zone at mouth to beyond backline breakers and 500 m either side of mouth.	Summer and winter count every year.	Sections where counts take place must be labeled as "distance from mouth"; summer counts to be done outside of holiday period, preferably February/March; annual counts are required to detect cycles of variability which may have a three-year periodicity; seasonal counts required for migratory species; collaborate with Lakes Bird Club and club counts; birds are good indicator species for large permanently open estuaries.

8.2 Evaluation

Evaluation of the EMP will become the responsibility of the local Estuarine Management Institution. Ideally technical working groups responsible for the major components, namely conservation and living resources, water quantity and quality, land-use and infrastructure, institutional and management structures and social and cultural issues (education and awareness, non-consumptive use, sustainable livelihoods) should evaluate the efficiency of the EMP in the context of their area of responsibility. It is essential that representatives from the CMA are included within the EMF structure to address the RQO-related issues.

The evaluation process will be carried out every five years when a State-of-the-Estuary Report (Situation Assessment), which utilises the data from monitoring programmes, will indicate whether the Vision and Strategic Objectives have been achieved. In a situation where this has not been achieved, the EMF executive will need to determine which aspects of the EMP need to be altered in order to rectify these shortfalls. Usually this will involve the adaptation of Management Strategies or aspects of the MAPs themselves, although the problem may be with implementation (capacity and finance). Monitoring programmes may also be altered to supply specific data to fill existing knowledge gaps.

9 RESEARCH

The following research needs that should fill the knowledge gaps and provide supplementary data for monitoring programmes involved with the exploitation of living resources have been identified and should be initiated at the soonest possible moment. The local EMI may approach tertiary and research institutions such as Universities, CSIR, SAIAB, SAEON and the Knysna Basin Project to create an awareness of what is required. There may be a degree of overlap with the long-term monitoring programmes defined above.

- Assess the influence of hydrodynamics on the recruitment of both invertebrates and vertebrates into the Knysna Estuary (study should focus on both the influence of marine and freshwater on the recruitment dynamics of estuarine fauna).
- Assess the influence of human disturbances on the population structure of invertebrates associated with submerged beds of macrophytes within the different reaches of the estuary.
- Examine the nutrient dynamics within the estuary, with particular reference to the role of nutrient cycling within the submerged beds of macrophytes. Clearly the reduction in fresh water inflow into the estuary has been associated with decline in the overall availability of macronutrients within the systems.
- Examine the potential influence of global climate change on the ecosystem dynamics within the estuary. Recent studies suggest that global climate change is likely to be associated with changes in the coastal rainfall and in disturbances in the oceanographic regime, including increases in sea water temperature. Such changes are likely to be associated with an extension in the home range of several species, including invasive species.
- Fishery survey comprising both bait and fish. Key elements include fishing/collecting effort, *cpue*, user dynamics, target fish species, catch composition, bait utilisation in relation to existing regulations (waste), motivation for using resource, economic value of the fishery, degree of compliance and conflict between different fishing fraternities.
- Invertebrate organisms primarily used for bait. Key elements should include densities (in and outside sanctuary areas and in control areas), recovery periods after disturbance (collecting and trampling that alter habitat), community structures before and after disturbance, effect of pollutants in the sediment, mortality due to birds foraging after collection activities, effect on birds by bait collectors (both use same area at low tide) and larval settlement times and location along the tidal cross-section (avoid these areas at specific times).
- The carrying capacity of the estuary needs to be determined so that the EMI can make an informed decision about the numbers of users from each stakeholder group utilising the system at any given time. Some data can be collected as part of the fishery survey, but some aspects such as sense of place, pollution due to engine emissions and incidents of confrontation between all user groups will need to be addressed by a dedicated project.
- A comparison between biodiversity and habitat health within the sanctuary area compared to the conservation areas in the rest of the system. An aspect that should be included is the response of communities (plant and animal) to freshwater pulses, instream flows and contaminants in order to monitor the efficacy of the recommended RQOs.

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