C.A.P.E. Estuaries Management Programme

KNYSNA ESTUARY MANAGEMENT PLAN
PART I: SITUATION ASSESSMENT

Prepared for:

CapeNature

Prepared by:

Coastal & Environmental Services

GRAHAMSTOWN	EAST LONDON	DURBAN
046 622 2364	*043 742 3302*	*031 312 4800*
P.O. Box 934	2 Marine Terrace,	9 Humped Road,
Grahamstown, 6140	Hampton Court	Durban, 4001
	East London, 5201	

South Africa

www.cesnet.co.za

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Acronyms and Abbreviations

CAPE	Cape Action for People and the Environment
CD: RDM	Chief Directorate: Resource Directed Measures
CES	Coastal and Environmental Services
CFR	Cape Floristic Region
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CPUE	Catch per Unit Effort
CSIR	Council for Scientific and Industrial Research
DEA&T	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
ECA	Estuarine Conservation Areas
ECPB	East Cape Parks Board
ELWST	Extreme Low Water Spring Tide
EMA	Estuarine Management Areas
EMP	Estuary Management Plan
EPA	Estuarine Protected Areas
EWR	Ecological Water Requirements
FSA	Full Supply Area
FSC	Full Supply Capacity
GA	General Authorisation
GIS	Geographical information Systems
ha	Hectare
HWST	high water of spring tide
I&AP	Interested and Affected Parties
IDP	Integrated Development Plan
ISP	Internal Strategic Perspective
KADA	Knysna Angling and Diving Association
KEPMAP	Knysna Estuary Pollution Management Action Plan
kg	Kilogram
MAR	Mean Annual Runoff
MEC	Member of Executive Council
MCM	Marine and Coastal Management
MLRA	Marine Living Resources Act
MTO	Mountain To Ocean
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
NPB	National Parks Board
NSRI	National Sea Rescue Institute
NWA	National Water Act
NWRS	National Water Resource Strategy
OCWSS	Outeniqua Coast Water Situation Study
PES	Present Ecological State
PG&DS	Provincial Growth and Development Strategy
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
SAFCOL	South African Forestry Corporation Limited
SANParks	South African National Parks

SBPR	Spawner Biomass per Recruit
SCUBA	Self Contained Underwater Breathing Apparatus
SDF	Spatial Development Framework
TL	Total Length
WESSA	Wildlife and Environmental Society of South Africa
WC/WDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WSDP	Water Services Development Plan
WWF	World Wildlife Foundation
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 General 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 some form of 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 of officials from C.A.P.E., CapeNature, Marine and Coastal Management (MCM), the Department of Water Affairs and Forestry (DWAF), the Eastern Cape Parks Board (ECPB) and the Council for Scientific and Industrial Research (CSIR), which heads the technical support group.

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

Approximately 62 estuaries exist within the CFR. These vary from small relatively simple systems to large complex systems. In order to create a focal area within which the programme can be initiated, six priority estuaries were identified at a stakeholder workshop (proceedings available on request). These priority estuaries are located on the following six rivers: the Olifants, Breede, Heuningsnes, Klein, Knysna and Gamtoos.

Coastal & Environmental Services (CES) has been contracted by CapeNature to address the development and implementation of the Knysna Estuary Management Plan. This report fulfils the requirements of Objective 1, namely the Situation Assessment.

1.2 Terms of Reference

OBJECTIVE 1: SITUATION ASSESSMENT

The consultant is expected to review all existing local information in the form of local research reports and management processes. This information can be obtained from Local Authorities and forums. A map of the estuary should be developed identifying different habitats and potential and existing management zones. The map should identify and record all developments in at least a 500m zone surrounding the estuary. The possible direct impacts of these and other local developments should be noted.

The description of the current situation should include information on:

- Legal requirements relevant to the specific estuary
- Requirements stipulated under existing institutional Management Strategies such as Catchment Management Strategies, Integrated Development Plans (IDPs) (including Strategic Development Frameworks (SDF) and Water Development Services Plan), Ramsar

& National Heritage Site Strategies, Protected Area & Conservation Plans (C.A.P.E. Estuaries) relevant to the specific estuary
- the Biophysical environment (present Ecological Health & Important physical processes)
- the Socio-Economic environment (e.g. demographics & economic profile, land-use and planning provisions, cultural & heritage resources, water supply & demand, waste management etc.)
- Conservation Planning
- The Exploitation of living resources
- Mariculture activities
- Resource Directed Measures, e.g. Classification, Reserve etc.
- Current institutional structures governing estuarine issues

The estuary should be represented spatially in the form of a Geographical Information Systems (GIS) map indicating the following:

- Important biophysical features
- All protected/conservation areas
- Areas earmarked for rehabilitation
- Land-use and planning provisions of surrounding lands
- Infrastructure
- Cultural & heritage sites
- Recreational activities
- Living resource exploitation
- Mariculture activities
- Wastewater discharges
- Stormwater drains
- Solid waste dump sites

Finally, an assessment of the opportunities and constraints (e.g. legal obligations, constraints of tenure, prior usage, health and safety, natural hazards) should be done to guide the development of the EMP.

1.3 Project Team

Overall responsibility for the project lies with CES, whilst the project team consists of a number of in-house staff as well as CES Associates, detailed in Table 1-1.

Table 1-1: Project team

Name of Staff	Firm	Position Assigned	Task Assigned
Bill Rowlston	Coastal & Environmental Services	Team Leader	Overall team leader, legal policy review, report and management plan review
Ben Cobbing	Coastal Support Services	GIS / Spatial Planning Specialist	GIS mapping
Maura Andrew	Coastal & Environmental Services	Social Specialist	Stakeholder engagement / facilitation and review, social and resources assessment
Prof William Froneman	Rhodes University	Estuary Ecologist	Estuarine ecology assessment
Dr Patsy Scherman	Coastal & Environmental Services	Freshwater Ecologist	Water quality and quantity assessments, freshwater ecosystem studies
Dr Aidan Wood	Gleneagles Environmental Consulting	Living Resources Specialist	Assessment of living resource importance and use
Dr Brian Colloty	Coastal & Environmental Services	Conservation Initiatives	Conservation initiatives, habitat and integrity mapping
Mike Jennings	Coastal & Environmental Services	Project Manager, Water Quality Requirements	Day to day management, water quality requirements, report writing
Bronwyn Palmer	Coastal & Environmental Services	Stakeholder Liaison	Stakeholder database, GIS mapping
Lungisa Bosman	Coastal & Environmental Services	Stakeholder Liaison	Stakeholder database and interaction

2 LEGAL REVIEW

Detailed analysis of all the laws that have direct or indirect relevance to the management of the estuary is beyond the scope of the present Terms of Reference. Two previous analyses of the regulatory environment as it relates to estuaries [1], one of which was itself a consolidation and refinement of three earlier studies, have clearly indicated the complexity of the inter-relationships between and among a very large number of regulatory instruments at international national, provincial and local levels.

Accordingly we have chosen to provide information, at a range of levels of detail, on a variety of regulatory instruments - legislation, regulations, strategies, plans and guidelines – that we believe can be applied to provide a basis upon which the estuary can be effectively managed, particularly with regard to affording estuaries protection from environmental threats.

Policies were not considered in the review. Although policy documents can act as interpretative tools or decisional referents in relation to environmental decision-making (Smith et al, 2005), the major policies relating to estuaries have been given legal significance in their associated legislation. They are, in any case, dealt with in the C.A.P.E. Estuaries Guideline noted below.

The review deals successively with legislation, institutional management strategies, and institutions.

2.1 Legal Provisions Relevant to the Specific Estuary

2.1.1 National Environmental Management Act (107 of 1998)

The Act is of general application throughout South Africa. Relevant provisions therefore apply to the Knysna Estuary.

Regulations made in terms of the Act require certain activities with potential impacts on the environment, socio-economic conditions and the cultural heritage to be authorised by a competent authority. A prerequisite for authorisation is that the impacts of the activities must be considered, investigated and assessed. These activities are listed in the *List of activities and competent authorities identified in terms of sections 24 and 24d of the National Environmental Management Act, 1998*, Government Notices R.386 (applications subject to basic assessment) and R.387 (applications subject to scoping and environmental impact assessment), 21st April 2006 in terms of Parts 2 and 3 respectively of *Regulations in terms of Chapter 56 of the National Environmental Management Act, 1998*, Government Notice R.385, 21st April 2006.

Many of the listed activities have the potential to affect the estuary. There is a specific provision in R.386 (basic assessment) in respect of the construction of facilities or infrastructure, including associated structures or infrastructure, in close proximity to a river or stream (see 1(m) below), but river or stream is not specifically defined (either in the Act, the regulations or the lists of activities) to include an estuary.

Some listed activities refer to activities that take place within 100 metres inland of the high-water mark of the sea, and sea is defined in R.386 and R.387 as including the water and the bed of any tidal river and tidal lagoon.

[1] G*uideline document on environmental legislation applicable to CapeNature's activities,* Nicholas Smith & Associates Environmental Law Specialists, 2005, and *C.A.P.E. Estuaries Guideline 1: Interpretation of legislation pertaining to management of environmental threats within estuaries*, C.A.P.E. Generic Management Plan, CSIR Stellenbosch, Version 1, May 2007

Listed activities in R.386 of direct potential relevance to the management of the estuary are:

- The construction of facilities or infrastructure, including associated structures or infrastructure, for –
- Aquaculture production, including mariculture and algae farms, with a product throughput of 10 000 kilograms or more per year (R.386 – 1 (i));
- Any purpose in the one in ten year flood line of a river or stream, or within 32 metres from the bank of a river or stream where the flood line is unknown, excluding purposes associated with existing residential use, but including (i) canals; (ii) channels; (iii) bridges; (iv) dams; and (v) weirs (R.386 – 1(m))
  Note: This restriction on any activity within close proximity to a river or stream effectively includes many of the listed activities.
- The off-stream storage of water, including dams and reservoirs, with a capacity of 50 000 cubic metres or more, unless such storage falls within the ambit of the activity listed in item 6 of Government Notice No. R. 387 of 2006 (R.386 – 1(n))
- The outdoor racing of motor powered vehicles including … (v) boats and (vi) jet skis (R.386 – 1(r)).
- Construction or earth moving activities in the sea or within 100 metres inland of the high-water mark of the sea, in respect of (a) facilities for the storage of material and the maintenance of vessels (b) fixed or floating jetties and slipways (c) tidal pools (d) embankments (e) stabilising walls (f) buildings or (g) infrastructure (R.386 – 2)
- The prevention of the free movement of sand, including erosion and accretion, by means of planting vegetation, placing synthetic material on dunes and exposed sand surfaces within a distance of 100 metres inland of the high-water mark of the sea (R.386 – 3)
- The dredging, excavation, infilling, removal or moving of soil, sand or rock exceeding 5 cubic metres from a river, tidal lagoon, tidal river, lake, in-stream dam, floodplain or wetland (R.386 – 4)
- The removal or damaging of indigenous vegetation of more than 10 square metres within a distance of 100 metres inland of the high-water mark of the sea (R.386 – 5)
- The excavation, moving, removal, depositing or compacting of soil, sand, rock or rubble covering an area exceeding 10 square metres in the sea or within a distance of 100 metres inland of the high-water mark of the sea (R.386 – 6)
- The decommissioning of a dam where the highest part of the dam wall, as measured from the outside toe of the wall to the highest part of the wall, is 5 metres or higher or where the high-water mark of the dam covers an area of more than 10 hectares (R.386 – 11)
- The transformation or removal of indigenous vegetation of 3 hectares or more or of any size where the transformation or removal would occur within a critically endangered or an endangered ecosystem listed in terms of section 52 of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (R.386 – 12)
- The abstraction of groundwater at a volume where any general authorisation issued in terms of the National Water Act, 1998 (Act No. 36 of 1998) will be exceeded (R.386 – 13)

The Western Cape Department of Environmental Affairs and Development Planning, Chief Directorate: Environmental and Land Management, has produced a useful guide to the interpretation of the listed activities in its series of guideline and information document s on the NEMA Environmental Impact Assessment Regulations - *Guideline on the interpretation of the listed activities*, November 2006 – which, among other things, compares the requirements for basic assessment and scoping / environmental impact assessments of activities of similar nature. The Guideline also includes a useful analysis of other relevant legislation.

2.1.2 National Environmental Management: Integrated Coastal Management Bill (B40-2007)

The Bill is currently in the parliamentary process. It is expected to be promulgated early in 2008. When it comes into force it will be of general application throughout South Africa. Relevant provisions will therefore apply to the Knysna Estuary.

The Bill aims to regulate the management of the entire coastal zone of the Republic, where management includes protection, conservation and rehabilitation of the coastal environment, regulation and management of the use and development of the coastal zone and coastal resources, monitoring and enforcing compliance with laws and policies that regulate human activities within the coastal zone, and planning in connection with the activities in the coastal zone.

The coastal zone comprises coastal public property, the coastal protection zone, coastal access land and coastal protected areas, the seashore, coastal waters and the exclusive economic zone. The definitions of the various components of the coastal zone, and the ways in which they may be altered, by whom, and under what circumstances, are not at all easy to understand. In particular, it is not clear where estuaries fit into the overall scheme of things. Under certain circumstances an estuary may be included in the definition of coastal waters, whilst coastal wetlands, lakes, lagoons or dams are included in the coastal protection zone. A previous version of the Bill included a provision for the National Estuarine Management Protocol (see Section 2.2 following) to give guidance on how the boundaries of estuarine management areas may be determined, but this provision does not appear in the version (B40-2007) currently in the parliamentary process.

Despite the lack of clarity noted above, since the Bill includes the specific requirement for estuaries to be managed in accordance with estuarine management plans (see Section 2.2 following), it is clear that estuaries are regarded as an important part of the coastal zone, and are intended to fall within the ambit of the law. A full analysis of to determine the implications of the law for estuaries is recommended when it is promulgated.

The Bill also sets out the institutional arrangements, and describes a framework of national, provincial and local (municipal) protocols, plans and programmes, for the management of the coastal zone (see Section 2.2 following).

2.1.3 National Water Act (36 of 1998)

The Act is of general application throughout South Africa. All relevant provisions therefore apply to the Knysna Estuary.

The management of water resources is a residual legislative competence of the National Government in terms of the Constitution. There are no provisions for delegating or assigning any powers or duties in respect of the management of water resources to the provincial or local spheres of government. These spheres of government do, however, have obligations in terms of the Act, particularly local government, since local authorities are major users of water to meet their constitutional mandate to provide water services to consumers in their areas of jurisdiction.

Definitions (Chapter 1)

The Act defines an estuary in s1 -

(ix) ``estuary'' means a partially or fully enclosed body of water -

(a) which is open to the sea permanently or periodically; and

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

Note: The authors of *Proposed generic framework for Estuarine Management Plans, September 2007* (CSIR, 2007) consider this to be the most appropriate definition for use in developing an EMP.

In s1(xxvii) the definition of a water resource includes an estuary. All relevant provisions relating to water resources therefore include estuaries, unless the context of the provision makes it clear that a provision cannot be applied to an estuary.

Strategies (Chapter 2)

The Act requires the Minister to establish a national water resource strategy (… the Minister must …) – see Section 2.2 following.

A catchment management agency must establish a catchment management strategy – see Section 2.2 following.

Protection of water resources (Chapter 3)

The Minister must prescribe (by regulation) a system for classifying water resources, to classify all significant water resources in accordance with the system, and to determine the Reserve and Resource Quality Objectives (RQO) for the water resource in accordance with its class.

Note that the Act provides for a Reserve and associated resource quality objectives to be determined before the classification system is established and implemented: such a determination is referred to as a preliminary determination.

In this respect, draft regulations for the classification system have been published for public comment [2], and a medium-confidence Reserve (preliminary) determination is in progress for, among others in the Outeniqua system, the Knysna River and Estuary.

Water use (Chapter 4)

Water use is defined very broadly in the Act, as follows –
S21. For the purposes of this Act, water use includes:

(a) taking water from a water resource;
(b) storing water;
(c) impeding or diverting the flow of water in a watercourse;
(d) engaging in a stream flow reduction activity contemplated in section 36;
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
(g) disposing of waste [3] in a manner which may detrimentally impact on a water resource;
(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
(i) altering the bed, banks, course or characteristics of a watercourse;
(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

Sub-sections (a), (c), (f), (j) and (k) relate to activities that could directly impact on an estuary, and are self-explanatory, whilst (b), (d) and (e) relate to land-based activities that could indirectly affect an estuary (respectively, the construction of an impoundment upstream of the estuary, commercial afforestation in the catchment, and irrigation of any land or recharging an aquifer with waste or water containing waste, all of which can affect the quantity and quality of the water in the river, and therefore the estuary

All water use requires authorisation, via Schedule 1 (which deals with very small quantities of water taken for, mainly, domestic use), a general authorisation (s39) or a licence (s40).

Existing general authorisations are discussed in the section following.

[2] The public comments are currently (December 2007) being considered by DWAF, prior to submitting them to the parliamentary process required in the Act in respect of regulations.

[3] Note that "waste" includes sediment in terms of the definition in s1(xxiii)

The issue of a licence requires consideration of a number of factors (s27), including the likely effect of the water use to be authorised on the water resource and on other water users, and the class and the resource quality objectives of the water resource.

All general authorisations and licence carry conditions (s29) relating, among many other things, to relating to the protection of the water resource in question; and the stream flow regime.
Authorisations to use water must therefore explicitly take into account the Act's measures to protect water resources discussed previously. n some cases the prospective user can be required to undertake an assessment of the impacts of the proposed use.

General Authorisations (GA) in terms of the NWA

The Department of Water Affairs and Forestry has established geographically-differentiated general authorisations [4] as follows:

- Revision of general authorisations in terms of section 39 of the National Water Act, 1998 (Act No. 36 of 1998), Government Notice No. 399, 26th March 2004.

The GA covers water use in terms of s21 of the NWA as follows –

(a) Taking water from a water resource

The GA does not apply to wetlands, or to an exclusion zone of 750 metres inland from the high water mark.

Surface water: The whole of the Knysna catchment (K50) is specifically excluded from the GA, the implication being that any new surface water abstraction will require a licence.

Groundwater: The Knysna catchment lies in Zone E (table 1.2), which allows 400m^3 per hectare to be abstracted from groundwater.

(b) Storing water

Up to 50 000 cubic metres of water may be stored, provided it does not impact on a water resource or any other person's water use, property or land; is not excessive in relation to the capacity of the water resource and the needs of other users, and is not detrimental to the health and safety of the public in the vicinity of the activity.

(e) Controlled activity - Irrigation of any land with waste or water containing waste generated through any industrial activity or by a waterwork

In addition to detailed requirements in respect of the physico-chemical characteristics of the waste, and general requirements for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity, irrigation may not take place within the 100 year flood line, or alternatively, less than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, which ever is further; or on land that overlies a Major Aquifer.

(f) Discharge of waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit

and

(h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process

The GA specifies the physico-chemical characteristics of the waste and volumetric limits for the discharge, beyond which a licence is required.

There is a general requirement for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity.

The GA specifically excludes complex industrial wastewater.

[4] The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary. A general authorisation may be restricted to a particular water resource, a particular category of persons, a defined geographical area or a period of time.

Note that the GA specifically prohibits any person from discharging stormwater runoff from any premises containing waste, or water containing waste emanating from industrial activities and premises, into a water resource.

(g) Disposing of waste in a manner which may detrimentally impact on a water resource

The GA deals with the storage of domestic and/or biodegradable industrial wastewater for the purpose of re-use or disposal.

It establishes volumetric limits for storage and disposal, beyond which a licence is required.

There is a general requirement for the activity not to impact on a water resource or any other person's water use, property or land; and not to be detrimental to the health and safety of the public in the vicinity of the activity.

The GA limits the disposal onto land of stormwater to stormwater runoff from any premises not containing waste or wastewater from industrial activities and premises.

Wastewater storage dams and wastewater disposal sites must be located: outside of a watercourse; above the 100 year flood line, or alternatively, more than 100 metres from the edge of a water resource or a borehole which is utilised for drinking water or stock watering, which ever is further; and on land that does not, overlie, a Major Aquifer.

All the above require the water use to be registered with DWAF, and all require some form of monitoring programme to be implemented, and may require information to be submitted to DWAF at regular intervals.

- General authorisations in terms of section 39 of the National Water Act, 1998 (Act no 36 of 1998), Government Notice No 398, 26th March 2004.

  The GA covers water use in terms of s21 of the NWA as follows –

(c) Impeding or diverting the flow of water in a watercourse

The GA does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland, or to any estuary or any water resource within a distance of 500 meters upstream from the salt water mixing zone of any estuary, implying that such activities will require a licence.

(i) Altering the bed, banks or characteristics of a watercourse

The GA does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland, or to any estuary or any water resource within a distance of 500 meters upstream from the salt water mixing zone of any estuary, implying that such activities will require a licence.

Regulations in terms of the NWA

- Regulations requiring that a water use be registered (s26 and s69), Government Notice No.R.1352, 12th November, 1999:

  This is relevant only in a general sense, in that the registration process was intended to identify all water users (in terms of abstraction of water and, to a limited extent, some aspects of waste discharge), and the nature and extent of their use.

  Registration was the first step towards general licensing of all water use, one of the main prerequisites for achieving equitable and sustainable water use.

- Draft Regulations for the use of water for recreational purposes generally and in respect of a government waterworks and surrounding state-owned land, Government Gazette 29413, Notice 1188, 1st December 2006 [5] .

  Refers to s21(k) of the NWA - using water for recreational purposes.

  The regulations are intended to regulate the recreational use of all water resources, in particular government waterworks (that is, dams).

[5] In addition to the Draft regulations, there is a range of policy documents relating to recreational use on DWAF's website – www.dwaf.gov/za, Documents, Water-related Policy: Using water for recreational purposes - Recreational Water Use Manual, October 2007 (second release)

There is a general provision that the water use does not detrimentally impact any other water use, and that the water use is not harmful or potentially harmful to human health and safety or the water resource and the associated ecosystem.

Other provisions include the requirement to register such uses in terms of Government Notice R 132\52 (see above), and adherence to precautionary practices in respect of, *inter alia*: general safety on the water; prevention of scour, erosion and sedimentation; compliance with reservations of areas for specific purposes; damage to or removal of riparian indigenous vegetation; and lawful disposal of waste.

An operational plan must be prepared for high impact and commercial uses, but only when the user is notified in writing by the and responsible authority [6] to do so. the plan must be approved by the responsible authority.

Important Note: DWAF's Draft Regulations are currently being scrutinised by the State Law Adviser, who is of the opinion that they cannot be made for water resources other than government waterworks in terms of the National Water Act. Until such time as this issue is resolved, the only national legislation applying to recreational use of estuaries is the Merchant Shipping (National Small Vessel Safety) Regulations, August 2007, made by the Department of Transport in terms of the Merchant Shipping Act (No 57 of 1951) and published in Government Notice R705..

2.1.4 Other relevant national legislation

There are, as observed in the *C.A.P.E. Estuaries Guideline 1: Interpretation of legislation pertaining to management of environmental threats within estuaries* (see Note 1 above), many other laws that relate to estuarine management.

The Marine Living Resources Act (18 of 1998) aims to achieve the optimum utilisation, ecologically-sustainable development and conservation of marine living resources, to preserve marine biodiversity and to minimise marine pollution. The estuary falls within the ambit of the Act, inasmuch as it applies to South African waters [7].

The Conservation of Agricultural Resources Act (43 of 1983) embodies two aspects that contribute to the maintenance of the ecological character of the estuary. It requires the maintenance of riparian vegetation (thereby providing both a migratory corridor for fauna, and a buffer to the entry of sediment to the river), and provides a list of invasib\ve alien vegetation that must be controlled or eradicated (thereby reducing the effects of such vegetation on surface water runoff into the river.

The National Environmental Management: Biodiversity Act (10 of 2004) provides for the conservation of biological diversity, regulates the sustainable use of biological resources and ensures a fair and equitable sharing of the benefits arising from the use of genetic resources.

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[6] The Department of Water Affairs & Forestry or, when the duty is delegated to it, the relevant catchment management agency.

[7] ''South African waters'' means the seashore, internal waters, territorial waters, the exclusive economic zone, and in relation to the sedentary species as defined in Article 77 of the United Nations Convention on the Law of the Sea, the continental shelf as defined in section 7 of the Maritime Zones Act, 1994, and such waters include tidal lagoons and tidal rivers in which a rise and fall of the water level takes place as a result of the tides. The internal waters of the Republic are all waters landward of the baseline, where the baseline is the low water line.

The National Environmental Management: Protected Areas Act (57 of 2003) provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas.

2.1.5 Municipal bylaws

Eight bylaws (including three drafts) are posted on Knysna Local Municipality's website. None of them appear to relate specifically to the estuary and only one – on stormwater management - can be considered to be potentially relevant to the estuary. The bylaws are much more concerned with avoiding adverse effects on the development, operation and maintenance of the stormwater system, and not at all concerned with the impacts of stormwater discharges on the receiving environment. The municipality is in any case subject to other laws, notably the National Water Act, in terms of its obligations not to allow stormwater discharges to prejudice the quality of water resources.

A further by law – on sporting facilities – could have been expected to deal with recreational use of the estuary, but the sports in view are all terrestrial, and not water-based.

2.1.6 Conclusion

The suite of laws relating to estuaries provides a number of provisions that can be invoked to contribute to the sustainable management of the estuary. However, the extent to which the laws will prove to be useful will depend intimately on the extent to which their provisions can be effectively implemented and enforced. This, in turn, will depend on the effectiveness of the institutions through which the provisions, and financial resources, are channelled.

2.2 Requirements Stipulated Under Existing Institutional Management Strategies

The review of the various national, regional (provincial and water management area) and local strategies and development plans was not undertaken with any great scientific rigour. The national and provincial documents are framed in relatively high level, strategic terms, and language. Accordingly, general references were selected that acknowledge the importance of the natural environment, together with specific references to estuaries in general, and Knysna Estuary in particular.

2.2.1 Western Cape Provincial Growth and Development Strategy - iKapa Elihlumayo, October 2006

The WC PG&DS was published as a Green Paper for public comment.
The Strategy recognises the importance of the natural environment to the future well-being of the province in a number of places and, referencing the Provincial Spatial Development Framework, states that *protecting, growing and managing the ecological system therefore have to be integrated into any future vision of growth and development*. Other example statements are:

- Although home to two of the world's ecological hotspots, the Province faces increased biodiversity loss and key environmental resource constraints (water and energy) with increasing vulnerability to the impacts of climate change (p25).
- Ensuring environmental integrity requires that the province develops within carrying capacity of the environment, that the natural resource base is protected through effective policy, pricing and regulation and that the Western Cape mitigates and adapts to environmental risks associated with climate change.(p30).
- The argument in *iKapa Elihlumayo* is that the form and rate of growth will need to be framed by resource availability, especially water, energy and biodiversity (p32).

With regard to future developmental pressures on Knysna and its natural resources, Knysna is identified in the Strategy as a regional motor of economic opportunity (p40), a leader town with high growth potential, and a prioritised area of economic intervention, the previous character of a holiday strip with seasonal occupants having turned into the second most important economic hub of the provincial economy. The area around George and Knysna, linked to a strip of small towns along the southern coast, is described as a second, emerging metropolitan area in the province.
The necessity to align local IDPs with the PG&DS is emphasised in the Strategy. Implicitly this is intended to ensure consistency between the various IDPs, and the Strategy therefore serves as a vehicle to achieve consensus and collaboration between municipalities in managing the natural resource base in an informed manner that protects the public good, which is identified as one of the critical challenges facing local government (p 94).

Note: The Green paper has subsequently (15th November 2007) been gazetted as a Draft White Paper. It is a slightly shorter version of the Green Paper but says essentially the same things.

2.2.2 Knysna Integrated Development Plan 2007-2011

Knysna's Integrated Development Plan for the five-year period 2007-2011 identifies environmental planning and management as one if its priority focus areas.
It makes no specific reference to the estuary.
However, with regard to water it notes that the municipality's licence to abstract water from the Knysna River allows for an abstraction rate of 123 l/sec, whilst the current abstraction rate stands at 105 l/sec. Increased abstraction is needed to alleviate supply shortages during the peak season, and to increase storage capacity in the off-peak season. Achievement of the licensed abstraction rate will require Eastford pump station to be upgraded, for which funds have been requested from the capital budget.

2.2.3 Knysna Municipality Spatial Development Framework: "A Path to a Sustainable Future", April 2006 (Consultative Draft), June 2006 Amendments

This is the latest available version.
The Spatial Development Framework (SDF) forms part of the municipality's integrated development plan.
The SDF states that Knysna Municipality's greatest strength is its natural resource base, that it is endowed with a wide variety of unique natural systems and resources, and that rivers, lagoons and vleis are among the most significant of these.
Significant destruction of key natural resources is noted, from a variety of causes, and cites as an example the extinction of one type of indigenous vegetation, and the near-extinction of five others, because of urban development on the islands of the Knysna Estuary.
It concludes that the value of the natural environment and the current pattern of development have implications for the way in which the municipality should guide growth trends in the future if its most valuable assets are to be retained. (2.2 – Natural systems).
Further specific references to the Knysna River and its estuary are as follows:

- Ecological corridors (s6.1.1(b)) provide linkages between the mountains and the ocean, and the ecological systems that exist between them: the y are a means to promote and sustain biodiversity. The proposed ecological corridors include the entire courses of major rivers within the Municipal boundaries, including the Knysna River. In addition to the rivers themselves it is proposed that a 30m-wide buffer either side of the rivers be included in the ecological corridors.
- Secondary conservation areas (s6.1.1(c)) are intended to act as buffers for core conservation areas, and include parts of the Knysna River valley, outside the 30m buffer.
- Urban edges (s6.1.2(c)): Future urban development should be limited to within the existing urban areas of Knysna and Sedgefield, limited to the one side of the river / estuary that is the eastern side.

S7.4 – Economic Development and Land Use Implications - proposes that any new industrial areas should be removed from the sensitive environment of the estuary.
S 8.1.7 – Knysna Lagoon Edge – proposes that public access and use of the lagoon edge as an important part of experiencing the key place-making element of Knysna Basin should be promoted, and also that public recreation areas at parts of the lagoon 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 should be promoted.
Finally, and of questionable value given its age, the Summary of the Draft Welbedacht / Eastford Local Structure Plan, 1998 (Annexure 6 to the SDF), proposes that further development close to the (Knysna) estuary should not be permitted, in order to protect the natural character of the shoreline, its green verges and overhanging vegetation, and that the minimum subdivision sizes for single residential erven along the edge of the Knysna Estuary, and overlooking it, should remain at 8 000m². The plan does make the important point that sedimentation is a threat to the survival and diversity of the estuary, and that all development proposals should be examined with this threat in mind.

Note: Both Knysna documents – IDP and SDF – claim that they cohere with all relevant regional planning and strategies, including the Western Cape Provincial Growth and Development Strategy (iKapa Elihlumayo) and the Western Cape Spatial Development Framework.

Conclusion
The provincial and local documents acknowledge the importance of the natural environment in general and, in the local development plan and framework, the particular importance of Knysna Estuary. The provincial strategy, whilst not specifically mentioning the estuary, identifies the importance of Knysna as a growth centre. The local documents indicate, among other things, that future development in the proximity of the estuary should be appropriate to its environmental significance.

2.2.4 Plans, programmes and protocols required by the National Environmental Management: Integrated Coastal Management Bill

The requirements of the Bill (in the parliamentary process) relating to the preparation of, protocols, programmes and plans should be noted, particularly because they include the requirement for the Minister to prepare a National Estuarine Management Protocol, which is intended to guide the subsequent preparation of estuarine management plans.

National Coastal Management Programme (s44)
Must be prepared by the Minister and adopted, within 4 years of the Act talking effect.
The programme must be a be a policy directive on integrated coastal management; and must provide for an integrated, co-ordinated and uniform approach to coastal management by organs of state in all spheres of government, nongovernmental organisations, the private sector and local communities.

National Estuarine Management Protocol (s33)
Must be prepared by the Minister, with the concurrence of the Minister for Water Affairs and Forestry, and adopted within 4 years of the commencement of the Act.
The Protocol must, among other things, determine a strategic vision and objectives for achieving effective integrated management of estuaries, set standards for the management of estuaries, and establish procedures or give guidance regarding how estuaries must be managed.
In particular, the Protocol must identify who must prepare estuarine management plans and the process to be followed in doing so.

Provincial Coastal Management Programmes (s46)
Must be prepared by the MEC and adopted within 3 years of the commencement of the Act.
The programme must be a provincial policy directive for the management of the coastal zone in the province, and must provide for an integrated, coordinated and uniform approach to coastal

management in the province. It must be consistent with the national coastal management programme and the national estuarine management protocol.

Municipal Coastal Management Programmes (s48)
Must be prepared by coastal municipalities and adopted within 4 years of the commencement of the Act.
A municipal coastal management programme must, among other things, be a coherent municipal policy directive for the management of the coastal zone within the jurisdiction of the municipality; and be consistent with the national and provincial coastal management programmes; and the national estuarine management protocol.

Estuarine Management Plan (s34)
Management plans for individual estuaries – EMPs – must be consistent with the National Estuarine Management Protocol, and also with national, provincial and municipal coastal management programmes. EMPs may also form an integral part of a provincial or municipal coastal management programme.
Responsibility for preparing individual estuarine management plans, and the way in which they must be prepared, will be specified in the National Estuarine Management Protocol.
No time frames are specified for the preparation of EMPs.

Conclusion
The time frames for the preparation of protcols, etc, in terms of the Bill are relatively long, and should not be expected to provide guidance for the management of the estuary in the short- to medium-terms.

2.2.5 Water Services Development Plan

Knysna's Water Services Development Plan (WSDP) was not reviewed.
Knysna has registered its water use with DWAF in terms of the relevant regulations (see previous notes on regulations).
Authorisation for any changes to registered water use is required from DWAF in terms of the NWA which, as observed previously, includes provisions for the protection of water resources.
However, note the remarks, in Knysna's IDP discussed previously, concerning the intention to increase the present rate of abstraction from the river to the full authorised rate, and the need for the existing pumping station to be upgraded.
Note also DWAF's concerns, in the Internal Strategic Perspective (ISP) discussed later, about the discharge of treated effluent directly into the lagoon, rather than into the river. This could become more significant should the treatment works become overloaded (as is the case in many other parts of the country where development has overtaken the capacity of sewage treatment works) and the quality of the effluent deteriorates.

2.2.6 National Water Resource Strategy, First Edition, 2004

The National Water Resource Strategy (NWRS), prepared by DWAF in terms of ss5-7 of the National Water Act, is of general application throughout the country.
It describes implementation strategies for all major aspects of water resources management, in accordance with relevant provisions in the NWA. It is acknowledged that, although all strategies apply everywhere in the country, the details of their implementation will vary depending on the conditions prevailing in different parts of the country.
The strategies for the protection of water resources, in Chapter 3, Part 1, are of particular relevance to the Knysna Estuary, in that they relate to the determination of resource directed measures for the estuary – the Reserve and water quality objectives.
Appendix D.16 – Gouritz water management area – gives more detailed information on the water situation, both at present and in the future, in the water management area.
An excess of water requirements over water availability is noted for the Coastal sub-area as a whole (Knysna is located in this sub-area), both at present and increasingly into the future. It is suggested that there may be further potential for development of water resources (that is, mainly

by the construction of dams) in the sub-area to address the deficit.
Strong potential for growth related to tourism and eco-tourism in the coastal area is noted in the appendix, but the Knysna Estuary is not specifically mentioned.

2.2.7 Catchment Management Strategies

Catchment Management Strategies (CMS) are sub-national strategies for managing water resources in each of the 19 catchment-based water management areas in South Africa. They will be prepared within the overall framework of the NWRS, applying each of the several strategies for water resources management described in the NWRS in ways that account for the specific circumstances in the area.
The Knysna estuary is situated in the Gouritz Water Management Area (WMA 16)
The Gouritz Catchment Management Agency (CMA) was established by Government Notice 902 in Government Gazette 29205 on 15th September 2006.
Appointment of the governing board is well-advanced, and could be finalised by March 2008.
Preparation of a CMS is one of the initial functions of the CMA (NWA, s80(b)), but it is unlikely that a CMS will be in place before the end of 2009.
In the meantime DWAF's regional staff will continue to manage the area's water resources (as the so-called "proto CMA), and DWAF's Internal Strategic Perspective (ISP) – prepared by DWAF's Directorate: National water Resource Planning - will continue to provide the strategic framework for managing water resources in the area.
Note that DWAF has prepared Guidelines for the Development of Catchment Management Strategies (First Edition, February 2007). An important part of the CMS process is to develop, in consultation with all stakeholders, a vision for the water management area. In this water management area the vision, will, given its importance to the character of the coastal areas of the water management area, include the Knysna Estuary.

2.2.8 Internal Strategic Perspectives (ISP)

As noted previously, the Coastal area is indicated to be in deficit, but the deficit includes desktop estimates of the Reserve (but, importantly, excluding estimates for the estuaries), which has not yet been implemented, and a comprehensive study is in progress. The actual shortfall experienced by users is therefore less than indicated in the ISP. The assessment is for all the catchments in the Coastal area, broken down into three sub-sub-areas – all are in deficit.
Increased shortfalls in water availability compared with water requirements are indicated for a high growth scenario (economic / population), and such a scenario is indicated as probable in the Western Cape Provincial Growth and Development Strategy (see later in this section). Possible interventions include Water Conservation and Water Demand Management (WC/WDM) including alien invasive vegetation removal and control, with some potential for supply-side augmentation for high value uses (ie not irrigation). Further development of groundwater, from the Table Mountain Group aquifer, is possible.
High-confidence determinations of Reserves for rivers and estuaries are necessary to refine water balance calculations, and determinations of the Reserve and RQO are accorded a very high priority in the ISP.
The ecological importance of the rivers, vleis and estuaries is acknowledged in the ISP. It describes 26 strategies in 10 strategic areas to manage water resources: Strategy 2.2 (in Strategic Area 2 – Resource Protection) deals specifically with estuaries, but a number of others are also relevant to estuary management.
The ISP notes that Knysna Waste Water Treatment Works (WWTW) discharges treated effluent directly into the Knysna Lagoon, rather than diverting it to a preferred upstream point on the river, to facilitate some dilution, before reaching the lagoon.

Conclusion
The strategies relating to water resources acknowledge, at least at the water management area level (the ISP) the importance of the estuary, and that the ecological water requirements are a priority both in terms of the law, and also in terms of determining the balance between avialbility of and requirements for water.

2.3 Institutional Structures Governing Estuarine Issues

2.3.1 Institutions in terms of the National Environmental Management Act: Integrated Coastal Management Bill (B40-2007)

The Bill in its present form (it is currently in the parliamentary process) proposes the establishment of a number of institutions to manage the coastal zone, of which those most directly relevant to the management of the estuary are briefly described below.

Careful reading of the Bill indicates that the responsibility for implementing its provisions will rest with local government – metropolitan, district and local municipalities. In an area that falls within both a local and a district municipality the district municipality may, by agreement with the local municipality, assign the implementation of some provisions to the local municipality (s1 – definitions).

National Coastal Management Committee (s35)
Establishment is at the Minister's discretion (… *the Minister may* …).
Responsible for promoting integrated coastal management, and for ensuring the integration of coastal management concerns and objectives into plans, programmes, policies and strategies prepared by all spheres of government.

Provincial Lead Agency (s38)
A provincial organ of state must be designated by the Premier within 2 months of the Act coming into force.
Responsible, among other things, for co-ordinating the implementation of the provincial coastal management programme, and monitoring coastal management in the province.

Provincial Coastal Committee (s39)
Must be established by the MEC, and its powers determined, within 12 months of the Act coming into force.
Responsible for, among other things, promoting integrated coastal management in the province, and the co-ordinated and effective implementation of the Act and the provincial coastal management programme.

Municipal Coastal Committee (s42)
Must be established by metropolitan and district municipalities within 12 months of the Act coming into force.
May be established by local municipalities with jurisdiction over any part of the coastal zone (assigned to it by the district municipality), but the Bill does not specify time frames.

2.3.2 Local institutions and existing management plans

The management of the Knysna Estuary and Lagoon is affected by a variety of institutions and their mandates as well as the legal environment.

Knysna town is the main urban and administrative centre of the Knysna Local Municipality. As it currently exists, the Knysna Municipality emerged from the amalgamation of a number of local authorities in terms of the Local Government: Municipal Structures Act, 1998, at the time of the local government elections held on 5 December 2000. It brings together the former local council areas of Belvidere Estate, Brenton, Knysna, Noetzie, Sedgefield (including Buffalo Bay) and the intervening areas formerly administered by the Garden Route / Klein Karoo District Council, including Old Belvidere, Rheenendal / Keurhoek, as well as the welfare village of Karatara and a number of forestry workers' villages. The municipality is one of seven local municipalities in the Eden District Municipality within the Western Cape Province of South Africa. It is some 1058km² in extent and has a population of 51,467 people.

Management actions and frameworks pertaining to the Knysna Municipality are detailed in the SDF and IDP, briefly summarized in Section 2.2. The identified ecological corridors, conservation areas and urban edges are managed in terms of the Knysna Open Space System. According to this system, co-ordination of management efforts of the range of categories of open spaces that are under the jurisdiction of numerous stakeholders is required. The major stakeholders in the municipality's area of jurisdiction, in terms of the Open Space System include: the Municipality itself; Cape Nature Conservation; South African National Parks (SANParks); the Department of Water Affairs and Forestry (DWAF); South African Forestry Corporation Limited (SAFCOL) / Mountain To Ocean (MTO); owners of private nature reserves; and members of conservancies. There is a need for a co-ordinating institution(s) to co-ordinate and ensure effective management of the numerous parts of the Open Space System. As part of the Knysna Estuary Management Plan, an Estuarine Forum is proposed where such co-ordination can be achieved – it is assumed that the Municipality (its environmental co-ordinator), along with Cape Nature Conservation, the provincial conservation authority, and SANParks, amongst other groups will play such a role.

In terms of management of the estuary and lagoon, SANParks manages the system as a Protected Environment in terms of Section 55 of the National Environmental Management: Protected Areas Act No 57 of 2003. The Protected Areas Act repealed the Lake Areas Development Act, under which the Knysna system was managed as a National Lake Area. The newly promulgated Act has placed greater responsibilities and accountability upon SANParks to the public, local and national government. In particular, greater emphasis has been placed upon a park planning and management function to improve conservation and its implementation effectiveness. SANParks are at present in the process of finalizing Draft Regulations for the Knysna system, and the intention is to release these in to the public domain for comment and input early in 2008. In addition to these regulations, the development Garden Route Protected Areas Management Plan is underway – this will result in management plans for the SANParks areas and provincial reserves along the Garden Route, that will comply with the management planning requirements of the Protected Areas Act. The Knysna Estuary Management Plan will fit into the context of the Garden Route Protected Areas Management Plan, but deal specifically with the management of the Knysna Estuary / Lagoon. A marine zonation plan will also be produced in association with the World Wildlife Foundation (WWF). This will be based on current uses of the marine environment along the Garden Route coastline, and through a series of stakeholder work, a zoning scheme will be developed that will take all of the conservation, commercial and recreational uses and users into account. This zonation plan, however, will not deal specifically with estuaries, although is part of the greater Garden Route Protected Areas Management Plan.

There are various forums that exist in and around Knysna with an active interest in the management of the estuary and lagoon, as well as the catchment. The Knysna Catchment Management Forum consists of representatives of the following interest groups and role players:

- Knysna Municipality – Officials & Councillors
- Eden Municipality
- Department of Water Affairs and Forestry
- Government Environmental Organisations i.e. SANParks, Cape Nature, Working for Water etc
- Non-Governmental Organisation (NGO) environmental groups i.e. Knysna Basin Project, Knysna Environmental Forum, Wildlife and Environmental Society of Southern Africa etc.
- Farmers Organisations
- Ratepayers Associations

The Forum, with its Sub-Committee undertake water sampling at selected locations (and are producing a document on the Knysna Water Situation), improve communication between parties, act as a lobby group, challenging questionable developments, and have been instrumental in the formation of Management Action Plan Committee, which led to the formation of the Knysna Estuary Pollution Management Plan, to be followed by the Lagoon Revival Project.

The Knysna Environmental Forum are a networking group who shares concerns and attempt to assisting the authorities where possible through developing practical solutions. They have an active interest in environmental matters in the Knysna area, whether terrestrial, marine or estuarine. Representatives are similar to those of the Knysna Catchment Management Forum, and include in addition:

- Botanical Society
- Lepidopterists' Society, Knysna Basin Project
- Conservation Systems
- Lakes Bird Club
- Western Heads Conservancy

I addition to these NGOs, organisations and forums, a number of clubs exist around the lagoon with an interest in how the estuary and lagoon are managed i.e. the Knysna Angling and Diving Association (KADA).

3 BIO-PHYSICAL DESCRIPTION

3.1 Introduction

The Knysna Estuary is classified as an estuarine bay, the only system of its kind in South Africa (Whitfield, 1992). The total surface are of the bay is estimated at 1827 hectares. The channel of the estuary is ~ 19km long and 2km wide (Grindley, 1985). The estuary is navigable by small craft over almost its entire length. The main source of freshwater in the estuary is derived from the Knysna River catchment which has an annual rainfall of ~ 928 x 10 6 m^{-3} a^{-1}. Maximum rainfall typically occurs during summer. The Knysna Estuary is home to a number of critically endangered invertebrate species including the Knysna seahorse (*Hippocampus capensis*), the pulmonate limpet, *Siphonaria compressa*, and the Pansy shell (*Echinodiscus bisperforatus*) (Grindley, 1985; Angel *et al*., 2006). As a consequence, the Knysna Estuary ranks very highly in terms of its conservation importance and the preservation of its fauna and flora would ensure that nearly 43% of South Africa estuarine biodiversity would be conserved (Turpie, 2000).

3.2 Hydrographical characteristics

Water contained within the estuary basin is primary renewed by the action of tides, and to a lesser extent river inflow. The lower and middle reaches of the estuary are marine dominated and their ecology and structure are determined by the ebb and flow of the large tidal prism (estimated at spring tide at 19 x 106 m^{-3}) that enters through the Knysna heads twice daily (Largier *et al.*, 2000). Based on hydrographical characteristics, the Knysna Estuary can broadly be divided into three distinct regimes (Largier *et al.*, 2000):

- **Upper estuary regime**, 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**, 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**, which if 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). Thus, during periods of high rainfall within the catchment area of the Knysna River, the upper estuary may extend as far down as the large marine embayment resulting in the disappearance of the lagoon (Largier *et al.*, 2000).

3.3 Physico-chemical variables

Water temperatures with the estuary demonstrate a strong seasonal pattern with maximum temperatures (up to 29°C) recorded during summer and minimum values during winter (12°C) (Grindley, 1985). The temperature regime within the estuary may, however, be modified by the intrusion of colder marine water derived from coastal upwelling into the system. Salinities within the estuary range from freshwater to hypersalinity (> 35 practical salinity units) within the upper reaches of the estuary during periods of drought (Grindley, 1985). A distinct horizontal pattern in salinity is evident with marine waters dominating in the lower and middle reaches of the estuary and freshwater in the upper reaches.

3.4 Sediments

The substratum of the Knysna Estuary comprises mainly unconsolidated sandy sediments, which are largely distributed on extensive inter- and subtidal sandbanks along the edge of the channels. (Redding & Esterhuizen, 1987). The sediments are marine, fluvial and aeolian in origin. Marine sediments primarily occur at the mouth of the estuary whereas the sediments in the middle

reaches are almost exclusively aeolin in origin (Redding & Esterhuizen, 1987). Finally in the upper reaches of the estuary, the sediments are derived fluvially. Flood events have been demonstrated to play a significant role in the sediment dynamics of the estuary contributing to the deposition of fine sediments in the middle reaches of the system (Marker, 2000). The deposition of the sediment is associated with changes in the hydrodynamics, water quality (clarity) and the loss of habitat (salt marsh vegetation) for both invertebrates and vertebrates (Maree, 2000).

3.5 Nutrient dynamics

Overall, the Knysna Estuary can be considered as a nutrient poor (oligotrophic) system largely due to the large volumes of nutrient poor marine waters that pass through the heads twice daily (Allanson *et al.*, 2000). Localised regions of high nutrient impute are derived from storm water and sewage plant inflows although the contribution of these sources to the total nutrient budget within the system is generally considered low (Allanson *et al.*, 2000). It is worth noting that inflow of freshwater from the Knysna River contributes to increased nutrient loads within the system. The observed pattern appears to relate to agricultural activities within the catchment area, which contribute to increased nutrient loads within the Knysna River (Allanson *et al.*, 2000).

Associated with the oligotrophic status of the system is high water clarity. However, the water clarity does demonstrate a strong spatial pattern with the highest water clarity values recorded within the embayment and lowest, in the upper reaches of the estuary (Grindley, 1985). The observed pattern can be ascribed to the hydrology of the estuary. Furthermore, a distinct seasonal pattern in water clarity has been observed with lowest water clarity recorded during the rainy season in summer. The observed pattern can be related to river and stream inflows which are high in total suspended solids (Allanson *et al.*, 2000a).

3.6 Plankton

Results of numerous studies indicate that total phytoplankton biomass within the estuary is low, generally < 2 mg chl-a m^{-3}, which can be linked to the low macronutrient availability within the system. Statistical analyses reveal no significant spatial differences in the total phytoplankton biomass along the length of the estuary (Grindley, 1985; Allanson *et al.*, 2000a). Wind generated coastal upwelling in the marine environment appears to play an important role in determining the phytoplankton biomass within the Knysna Estuary. Cold, nutrient rich water penetratong into the estuary is associated with a dramatic increase in the total phytoplankton biomass within the estuary with levels of up to 18.4 mg chl-a m^{-3}, being recorded (Allanson *et al.*, 2000). The freshwater inflow from the Knysna River is also associated with increases in the phytoplankton biomass as riverine inflow represents the most importance source of macronutrients necessary to sustain the growth of the phytoplankton. These results highlight the importance of catchment management strategies in maintaining the health of the Knysna Estuary.

A comprehensive description of the zooplankton community within the Knysna Estuary is given by Grindley (1985). The zooplankton community structure within the Knysna Estuary demonstrates strong horizontal patterns reflecting the hydrodynamics of the system. Neritic (oceanic) species dominate in the lower and middle reaches of the estuary while true estuarine species predominate only in the upper reaches (Grindley, 1985). The zooplankton community throughout the estuary is numerically dominated by copepods. Among the copepods, species of the genera *Oithona*, *Paracalanus*, *Oncaece* and *Pseudodiaptomus* dominate in the lower and middle reaches while in the upper reaches the estuarine copepods on the genus *Psuedodiaptomus* and *Acartia* are most numerous. In addition to the copepods, several additional neritic species of chaetognath, mysid and gelatinous zooplankton have also been recorded within the system.

3.7 Intertidal wetlands

The total surface area of the intertidal wetlands in the Knysna Estuary has been estimated at 1000 hectares and is second only to Langabaan Lagoon on the west coast of southern Africa (Maree, 2000). The intertidal wetlands are an important component of the estuarine ecosystem as they act as a nutrient sink, provide an important habitat for numerous invertebrates and vertebrates and are an important source of detritus. Due to the elevated abundances and biomass of invertebrates and nekton associated within the submerged vegetation, the wetlands also represent important foraging grounds for both fish (Le Quesne, 2000) and birds (Martin *et al.*, 2000). A total of 54 plant species have been recorded with the wetland of the Knysna Estuary. Three distinct zones can be identified within the salt marsh:

- The **subtidal marsh** in the lower and middle reaches of the estuary are dominated by the eel grass, *Zostera capensis* and *Halophila ovalis* which are inundated at all tides, partially exposed during most low tides; and fully exposed during extreme low water spring tide (ELWST). In the upper reaches of the system, *Ruppia maritima* becomes more common, eventually replacing *Z. capensis* (Grindley, 1985).
- The **intertidal marsh** which is inundated at all tides and exposed during all tides and largely dominated by *Spartina maritima*
- The **supratidal marsh**, which is only inundated during high water spring tides (HWST). The vegetation of the supratidal; salt marsh is dominated by a variety of vegetation including *Chenola diffusa*, *Sarcorcornia perrenis*, *Juncus* spp and Plantago spp.

A detailed map of the distribution of the intertidal wetlands within the Knysna Estuary is presented in Maree (2000). A number of anthropogenic threats to the intertidal wetland of the Knysna Estuary have been identified including the formation of pathways, collection of bait, unmoored boats, the construction of causeways and housing developments which interfere with the natural tidal movement over the marshes, storm water outflows and siltation resulting from poor catchment management strategies in the Knysna River catchment (Maree, 2000).

3.8 Benthic macrofauna

The community composition and distribution of the benthic macrofauna within the Knysna estuary was first described by Day *et al.* (1952) (cited in Allanson *et al.*, 2000b). Subsequent studies conducted by Allanson *et al.* (2000) revealed that although there have been little changes in the species richness in the estuary over the past 50 years, the benthic macrofauna diversity has increased. It is suggested that the observed pattern can related to the increase in fine sediments within the estuary, which have become incorporated into to intertidal sediments through anthropogenic activities (mainly land use patterns within the catchment area) (Allanson *et al.*, 2000b). The macrobethic macrofauna within the estuary comprises crabs, prawns, bivalves, isopods and gastropods (Grindley, 1985; Allanson *et al*., 2000b).

According to Day (1981), 310 species on benthic macrofauna have been recorded in the estuary. A strong horizontal pattern in the number of benthic macrofauna species is evident with highest diversity recorded at the heads and the lowest towards the upper reaches of the estuary (Grindley, 1985). The faunistic divisions of the macrobenthos in estuary appear largely to correspond to physical and chemical changes along the length of the system. Day *et al.*, (1951) (cited in Grindley, 1985), identified four basic faunistic divisions of macrobenthos:

1. The Knysna heads
2. The estuary from Leisure Isle to beyond the point
3. Westford channel to the old drift
4. The Charlesford Rapids

Subsequently, Day (1967) distinguished the different macrobenthic communities according to their salinity preferences. On this basis, five communities were identified:

1. Freshwater community
2. Stenohaline community (restricted to the mouth of the estuary)
3. Euryhaline community (recorded throughout the different reaches of the estuary)
4. Estuarine community (restricted to the upper reaches of the estuary)
5. Migratory community (comprised of species which move in and out of the estuary e.g. prawns)

A key component of the benthic macrofauna within the estuary is the thalassinidian prawn, *Upogebia Africana*, which is heavily exploited for bait by both recreational and subsistence fishers (Hodgson *et al.*, 2000a). The density and biomass of the prawn within the estuary is highly variable with only small individuals being recorded in the upper reaches of the system. Maximum abundances and biomass of *U. africana* are recorded in the middle reaches and are associated with the *Spartina* and *Zostera capensis* beds within the intertidal wetlands (Hodgson *et al.*, 2000a). Results of study conducted at six sites in the estuary revealed that fishers removed ~ 0.9% of the entire stock of prawn annually with the bulk of the exploitation being undertaken by the subsistence fisherman (Hodgson *et al.*, 2000b).

4 SOCIO-ECONOMIC DESCRIPTION

4.1 Description of the Socio-Economic Environment

4.1.1 Demographics

The Knysna Local Municipality had a population of 43,194 in 1996 and 51,486 in 2001. This represents a growth rate of 3.2 % per annum during that period. This rate of growth is likely to have continued and may have increased since 2001 due to the economic growth of the area. Unfortunately there is no disaggregated population data for Knysna that can be obtained from the General Household surveys since 2001. The population growth statistics for the Western Cape are very low compared to other provinces (0.5% growth between 2001-2004 based on the data from the General Household Surveys undertaken by Stats SA). However, an analysis of migration data indicates that 35% of immigrants to Knysna between 1996 and 2001 were from the Eastern Cape. The Eastern Cape has experienced a 9% population growth rate in recent years so Knysna may experience an increase in immigration from the Eastern Cape.

The racial composition of the Knysna population in 2001 was as follows:

- Black: 31.9%
- White: 23.8%
- Coloured: 44.1%
- Indian: 0.1%

Income distribution in Knysna follows the very typical skewed pattern characteristic of other urban areas of South Africa with large sections of the population living in poverty or with low incomes. As indicated in Figure 4-1 below, about 30% of Knysna households lived below the poverty line in 2001 (earning an annual income of less than R9 600). Another 38.5% of households had incomes from R9 601 – R38 400 per annum, 24.6% had incomes between R38 400 and R153 600 per annum and the remaining 7% earned more than R153 600 per annum.

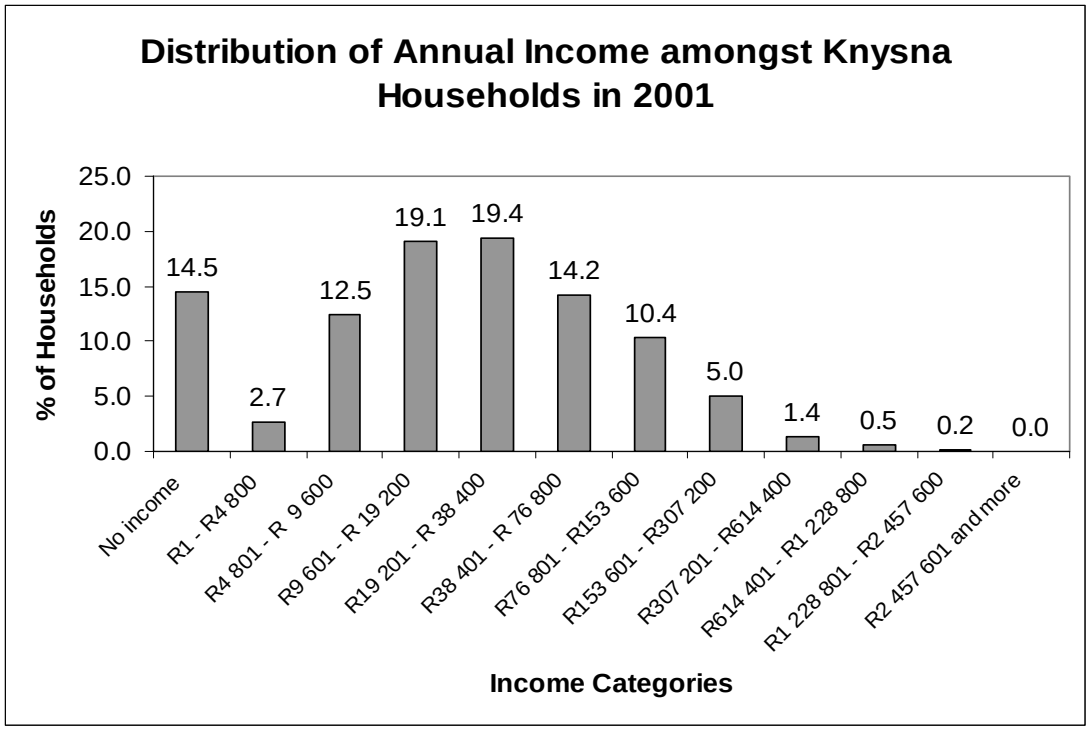

Figure 4-1: Distribution of income amongst Knysna households in 2001

4.2 Knysna Economy

The 2001 census indicates that 55% of the residents of the Knysna Local Municipal area live in formal urban settlements and another 33% live in informal settlements in urban areas. Only 11% of residents lived on farms or small-holdings. Income data for the various economic sectors also indicates that the vast majority of residents in this area earn an income from a variety of urban commercial goods and services. This includes the variety of activities and facilities associated with the tourism sector.

Table 4-1: Income data per economic sector

Economic Sectors	Total Income	% income
Agriculture, hunting; forestry and fishing	R 30,016,757	4.7
Mining and quarrying	R 1,844,994	0.3
Manufacturing	R 42,559,745	6.7
Electricity; gas and water supply	R 1,685,399	0.3
Construction	R 53,261,734	8.4
Wholesale and retail trade	R 114,499,584	18.0
Transport; storage and communication	R 33,433,457	5.3
Financial, insurance, real estate and business services	R 70,173,574	11.1
Community, social and personal services	R 113,554,417	17.9
Private Households	R 12,368,697	1.9
Undetermined	R 34,842,845	5.5
Not applicable (Grants and earnings not derived from employment)	R 126,625,689	19.9
Total	R 634,866,889	100.0

4.3 The Importance of the Knysna Estuary to Residents and Visitors

Knysna is located at the heart of the Garden Route, forming its main attraction. The topographical features of the area, the estuary and surrounding forests together make Knysna a highly attractive location. The town has grown up around the estuary which is known as the "Knysna lagoon". The town plays host to an estimated 843 000 visitors per year (2002 estimate) (Knysna Tourism Office, pers. comm. with Turpie in 2004) of whom almost half are overnight visitors. About 27% of visitors at any one time are foreign.

South African visitors, and particularly foreign visitors, have a much wealthier profile than the town inhabitants. Knysna's wealthier white inhabitants are largely attracted to the town by the lifestyle. South African visitors tend to be visiting Knysna specifically, while foreigners tend to have Knysna as one stop on a multiple destination trip. Nevertheless, this stop is considered a significant part of the reason for visiting South Africa. Thus Knysna contributes significantly to the national tourism economy. As indicated in more detail below, the Knysna Estuary contributes about 60% of the value of Knysna for both residents and visitors.

A survey of residents and visitors in 2004 (Turpie *et al.,* 2004) found that among the recreational activities on the estuary, walking and sitting around the estuary is the most popular (contributing an average of 42% to overall enjoyment of the estuary), followed by swimming and boating (both 17%) and fishing (14%). Birding contributes 8% and diving 2%. Some expected differences are seen between three types of users. For example, foreign visitors mainly use the estuary for walking and boating, and fishing is more important for residents than other groups. Some 31% of the resident households have boats, as do 18% of South African and 9% of foreign visitor groups. A total of 32% of survey respondents report that members of their group or household engage in fishing.

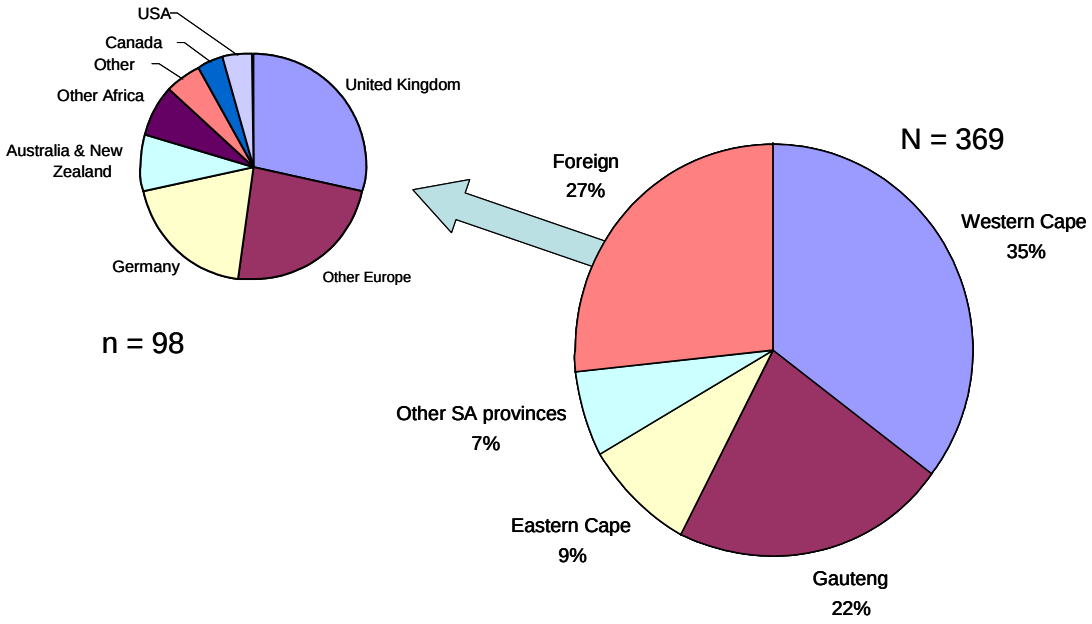

Figure 4-2: Origin of visitors to Knysna (Turpie *et al.*, 2004)

4.4 Value of Environmental Goods and Services

The estimated value of the Knysna Lagoon is summarised below. These estimated values were derived from a study of the use and value of the Knysna estuary (Turpie *et al.,* 2004) undertaken in 2004, and papers emanating from this report (Turpie & Joubert, 2005, Napier *et al.,* 2005, Turpie & Savy, 2005). Turpie *et al.* (2004) based their study on a survey of 1016 respondents in Knysna (647 residents and 369 visitors), interviews with estate agents, focus group discussions and interviews with 70 subsistence fishers, and a survey of 505 respondents throughout the rest of the Western Cape.

4.4.1 Tourism and recreational value

The recreational use value of the estuary includes its aesthetic value, and is expressed in terms of (i) expenditure by visitors on trips to the estuary, and (ii) by investment in property with access to or views of the estuary, in the case of residents and holiday home owners. This expenditure impacts on the broader economy, creating income for the tourism industry, the real-estate sector and knock-on effects. Moreover, the existing expenditure may be less than users' actual willingness to pay for access to the estuary, with the differential being expressed as the aggregate consumers' surplus. From the users' perspective, total recreational use value in the sense of the total utility or wellbeing derived from the estuary includes this consumer surplus.

4.4.2 Property value of the Knysna Estuary

Based on the proportion of properties with views in each suburb and the premium paid in those suburbs for having a view of the estuary, a total of about R1485 to R2015 million is estimated to be invested in views of the Knysna Estuary in the property market (Turpie *et al.,* 2004). In other words, the estuary contributes significantly to turnover in the real estate market.

4.4.3 Visitor expenditure attributable to the estuary

South African visitors to Knysna spend about R2200 per person per trip, whereas foreigners spent about six times more, about R12 000 per person per trip, not counting the amount they also spend outside the country (Turpie & Joubert, 2005). The estimated total expenditure in South Africa by tourists visiting Knysna was almost R4 billion per year. Based on the stated importance of the estuary, an estimated R1 billion of this expenditure can be attributed to the estuary itself, with foreign expenditure accounting for half of this. 21% of foreigners' expenditure and 46% of South

African visitors' expenditure was attributed to the estuary.

4.4.4 Subsistence use value of the estuary

Knysna Estuary supports an estimated 30 full time and 200 part time subsistence fishers (Napier *et al.,* 2005). The fishers are involved in bait collection, mud crab harvesting, and fishing, mainly with hand and set lines. Both bait and fish are harvested for sale as well as for own consumption. The bait fishery is dominated by the mud prawn, *Upogebia africana*. Estimated catches amount to about 3% of the standing stock, suggesting that the fishery is well within sustainable limits. The harvest of other more valuable bait species, such as worms (*Marphysa* and *Gorgonorhynchus*), is only viable through damaging methods, and poses a threat to the estuary's endangered Knysna seahorse, *Hippocampus capensis*. Fish catches are dominated by small species and individuals, particularly cape stumpnose, *Rhabdosargus holubi*, caught with hand lines, but most of the value of the fishery lies in the catches of spotted grunter, *Pomadasys commersonnii,* and white steenbras, *Lithognathus lithognathus*, which are caught with set lines. Indications are that the linefishery is also sustainable at present. Most of the more valuable bait and fish are caught to order. The subsistence fishery is worth at least R0.7 – R1.1 million per annum, with full time fishers earning at least R11-17 000 per annum from the estuary, and earning more per hour than in many other possible occupations. Note that although some of the catch is sold, the fishery is still within the definition of a subsistence fishery (Napier *et al.,* 2005).

4.4.5 Commercial aquaculture in the estuary

Approximately 450 tons of oysters (*Crassostrea gigas*) are produced annually in South Africa, with a total production value of some R9.765 million (1997 rands, Hoffman *et al.* 2000). The Knysna estuary currently produces about 105 tons per year (S. Burton, Knysna Oyster Co., pers. comm.), with an estimated value of R3.15 million.

4.4.6 Indirect use value

The Knysna estuary acts as a nursery area to many marine fish species that are utilised along the coast. These include valuable species such as white steenbras. Thus the estuary helps to maintain these fisheries. Based on the catch composition of inshore marine fisheries and the degree of dependence of different species on estuaries, Lamberth & Turpie (2003) estimated that estuaries along the southern Cape coast (including Knysna) contribute some R26 400 per ha in value to inshore marine fisheries per year, which suggests that the Knysna estuary is worth some R95 million per annum in terms of its indirect use value.

4.4.7 Existence value

In addition to the direct use values of the estuary described above, many South Africans value the existence of the Knysna estuary and its biodiversity. There is a high level of ignorance of South African estuaries among the public, but two thirds of the adult, income earning residents of the Western Cape have at least heard of the Knysna estuary or "Knysna Lagoon". Based on a Contingent Valuation survey, South Africans are willing to pay a total R93 million per annum towards the conservation of estuaries. The existence value of the Knysna estuary is estimated to be some R9.7 million per annum (Turpie & Savy, 2005).

Knysna estuary thus represents a significantly valuable resource in terms of its natural resources both through its direct use by residents and visitors, and South African concern for the continued existence of the estuary (Table 4-2). Any future management or development decisions taken on the estuary should be guided by the current value of the estuary with the aim of maximising value to all stakeholders.

Table 4-2: Summary of values of the Knysna Estuary

Type of value	Activity	Value per year
Non-consumptive use	Tourism and recreation	R1000 million
	Resident investment	R149-202 million*
Consumptive use	Subsistence fishing	R0.7 – 1.1 million
	Commercial aquaculture	R3.15 million
Indirect use	Nursery contribution to marine fisheries	R95 million
Non-use	Existence value	R9.7 million
TOTAL		**R1258-1311 million**

* assuming a 10% annual return

4.5 The Relative Importance of the Knysna Estuary

A comparison of various elements of the economic value of temperate estuaries in South Africa undertaken by Turpie & Clark (2007) as part of a process of developing a Conservation Plan for these estuaries, found that the Knysna estuary had the highest property, tourism and nursery values of all the estuaries studied, and the second highest subsistence value (behind the Swartkops Estuary). The Knysna Estuary was ranked fourth (and 'High') in terms of existence value. This compared favourably to the existence value to many other pristine estuaries in undeveloped areas along the South African coastline (i.e. the Transkei wild coast) despite it being highly developed and relatively disturbed.

Table 4-3: Economic values of the Knysna Estuary per indicator, as well as rank in terms of South African temperate estuaries (Source: Turpie and Clark, 2007)

Indicator	Value (R)	Rank (temperate estuaries in South Africa)
Subsistence Value (R/yr)	786 500	2
Property Value	1 400 000 000	1
Tourism Value (R/yr)	1 000 000 000	1
Nursery Value (R/yr)	167 600 000	1
Rank of Existence value		4 (High)
Recreational Value	> 1000 000 000	

5 EXPLOITATION OF LIVING RESOURCES

5.1 Ichthyofauna

The Knysna system is permanently open to the sea and has been classified as a medium/large estuary bay that is in good condition overall and whose ichthyofaunal community status is good (Harrison *et al*., 2000; Whitfield, 2000). As many as 200 species of fish have been recorded in the system, with several being marine species not usually associated with estuaries (Grindley, 1976; 1985) but which are present in the marine dominated rocky mouth region. The composite estuarine fish community is representative of other warm temperate systems in terms of species richness, but it will differ from other smaller systems or closed estuaries in terms of biomass or population size (see Turpie and Clark, 2007). There is only one red-data species that is listed as threatened, namely the Knysna seahorse (*Hippocampus capensis*). This species is adapted to the temperate estuarine environment and will not tolerate freshwater or hypersaline conditions; it is also found in the Keurbooms, Swartvlei and Klein Brak estuaries.

Although not listed as red-data species, there are several species that are important components of the recreational linefishery whose population size on a national scale is at severely depleted levels. For example, the spawner biomass per recruit (SBPR) estimate for white steenbras (*Lithognathus lithognathus*) is 6% (Bennett 1993) and for dusky kob (*Argyrosomus japonicus*) it is 2.3% (Griffiths, 1997). These estimates are dated and given the increase in fishing effort since then, and hence mortality, it is likely that these values would be even lower at present. A population or stock with a SBPR of < 20% is considered to be collapsed; from a fisheries point of view these fish would be regarded as threatened and endangered and as such should perhaps be regarded in the same light as any other red-data species. Interestingly the National Environmental Management: Biodiversity Act (Act 10 of 2004) lists *L. lithogntahus* as being critically endangered and that no person may be in possession of any specimens. This clearly contradicts the Marine Living Resources Act (Act 18 of 1998) which prescribes a restriction of 1/person/day and a minimum size of 600 mm TL. This discrepancy is yet to be sorted out, but until then it is understood that the MLRA will be applied.

Targets for the protection of fish species (as a percentage of the total national population) have recently been calculated (Turpie and Clark, 2007) and were set at 50% of the population of red-data species; 40% of the population of exploited species; and 30% of the population of all other species. The effective targets for selected individual species that are associated with the Knysna Estuary are provided in Table 5-1 (after Turpie and Clark, 2007). The Knysna seahorse target is 50% due to its threatened status, and existing legislation that places a moratorium on exploiting this species should be sufficient to achieve this provided their habitat receives an equally sufficient degree of protection. All the major fishery species, such as *A. japonicus, Diplodus sargus capensis, L. lithognathus, Pomadasys commersonnii, Pomatomus saltatrix, Rhabdosargus holubi* and *Sarpa salpa* require a level of 40% protection. Smaller species, such as *Gilchristella aestuaria* and *Atherina breviceps* which are not exploited in the fishery but which form an important part of the food chain for piscivorous fish, have been designated a 30% target level of protection. These smaller fish are also known to be numerically the most abundant estuarine species in all systems in which they are found.

Not present in the list of estuarine fish that require protection is the white musselcracker (*Sparodon durbanensis*). This species is not regarded as being an estuarine dependant or associated species and is found in the nearshore and shallow subtidal zone. However, during periods of severe upwelling in the late summer months usually, this species enter the Knysna Estuary to seek warmer waters; they tend to be large mature individuals and fishermen catch them in big numbers. Anecdotal evidence suggests that there is a period of wholesale slaughter of this species while it is resident in the estuary. Current restrictions are a limit of 2/person/day and a minimum size of 600 mm TL; the bag limit is ignored by many anglers when targeting this fish in the system.

Table 5-1: Target percentages for the protection of estuarine fish species (after Turpie and Clark, 2007)

FISH SPECIES	TARGET %
Acanthopagrus berda	30
Anguilla mossambica	30
Argyrosomus japonicus	40
Atherina breviceps	30
Caffrogobius gilchristi	30
Caffrogobius natalensis	30
Caffrogobius nudiceps	30
Diplodus sargus capensis	40
Elops machnata	40
Galeichthys feliceps	40
Gilchristella aestuaria	30
Hemiramphus far	30
Heteromycteris capensis	30
Lichia amia	40
Lithognathus lithognathus	40
Liza dumerilii	40
Liza richardsonii	40
Liza tricuspidens	40
Monodactylus falciformis	30
Mugil cephalus	40
Myxus capensis	40
Omobranchus woodi	30
Pomadasys commersonnii	40
Pomatomus saltatrix	40
Psammogobius knysnaensis	30
Rhabdosargus holubi	40
Sarpa salpa	40
Solea bleekeri	30
Syngnathus acus	30

A number of elasmobranchs are also found in the estuary and although they too are exploited by competitive anglers they are returned alive and thus do not appear to be under any significant threat. These include *Mustelus mustelus, Triakis megalopterus, Carcharias taurus, Rhinobatos annulatus, Dasyatis chrysonota, Gymnura natalensis, Myliobatis aquila* and *Pteromylaeus bovinus*.

5.2 Living Resource Exploitation

The following assessment has been based primarily on information obtained from various stakeholders during telephonic interviews; these included fishermen and SANParks. Limited information on the exploitation of living resources is available in the primary literature; in fact the only published data is that which describes fishing effort and the exploitation of mud prawn (Hodgson *et al*., 2000b).

5.2.1 The Knysna seahorse

The Knysna seahorse is considered to be threatened and its conservation is a high priority. There is no exploitation of this species in the estuary, but its habitat must be protected to ensure its survival; this includes aquatic vegetation such as *Codium* spp. and *Zostera capensis* and in close proximity to jetties where building rubble has been dumped (Hanekom and Russell, 1991).

5.2.2 Description of the linefishery

At present the only legal components of the linefishery in the Knysna Estuary are licensed recreational shore and boat-based angling. Although a number of unlicensed recreational and subsistence-type fishers do exist they do not possess the necessary permits to operate and so must be considered to be operating illegally. Another group of illegal operators are those that essentially conduct small-scale commercial operations, i.e. the catching and selling of fish. However, for the purpose of this report these groups will be recognized as separate user groups because their numbers and level of effort have a significant impact on the resource. The term subsistence is used to describe the sector of the fishery which relies on the resource as a primary source of food and income even though they are not in possession of permits issued by Marine & Coastal Management (MCM).

Effort

Hodgson *et al.* (2000b) revealed that amongst local anglers, the most effort by shore-based anglers was in areas that were easily accessible such as Thesen's Jetty, Loerie Park and close to the Knysna Angling & Diving Association (KADA) clubhouse. Only 6.5% of local anglers interviewed were boat based. In contrast, over half of the tourist anglers interviewed were boat anglers with the shore-based contingent targeting sites at Coney Glen, the Heads and the Railway Bridge. Local anglers also mostly walked to their selected fishing sites while tourists tended to use boats or cars. Most fishing outings for all those interviewed exceeded two hours, with more than 35% fishing for longer than four hours. Almost 74% of local anglers use hand lines, indicating a high subsistence-type component and 17.4% admitted to setting plant lines; tourists exclusively used rod & line. The sample size for the above study was small, only 46 local anglers and 31 tourists, and so it is likely that a detailed survey would reveal different estimates.

According to local fishers, estimates of shore-based effort are difficult to calculate as so many people fish close to or from their homes and of jetties that are not all visible to other users on the water. Clearly though, all forms of effort increase during holiday periods and hundreds of anglers may be seen fishing from the shore on any given day. Out of season though shore-based fishing appears to be the domain of the subsistence angler, of which there are between 80 and 100 participants. Generally subsistence fishers will fish most days except when weather conditions (rain) prevent them from doing so and some will travel between five and ten kilometres to get to their fishing sites. A common complaint amongst this sector is that new boating regulations prohibit them from using boats as they cannot afford to buy the necessary safety equipment or pay for the licensing fee.

Local anglers say that the majority of experienced boat-based fishers fish at night, while those less accomplished fishers tend to only venture out during the day. The greatest levels of effort are during the holiday period when between 15 and 20 boats fish at night, although they conceded that this only included registered boats with lights that are visible; there may well be some smaller boats without lights also out on the water. During the day between 20 and 30 boats may be seen fishing in season. Out of season there is considerably less boat-based effort with one or two boats fishing at night during the week and seven or eight over the week-end; daytime boat-based angling out of season is not a common occurrence. A total of 23 boats with licensed local anglers are registered at the KADA for this year. While some anglers may anchor and fish in one area, most will drift with the tide; more effort is expended in the region of the White Bridge during summer when the dusky kob are in the vacinity; this pattern changes to areas closer to the mouth (White Poles) in winter when white steenbras usually make their appearance.

Organized fishing competitions take place on average once every four to five weeks when between eight and fifteen boats take part. However, once a year in July during the Oyster Festival there is a Skins Tournament where as many as 60 to 100 boats may participate over a two-day period.

Shore-based anglers tend to fish wherever access is easiest or at a site closest to home in order to reduce travel time and cost. Some subsistence-based fishers live next to the estuary on a semi-permanent basis and always fish the same site. According to SANParks estimates there are approximately 20 such anglers between the white bridge and Thesen's Island and another 15 between the island and the Heads. Other subsistence fishers appear to have several sites that they fish on a regular basis between the Railway Bridge and Leisure Isle although recently they claim to have been denied access to some of their favourite sites and do not understand why; in some cases they have been verbally abused and chased away. These sites include the Sandpit off the SANParks jetty, outside the National Sea Rescue Institute (NSRI) Station and a place known as Number 6 near Leisure Isle.

A small sector of the fishery set plant lines comprising 50 to 60 hooks on a long-line on the mud banks at low tide and leave them to soak over the high tide cycle to be collected again the following low tide. These fishers presumably used to belong to the subsistence sector but have since found that plant lines are a more lucrative undertaking. Some anglers that were interviewed claim that this happens almost every day.

Catch

Shore-based recreational and boat-based anglers appear to target mostly dusky kob, spotted grunter and white steenbras, although seasonal visitors such as elf, leervis and musselcracker are targeted opportunistically. Spotted grunter are found in the system all year round with the best catches over summer, and according to local anglers there has not been a noticeable decline in catches in the last five years. Historically, dusky kob has been caught mostly in summer, but recently an abundance of juveniles has begun to appear during winter. Unlike other large open systems like the Breede, Gamtoos and Mbashe, the Knysna system is not favored by the large dusky kob, and although the occasional large fish is caught, specimens of 5/6 kg are considered big for this estuary. White steenbras are a predominantly winter fish, and while catches of large fish (> 10kg) have declined in the last 10 years, the number of juveniles appear to have increased; the majority of fish caught are in the 250 – 550 mm TL size class. Leervis are not heavily targeted but large fish do enter the system in winter months; juveniles are more abundant in summer. Elf too are seasonal with late summer being the time when this species is caught in large numbers. White musselcracker enter the system during upwelling events, predominantly in summer/autumn, and large numbers are caught, with many anglers exceeding their bag limits; most of these fish are large mature individuals and this is cause for concern. For the most part it appears that undersize fish are returned alive and bag-limits are adhered to although a percentage of anglers are known to ignore both. A group of anglers that fish from the Railway Bridge are known to exceed bag limits and sell their catch to residents and restaurants.

Boat-based angling competitions are run on a species basis; one specimen of each species, of legal size, may be weighed. All non-edibles have to be returned alive and be seen to swim away in order to count for points. As expected the dominant species are dusky kob, spotted grunter, white steenbras and non-edibles such as the diamond ray, blue stingray, eagleray, lesser guitarfish and smooth-hound.

The subsistence sector predictably does not target specific fish but are happy to catch anything that is edible. Using hand lines and predominantly mud and sand prawns they catch mostly the smaller species such as Cape stumpnose, strepie, blacktail and juvenile dusky kob, grunter and steenbras. The majority of these fishers do not have licenses and are thus operating illegally but they claim they cannot afford licenses and have no choice but to continue fishing in order to survive; these fishers claim the existing regulations have forced them to engage in illegal activities by hiding away from enforcement patrols or hiding undersize fish from inspectors. A small proportion though have stopped fishing because they are afraid of being fined; in these cases it appears that at least one other household member earns an income.

Plant lines are baited predominantly with mud prawn and catch mostly grunter, kob and steenbras. These fish are then sold either to residents or restaurants.

5.2.3 Description of the bait fishery

A wide variety of bait organisms are exploited by all sectors of the linefishery. These include mud prawn, sand prawn, bloodworm, tapeworm, moonshine worm, redbait, cuttlefish and mullet.

Mud prawn
Probably the most widely used bait organism in the system due to its abundance and ease with which it is collected; it is the most frequently used bait by subsistence anglers. It is found from the Leisure Isle in the lower reaches to the Red Bridge in the upper reaches and occupies 62% of the available intertidal area (Hodgson *et al.,* 2000a) and is also found sub-tidally down to 1.5m. A study of bait collecting activities between Leisure Isle and the Railway Bridge revealed that recreational anglers collected an average of 59 prawns per outing and subsistence anglers an average of 101 prawns per outing (Hodgson *et al.,* 2000b); both these numbers exceed the legal limit of 50. A variety of collecting methods are used, including pumps, plungers, tin cans and digging implements (spades and forks). Effort, measured as number of collectors present per mudbank, appears to be highest on public holidays when an average of 43.5 collectors were recorded on each mudbank per day. This was followed by summer holidays (16.5 collectors) and the out of season spring/summer (8.6 collectors) and autumn/winter (4.6 collectors) periods. Thesen Island was the most heavily exploited area by local anglers with effort increasing significantly during holiday periods at Leisure Isle and at opportunistic sites depending on where fishing activities were taking place. Data gathered between February 1995 and April 1996 lead to an estimate of 1.86×10^6 prawns (740 kg dry weight) being removed annually; this equates to only 0.9% off the estimates estuary stock. A total of 85% of the prawns are removed by subsistence fishers who accounted for 77% of the fishing effort (Hodgson *et al*., 2000b). The above study did not include areas upstream of the Railway Bridge site and so it is likely that estimates were conservative. Given the likely increase in numbers of fishers since 1996, the numbers of prawns being removed presently probably exceed these estimates. Nevertheless it is unlikely that the population of mud prawn is threatened. Present day density estimates compare well with historical data; mud prawns are not difficult to obtain at any time; and the mean size of prawns has not decreased in the last 20 years (Hodgson *et al*., 2000b). Anecdotal evidence from fishermen also suggests that the resource is abundant and able to withstand high levels of exploitation. Local residents have revealed that bait collection in the Invertebrate Reserve behind Leisure Isle is a common occurrence, but SANParks claim to have it under control as their capacity to enforce has recently improved; they claim that only three people have been caught in the reserve in the past three months. Nevertheless, it is likely that collection in this area carries on at night when it is not visible to residents and SANParks officers are not on patrol.

Sand prawn
Also known as pink prawn, this is a popular bait for all sectors of the fishery. It is found on sand banks (best on white sand) between the Railway Bridge and the Red Bridge in the upper reaches. It is not as easily collected as mud prawn by using plungers or tins and as such is used mostly by recreational anglers who possess prawn pumps. The population appears to be healthy based on the ease with which they are collected and the average size.

Worms
The main species of worm collected by anglers are bloodworm, tapeworm and moonshine worm and according to those interviewed they are plentiful if one knows where to look. Collecting them requires a degree of finesse and they used to be collected only by a small component of the fishery. However, they are fast becoming more popular amongst other anglers as they realize how effective they are. There is a high incidence of illegal collecting in the form of digging with forks or spades and large areas of their habitat are destroyed in this manner. Bloodworm in particular are also collected by rock & surf anglers.

Cuttlefish
Cuttlefish are abundant in the system and it appears to be an important nursery area for juveniles which are found in great numbers wherever there is submerged vegetation. Juveniles in particular are collected for bait mostly by boat-based anglers, although subsistence fishers will collect them opportunistically either for food or bait. They may be targeted at night using headlamps and spears or even chokka dollies. Once again there is a small sector that catches these animals to sell to restaurants. The recent (November 2007) heavy rains and accompanying floods have killed off many cuttlefish that could not escape to sea in time to avoid the freshwater pulse.

Mullet
Mullet are netted for use as live-bait by estuarine anglers targeting kob, leervis and elf but may also be used as a dead bait by estuarine and rock & surf anglers who target sharks and rays. Cast-netting is non-selective and as such it is likely that a combination of *Liza* spp., *Myxus capensis* and *Mugil cephalus* are caught. Anecdotal evidence suggests that exploitation levels are low.

Red bait
Red bait collected in the estuary is mainly used to target musselcracker when they enter the system, and as a resource is not under threat. Some boat-based anglers also use long tube-shaped baits to catch white steenbras, and shore based anglers will catch a variety of fish on this bait, including blacktail, strepie and Cape stumpnose. It is not however widely used.

5.2.4 Mud crab

The estuarine mud crab (*Scylla serrata*) is found predominantly above the White Bridge and historically was targeted quite frequently by recreational fishers. According to SANParks there is very little effort spent catching this resource at present and this may be due to an apparent decline in numbers of large individuals. Subsistence users now target these crabs on occasion over spring low tide when they dig them out of their burrows and then sell them to restaurants.

5.3 Enforcement Capacity

SANParks are responsible for the overall management of the system and are required to enforce a wide range of regulations listed under various Acts not just the MLRA. At present their exact role in the management of the system and the legalities involved are being addressed by a draft management plan that should be in place by February next year (2008); essentially this plan should provide the basis for the management action plans as required by and defined in the Estuary Management Plan. Until recently only two SANParks rangers were stationed in Knysna and available for patrols and law enforcement; at the moment there are three rangers and ten new personnel undergoing training. Upon completion of training the rangers should total 13 and they will all be appointed by DEA&T in terms of the regulations to enforce the MLRA. At present SANParks posses two boats and two more (one inflatable and one cobra-cat) will be available imminently. These factors should combine to provide an effective policing force, not only for monitoring living resources but for all activities that impact on the system as a whole. SANParks claim to have a policy of responding to all complaints and so public involvement with regards reporting illegal activities should be encouraged; this should serve improve the image of SANParks within the community, many of whom could only criticize the organization when interviewed.

At present there are two MCM fisheries officers in the area but their area of responsibility extends from Plettenberg Bay to Mossel Bay and they do not spend much time on the Knysna Estuary.

5.4 Existing and Proposed Restrictions

National legislation in the form of the MLRA prescribes certain regulations that apply to the exploitation of living resources; the most recent linefish and bait regulations that apply to the Knysna Estuary are presented in Table 5-2, together with some proposed additional regulations that may assist in the protection of selected resources.

Table 5-2: National linefish and bait regulations and proposed additional regulations for the Knysna Estuary

Common Name	Species	Size limit	Bag limit	Other proposed regulations
Cape stumpnose	*Rhabdosargus holubi*	20cm	5	
Shad	*Pomotomus saltatrix*	30cm	4*	
Leervis	*Lichia amia*	70cm	2	Release fishery
Dusky kob	*Argyrosomus japonicus*	60cm	1	Release fishery; slot limits; closed area
White musselcracker	*Sparodon durbanensis*	60 cm	2	
Mullets	All species combined	None	50	
Ragged tooth shark	*Carcharhinus taurus*	None	1	Release fishery
Spotted gulley shark	*Triakus megalopterus*	None	1	Release fishery
Spotted grunter	*Pomadasys commersonnii*	40cm	5	
Springer	*Elops machnata*	None	5	
White steenbras	*Lithognathus lithognathus*	60cm	1	Release fishery; slot limits; closed area
Knysna seahorse	*Hippocampus capensis*	None	0	Prohibited species list

Common Name	Species	Size limit	Bag limit	Other and proposed regulations	
Bloodworm	*Arenicola spp.*	None	5	by hand, suction pump or wire	Closed areas; rotational collection areas
Cuttlefish	*Sepia spp.*	None	2	by hand or line	
Mud crab	*Scylla serrata*	140mm - carapace width	6	by hand, rod or line, no females in berry may be kept	
Marine worms	All species excluding *Arenicola* sp.	None	10	by hand or suction pump	
Pencil bait	*Solen spp.*	None	20	by hand, suction pump or wire by hand, suction pump or wire	
Mud prawn	*Upogebia spp.*	None	50	by hand, suction pump or tin	
Sand prawn	*Callianassa spp.*	None	50	by hand or suction pump	
Red bait	*Pyura stolonifera*	None	2 kg**	by hand or blade not exceeding 12 mm width	

* Closed season between 1st of October and the 30th of November
** Excluding the casing (shell)

In addition to these regulations, no fish or bait organisms collected or captured in the estuary may be sold in any form to any other individual or business.

5.5 Illegal Activities

The following illegal activities linked with living resources in the estuary are currently taking place:

5.5.1 Linefishery

- Participants not in possession of recreational fishing licenses
- Subsistence anglers are not in possession of subsistence permits
- Minimum size limits and bag limits are not adhered to by members of all sectors
- Plant lines are set on mud banks
- Selling of catch to residents and restaurants

5.5.2 Invertebrate fishery (includes bait and mud crab)

- Digging for bait with spades and forks and uprooting aquatic vegetation is destroying vital habitat
- Quotas are exceeded on a regular basis; this is the most common infringement evident on the system
- Bait collecting takes place within the designated invertebrate reserve
- There is an unlicensed and uncontrolled subsistence bait selling industry
- Cuttlefish and mud crab are sold to residents and restaurants

5.6 1990 SANParks Master Plan

In 1990 SANParks (then National Parks Board; NPB) compiled a Master Plan that outlined management and conservation objectives for the Knysna National Lake Area (van der Walt *et al.,* 1990). It is interesting to note that the NPB official policy statement (1987) mentioned estuary zonation as being the desired basis for any future management plan; it is precisely this concept that will form the basis of this EMP.

The following objectives and guidelines for achieving these objectives were highlighted in the Master Plan and are considered relevant to the current EMP process with regards to living resources (they are encompassed in the recommendations listed in Section 7):

5.6.1 Objective 1

Ensure sustainable utilization of the estuary.

Guidelines

- Utilization of biotic resources in the water area should only be undertaken in terms of existing regulations
- Disturbance of the inter- and sub-tidal areas through dredging and infilling should be avoided
- Endangered species and essential ecological processes must be identified and conserved

5.6.2 Objective 2

Create an awareness and a positive attitude towards the conservation of the area.

Guidelines

Identify important interest groups in the community and maintain close contact and exchange information with such groups

- Obtain public input into decision-making
- Ensure that rules for the water area are readily available to all users
- Promote interest and involvement by the community as part of an effective communication strategy

5.6.3 Objective 3

Permit multi-purpose use and controlled recreation by the general public, in a local and regional context.

Guidelines

- Apply zoning of the water area, based on ecological features of the area, requirements of various user groups, and adjacent land uses
- Investigate carrying capacities of different management zones for various types of activities and craft

In addition to the regulations then published in the Sea Fisheries Act (Act 12 of 1988), the following restrictions with regards to the catching of fish and bait were also mentioned in the Master Plan:

- No collection of invertebrates allowed in the so-called bait reserve (the existing invertebrate reserve)
- No fishing allowed in the mouth region of the estuary (SANParks could only confirm that the area close to The Heads used by SCUBA divers is currently closed to fishing)
- No commercial fishing allowed in the estuary
- No fish caught in the estuary may be sold privately or publicly (this is included in the new MLRA)
- No person shall catch or attempt to catch any fish or any other marine organism by means of a gaff, spear, club, flail, stick, stone or similar instrument

The Master Plan further recommended the following monitoring program that is relevant to the exploitation of living resources:

- Periodic evaluation of the status of any organism whose continued existence within the Knysna estuary is considered essential for the survival of the species, and whose survival within the estuary is considered to be threatened (currently this applies to the Knysna seahorse and possibly to the juvenile stages of dusky kob and white steenbras)

5.7 Mariculture

Oyster culture in the Knysna estuary was first attempted in 1948 with the Cape rock oyster (*Striostrea margaritacea*). This venture slowly gained momentum through the 1950s and 1960s and by the mid-1960s enjoyed government support which funded a program to develop and promote the industry. By 1973 *S. margaritacea* had been replaced with the Pacific oyster *Crassostrea gigas* and the Knysna mariculture operation became one of the most successful operations in the country (Cowley *et al*., 1998). Since this introduction of *C. gigas* in the estuary in 1973 there have been no incidences of the exotic species having established populations outside of the culture areas. According to the NPB Master Plan (van der Walt *et al*., 1990) three concession holders were permitted to operate in the estuary covering a total area of 23 hectares.

Currently there are two lease areas operated by the Knysna Oyster Company (12.5ha) and South Cape Oysters (4ha) with mariculture rights issued by SANParks and DEA&T respectively. South Cape Oysters were bought out by the Knysna Oyster Company in 2001 but the operation retained its name and so while two leases exist they are operated by the same owner. Juvenile seed oysters (*C. gigas*) are purchased from hatcheries in France, Chile and the UK and stocked into the lagoon where they are cultivated up to a size of around 20g in approximately 7 months. Thereafter,

they are sent to the company's operation located on the lee of the harbour wall in Port Elizabeth, where they are on-grown to market size. The Knysna estuary based operation is essential to the overall operation since small oysters cannot be grown in the open sea at Port Elizabeth, and the intertidal exposure in Knysna produces a better quality oyster, i.e. strong shell, no incidence of polydora infestation and good shelf life.

At present only six hectares of the lease area are being utilized and the stocking densities are very low. The main reason for this is that the survival rate of oysters has dropped dramatically over the last four years from 55% to 20%. The company believes this is largely due to increased pollution levels in the lagoon. This is supported by the extremely high arsenic levels that were detected in tests after a heavy mortality event last year; both SANParks and the Knysna Municipality were furnished with the test results. It would appear that both these institutions are currently trying to identify the sources of pollution and take action to eliminate them. However, the company is still experiencing heavy mortalities with losses of 960 000 oysters and 270 000 oysters in October and November 2007, respectively. With this drop in survival rates the company has been forced to send the oysters to Port Elizabeth earlier and hold lower stock levels in the Knysna estuary to minimise losses; there are currently only 1.2 million oysters in the water in Knysna. Recently the method of farming has been changed from fixed racks to adjustable long lines in an attempt to reduce mortality and improve overall efficiencies.

With regards future operational plans, the company is trying to increase their production and target the export market. To this end they have increased their seed orders for next year and are trying to increase stock levels. Should survival rates improve the overall stock will increase and more of the lease area will be required. Ideally the company would like to carry a stock of no less than seven million oysters in Knysna and reduce stocking densities by spreading the oysters out on new long lines, and therefore utilize much of the lease area which has not been used in recent years.

Since only seed oysters are being cultivated in Knysna, the operation is not required to follow the shellfish monitoring programme required of mariculture operations by DEAT:MCM. All monitoring is instead done in Port Elizabeth where the market stock is produced. Monthly oyster samples are however sent to the Knysna Municipality for testing.

The oyster industry is a major part of Knysna's history and the Knysna Oyster Company itself has played a major role in the development of the town by starting the annual Oyster Festival. This festival has now grown into a major annual event and many businesses in Knysna rely heavily on income generated during the festival to tide them over during the comparatively quiet winter season. In addition, oysters are associated with Knysna and attract tourists all year round; the oyster industry is considered to be a significant marketing tool for the tourism industry. The oyster culture operation is an integral part of the Knysna Oyster Tavern, one of the busiest and most popular tourist destinations in Knysna, and the restaurant benefits strongly from the spin-off clientele which are initially attracted to the activities at the oyster farm.

5.8 Recommendations for Living Resources Management

- A working group that deals specifically with living resources needs to be set up within the framework of a constituted management forum. This group must have representatives from all user groups and comprise a strategy of community involvement through communication.
- The carrying capacity of the estuary needs to be determined and restrictions placed on numbers of users from each user-group if necessary.
- The recent increase in SANParks' capacity to enforce regulations is encouraging and needs to be made known to all user groups. This will help in the following areas:
  - encourage members of the public to report transgressions
  - effective policing of the invertebrate reserve
  - effective enforcement of MLRA regulations, this will include bag limits (fish and bait), size limits, closed seasons, closed areas (if introduced), bait digging and the sale of fish, cuttlefish and mud crabs to restaurants
  - the use of plant lines can be prevented

- Both dusky kob and white steenbras need to be protected, and while a closed area above the white bridge may provide protection for a kob nursery area, a closure of the white steenbras fishery may be required for a predetermined period.
- SANParks have suggested a sanctuary area between the White Bridge and Red Bridge in order to protect sand prawns and mud crabs. This may be considered in the zonation plan and will dovetail well with a protected nursery area for dusky kob, but it is debatable whether sand prawns require protection.
- The status and extent of the closed area near The Heads needs to be determined.
- Investigate whether recreational anglers can be excluded from fishing and collecting bait within the oyster concession areas.
- Competitions result in concentrated effort by competent anglers within a restricted area and it is proposed that all species, not just non-edibles, are released. This is based on the assumption that the aim of competitive angling should be to win without having to kill.
- The format of species-based competitions should be encouraged.
- Slot limits for dusky kob and white steenbras have been proposed by some recreational anglers to protect proportions of both juveniles and spawner stock; this has merits but needs to be investigated in the context of existing National legislation.
- Subsistence fishers need to become organized and have representation within any management set-up; through this they need to apply for subsistence permits allowing both fishing and bait collecting/selling activities.
- Given that it is unlikely that all current subsistence fishers will get permits, a reduced recreational license fee needs to be considered for users who can prove indigence; users indicated they would be prepared to pay a R5 to R10 fee per day as this fee could be relatively easily obtained on an *ad hoc* basis in contrast to the R135 required for an annual fishing and bait collecting license.
- A bait selling industry whereby licensed subsistence users can operate through a SANParks controlled outlet should be investigated; SANParks are not opposed to the idea but caution against the problems of selecting license recipients and monitoring the fishery.
- Restaurants that buy fish, crabs and cuttlefish from estuarine fishers need to be identified and fined; locals know which outlets are the offenders and could possibly boycott them or name and shame them in the press.
- Although populations of bait organisms appear to be in a healthy state, this needs to be monitored and the possibility off rotational collecting areas considered in future.
- It is common knowledge when the white musselcracker enter the estuary; at these times SANParks should dedicate rangers to police fishing activities as they relate to this species.
- Residents have expressed their willingness to fund bait collecting monitors; this possibility should be explored with SANParks.
- Sites where the Knysna seahorse is found need to be clearly marked and proclaimed as sanctuary areas; no collection of this animal should be allowed for display purposes.
- A dedicated fishery monitoring programme needs to be initiated to assess vital components such as catch, effort, *cpue*, seasonality and socio-economic benefits and risks.

6 WATER QUALITY AND QUANTITY DESCRIPTION

6.1 Introduction

The information below describes the Knysna system, i.e. the rivers flowing into the estuary, as well as the estuary itself. As the freshwater inflow to the estuary is essential for its functioning, it is appropriate to describe the incoming river systems (Section 2), including dams and gauging weirs present on these systems and how the Knysna system is operated (Sections 3 and 4). Future water resource developments and water quality status of the Knysna Estuary are covered in Sections 4 and 5 respectively.

A wide range of literature is available for the Knysna system, but particular cognizance is taken of the Internal Strategic Perspective (ISP) prepared for the Department of Water Affairs and Forestry (DWAF) by Ninham Shand and Associates (DWAF, 2004), the Rapid Reserve study conducted by Allanson and Associates and partner organizations in 2004 (Knysna Municipality, 2004), and the set of documents produced for the Outeniqua Coast Water Situation Study (OCWSS), currently being completed. Information on the Knysna River system, the primary freshwater contributor to the estuary, is taken from the reports of the Outeniqua (Knysna/Swartvlei) Reserve study currently being undertaken, namely the Inception (DWAF, 2007a) and Delineation reports (DWAF, 2007b).

The requirement for detailed Reserve (or Ecological Water Requirements (EWR)) studies became apparent during the OCWSS, undertaken under the auspices of the Directorate: National Water Resources Planning of the DWAF and initiated in May 2005. The study area, known as the Outeniqua Coast, covers the coastal catchments between Still Bay and Knysna. The Outeniqua Coast primarily falls under the jurisdiction of the Eden District Municipality (DWAF, 2006a).

The National Water Act (NWA, Act No. 36 of 1998, Section 3) requires that the Reserve be determined for water resources, i.e. the quantity, quality and reliability of water needed to sustain both human use and aquatic ecosystems, so as to meet the requirements for economic development without seriously impacting on the long-term integrity of ecosystems. The Chief Directorate: Resources Directed Measures (CD: RDM) within DWAF is tasked with the responsibility of ensuring that the Reserve is considered before water allocation and licensing can proceed, so as to ensure the adequate protection and effective management of these resources. .

The DWAF, through the CD: RDM, therefore initiated an integrated Reserve determination study for selected surface water, groundwater, estuaries and wetlands in the Outeniqua Coast Catchment. The Reserve determination for the Knysna Estuary will be conducted at an *Intermediate* level, i.e. at a higher level of confidence than previous studies. The higher level of confidence in the Reserve determination results will assist the DWAF to make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

The planning stages for the various tasks of the project were undertaken from October 2006 to April 2007, with the first field surveys being conducted from April 2007 overlapping the final stages of planning. The finalisation of the study will be April 2009, although information on the present state and Recommended Ecological Categories (REC) for the systems will be available earlier in the study.

The Knysna Estuary is of national importance, and although an abundance of data exists for the marine-dominated section of the lagoon, little information is available for the river-estuarine interface. The Knysna Estuary Reserve study will therefore focus on this interface, although the whole lagoon will be considered. For the purposes of the Reserve study, the geographical boundaries are defined as follows (WGS 40) and presented in Figure 6-1 (DWAF, 2007b):

- Downstream boundary: The estuary mouth at the heads (S 34.0778, E 23.0854)
- Upstream boundary: Highest extent of tidal influence (S 33.9982, E 23.0027)
- Lateral boundary: 5m contour above Mean Sea Level (MSL) along the banks

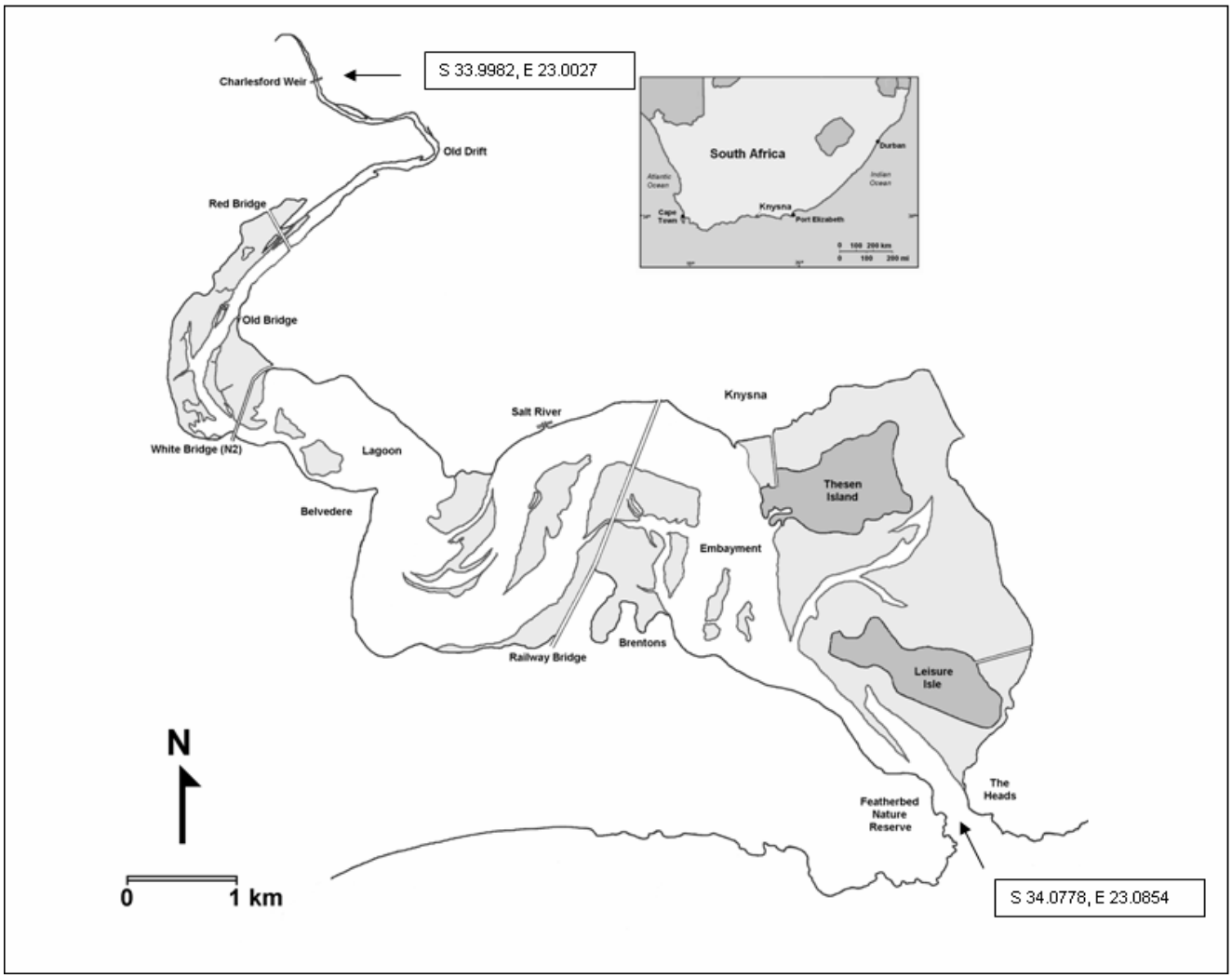

Figure 6-1: Knysna Estuary delineation for the Reserve study

6.2 Study Area

The Knysna River catchment comprises quaternary catchments K50A and K50B, which drain into the Knysna Lagoon. These catchments are located in the Gouritz Water Management Area (WMA) 16.

The Knysna catchment area covers the Knysna River catchment between the Indian Ocean coastline in the south, and the crests of the east-west trending Klein Langkloof mountains (part of the Outeniqua mountain system) in the north. The main tributaries of the Knysna River are the Kruis, Rooi-els and Gouna rivers. The Salt River and Bigai Stream have separate inflows into the Knysna Lagoon. The relevant areas for the Reserve study are the Knysna River, the Gouna River, the Knysna Estuary and Lagoon, the groundwater contributing to the river flow and the groundwater providing microhabitat on the margins of the estuary (DWAF, 2007a).

The predominant land-use in the Knysna catchment is forestry (i.e. 38 % of the total catchment). In 2001, the area of exotic afforestation in the Knysna River catchment was estimated at approximately 17 637 ha. Agricultural development is confined mainly to the farms of Portland, Charlesford, Westford, Eastford, Simola and on the Gouna Commonage. Irrigated food crops are cultivated at Portland, while the predominant agricultural activity is cattle grazing.

There are three streamflow gauging weirs in the Knysna River catchment (Table 6-1). These are weirs K5H001 (Gouna River at Gouna commonage), which has a short and inaccurate data record, K5H002 (Knysna River at Millwood Forest) and K5H003 (Knysna River at Charlesford). The catchment area upstream of weirs K5H001 and K5H002 are 91 km^2 and 133 km^2, respectively. Gauging at weir K5H001 started in 1959, but weir K5H001 was closed in 1984. The Charlesford Weir (K5H001) was completed in May 2003 and is the lowest gauging weir above the estuary. The total catchment area upstream of Charlesford Weir is 345 km^2 and the natural Mean Annual Runoff (MAR) at this weir is estimated at 80 million m^3. The catchment at the mouth of the lagoon (The Heads) is 434 km^2 in extent (Knysna Municipality, 2004).

Table 6-1: Knysna gauging weirs

Station	Place	Latitude	Longitude	Record date
K5H001	Gouna River @ Gouna Commonage	33º 59' 28.0"	23º 02' 33.0"	1959-11-16 to 1984-10-22
K5H002	Knysna River @ Milwood Forest Reserve	33º 53' 24.0"	23º 01' 54.0"	1961-08-02 to 2006-11-28
K5H003	Knysna River @ Charlesford	33º 59' 48.0"	23º 00' 10.0"	2003-05-14 to 2006-11-28

There are five dams which are registered with the DWAF's Dam Safety Office for the Knysna River catchment (see Table 6-2), although other dams do exist (see Section 6.3.4). Three of these are farm dams located on the Portland farm and are used for irrigation. The other two registered dams are the Glebe and Akkerkloof dams with a full supply capacity of $0.180x10^6m^3$ and $0.801x10^6m^3$, respectively. These two dams are owned and operated by the Knysna Municipality (du Plessis *et al*., 2004).

Table 6-2: DWAF-registered dams in the Knysna River

Dam number	Name of Dam	Name of River	Latitude	Longitude	Use of dam
K500-03	Nerina	Knysna River tributary	33°58'01"	22°58'50"	Irrigation
K500-04	Portland	Knysna River tributary	33°57'10"	22°59'20"	Irrigation
K500-05	Lawnwood Lake	Knysna River tributary	33°58'05"	22°59'05"	Irrigation
K500-06	Glebe	Grootkoops	33°58'05"	22°59'05"	Municipal
K500-07	Akkerkloof	Off-channels	33°58'05"	22°59'05"	Municipal

6.3 System Operation (prepared by Stephen Mallory of Water for Africa)

All information on the operation of the Knysna River system, the most important freshwater contributor to the estuary, is taken from the Delineation Report for the Outeniqua (Knysna/Swartvlei) Reserve study (DWAF, 2007b) and recently completed reports on the water situation of the Outeniqua Coast (DWAF, 2006a-d).

6.3.1 Urban water requirements

There are three distinct urban areas in the study area. The current supply to these towns is listed in Table 6-3.

Table 6-3: Urban water use

Town	Current water supply[1]	Allocation[1]
Knysna	3.416	4.827
Brenton-on-Sea		
Belvedere		

1 Unit in million m^3/annum

6.3.2 Irrigation water requirements

Crops irrigated in the study area are mostly vegetables and grazing. Table 6-4 summarizes the irrigation requirements per quaternary catchment.

Table 6-4: Irrigation requirements

Quaternary catchment	Crop area (ha)	Average crop requirement (million m^3/annum)
K50A	1 288	6.54
K50B	282	1.47

Source: DWAF (2006b)

6.3.3 Afforestation

There is a significant amount of afforestation in the study area. The estimated areas and reduction in stream flow are summarized in Table 6-5. Data was sourced from the 1996 CSIR satellite coverage.

Table 6-5: Afforestation - Areas and reduction in streamflow

Quaternary catchment	Afforested area (ha) DWAF 2006c	Reduction in streamflow (million m^3/annum)	
		DWAF, 2006d	Mallory, 2006
K50A	6 096	8.1	4.7
K50B	4 015	5.6	2.8

Source: DWAF (2006c)

6.3.4 Water resources and infrastructure, including the Knysna Regional Water Supply Scheme

The water resources of the Knysna catchments are largely undeveloped. Although there are a number of both instream and off-channel dams in the catchment area (see Table 6-6), they do not have a large influence on the natural hydrology of the catchment. Run-of-river abstraction probably has a larger influence in these catchments. Dam information is taken from the Agricultural Developments report (DWAF, 2006b) which was compiled as part of the Outeniqua Coast Water Situation Study.

Table 6-6: Dams in the study area

Quaternary catchment		On-stream		Off-stream		
	Number of dams	FSA[1]	FSC[2]	Number of dams	FSA	FSC
K50A	10	24.31	522 048	43	23.98	781 065
K50B	3	7.56	133 527	7	3.13	29 862

1 FSA: Full Supply Area (ha)
2 FSC: Full Supply Capacity (m^3)

Only two of these dams are used for domestic supply, i.e. the Glebe Dam located on the Goortkops River and the off-channel Akkerkloof Dam. The approximate supply of these dams is indicated in Table 6-7. Both of these dams are located near Knysna and form part of the Knysna Regional Water Supply Scheme. The remaining dams are used for irrigation, rural water supply and stock watering.

Table 6-7: Dams used for domestic water supply

Dam	FSA[1]	FSC[2]
Glebe Dam	4.5	150 000
Akkerkloof Dam	11	801 000

1 FSA: Full Supply Area (ha)
2 FSC: Full Supply Capacity (m^3)

The Knysna Regional Water Supply Scheme supplies water to the towns of Knysna, Brenton-on-Sea and Belveldere. Water for this scheme is sourced from the Knysna River, the Gouna River, the Glebe Dam on the Grootkops River, and groundwater. The approximate supply from these four sources is indicated in Table 6-8.

Table 6-8: Source of water supply to Knysna

Source of supply to Knysna	Average supply (million m^3/annum)
Knysna River	2.36
Gouna River	0.84
Glebe Dam (Grootkops River)	0.10
Groundwater	0.12
Total	**3.42**

The Knysna River and Gouna River abstractions are both from run-of-river. Water is pumped to a balancing dam which then gravitates to the Knysna Water Treatment Plant. The supply from the Grootkops River is pumped from a small dam (the Glebe Dam) to an off-channel dam, the Akkerkloof Dam. From the Akkerkloof Dam water gravitates to the balancing storage near the water treatment plant.

Groundwater is sourced mostly from five boreholes located near Belvedere and supply only Belvedere. The water supply to Belvedere is however supplemented from the Knysna reticulation system when necessary. In addition, water can be sourced from springs located on the eastern side of Knysna. This water is not treated and is only used occasionally when the capacity of the water treatment plant is exceeded.

Return flow from Knysna was recorded in 2003 as 1.78 million m^3/annum. This takes place in the form of treated effluent which is discharged into the estuary.

6.3.5 Freshwater inflow to the Knysna Estuary

A minimum freshwater inflow requirement during the dry season of 0.5 m^3/s at Charlesford has previously been suggested by Dr Allanson (DWAF, 1997c). However, for purposes of setting guidelines for the operation of the Knysna Bulk Water Supply Scheme, a flow in the order of 0.2 m^3/s was adopted as the minimum flow requirement for critical drought periods (DWAF, 1997). There is evidence, however, that municipal river abstractions may affect the salinity levels of the estuary adversely, even if they allow for the 0.2 m^3/s as the minimum flow requirement for critical

drought periods (DWAF, 1997c), and that 0.2 m^3/s for drought periods only were violated on several occasions since December 2003. The revision of the flows for the estuary is urgently required.

At the time, in the absence of more rigorous biophysical data, a flow of 0.5 m^3/s was deemed as a "desirable flow requirement" (DWAF, 1997c). This output was generated by the Rapid Reserve survey conducted in 2004 for the Knysna Municipality, and will now be updated by the results of the Intermediate Reserve for the Knysna system currently taking place.

6.4 Proposed Water Resource Developments for the Knysna System

The following information was submitted to CES in early 2007 as the potential nodes of development in the area (le Grange, BKS, on behalf of the Outeniqua Coast Planning Study for DWAF, pers. comm.):

- Knysna River at the Charlesford abstraction works (catchment K50)
- Gouna River at the existing weir (part of catchment K50)
- Knysna Estuary

Future water resource developments and planning scenarios for the Knysna area to be managed by the Knysna Municipality, and which will impact on the Knysna Estuary, are encompassed within the following reports. These reports were submitted to CES for the Reserve study by UWP Consulting and prepared by Ninham Shand.

- Knysna Bulk Water Supply: main report (vol. 1) and appendices (vol. 2)

6.5 Water Quality Status of the Knysna Estuary

According to the Rapid Reserve conducted by Allanson and Associates and partner organizations (Knysna Municipality, 2004), the Knysna Estuary receives varying river inflow from less that 0.5 m^3/s to > 100 m^3/s during periods of high rainfall. The tidal flow covers an area of 1827 hectares at HWST (high water of spring tide). These inflows, together with the contribution of stormwater inflow and the Knysna Sewage Treatment Works outflow into the Ashmead Channel, contribute to the supply of nutrients (nitrogen and phosphorus) to the estuarine ecosystem. Dissolved oxygen is sustained at near saturation, i.e. 82% – 97%, throughout the system, and pH increases conservatively with an increase in salinity from Charlesford Weir, i.e. from a pH of 6.5 to 8.2.

New and more detailed studies by Switzer (2004) have shown that the Knysna river catchment contributes considerable quantities of nitrogen to the estuary during spring storms when inorganic and organic fertilizers (urea) are used by dairy and beef farmers in the river catchment. However, intertidal wetlands aid in controlling the trophic status of the estuary.

The maintenance of clear water is critical to the functioning of the Knysna Estuary. However, the high sediment loads entering the system after heavy rains (seen in 1997 and again in August 2006), are contributing to high levels of suspensoids in the Knysna Estuary. Poor land management will result in a continuation of this trend, with a direct impact being a reduction in the eelgrass beds, which will directly impact on the biological state of the Knysna Estuary.

6.5.1 Knysna Estuary Pollution Management Action Plan (KEPMAP)

The Knysna Estuary Pollution Management Action Plan (KEPMAP) Project (Knysna Municipality, 2006) has been initiated by the Knysna Municipality, South African National Parks: Knysna Lake Area (SANParks), Eden District Municipality (Eden) and several individuals / specialists. This group has since formed the Estuary Pollution Prevention Committee (EPPC) to discuss this project and other estuary-related issues.

The project was initiated in response to the growing concern over the health of the estuary and its fitness for use by the residents, business and visitors to Knysna. While the Knysna Estuary has the largest tidal water exchange in South Africa and hence a diluting effect on released effluent thereby maintaining water quality, continued expansion of formal and informal suburban and industrial development areas around the estuary are increasingly having an effect.

The primary aim of the KEPMAP Project is to improve the water quality within the Knysna catchment through the reduction of the discharge of pollutants to rivers, wetlands, vleis and ground water that enter the estuary. A focus of the project will be a reduction on polluting effects at the source. These sources, however, are varied, and estuarine water quality can be impacted by discharges from industrial and municipal sources, contaminated runoff from urban and agricultural areas, erosion and siltation from landscaping and excavation work, contaminated groundwater, changes in the flow regime, over harvesting of aquatic resources, introduction of exotic species, the bioaccumulation of toxic substances and the deposition of pollutants from land and air into the aquatic environment. In addition to this range of influencing factors, there is a further complicating factor in that many forms of water pollution originate from point sources, non-point sources or both.

According to the KEPMAP document, “the estuary continues to be a dumping ground for human liquid and solid wastes. This disposal is not always directly into the estuary but into stormwater drains, the rivers feeding the estuary and through the soils within the catchment, which in turn enters the groundwater table and surfaces in rivers or in the estuary. These disposal practices may either be ongoing or be once-off events. Irrespective they have an effect on the estuary’s water quality and consequences for estuary users”.

The project has identified the following issues with regards to the water quality in the Knysna Estuary and principally the Lagoon:

- Ineffective, overloaded, cracked and leaking septic tanks which release largely untreated sewage into groundwater. Considering the number of such systems within the estuarine basin and the number which may have such problems, it is likely that this has an influence upon estuary water quality
- Polluted stormwater flows from the CBD, industrial areas, formal and informal suburbs/settlements into the estuary. The “first flush” of such stormwater linked to a rainfall event often includes raw sewage, which is carried by surface runoff into streams or stormwater drains and then into the estuary. Much of the stormwater pollution is “nonpoint source” in nature (i.e. cannot be tracked down to a single point of origin, examples being streets and public open spaces)
- Fertilizers, pesticides and herbicides from areas such as agricultural croplands and golf courses within the Knysna River catchment and estuarine basin enter stormwater, streams and groundwater systems which in turn enter the estuary
- Effluent that is treated in the sewage treatment works may still contain chemical pollution that is not removed by the biological treatment process
- Significant erosion from construction sites results in silt-laden and discoloured water entering the estuary changing the light transparency characteristics of the water column which effects the growth of aquatic flora

The KEPMAP Project has drafted a series of Objectives which will result in Action Plans, but these have yet to be implemented. It is anticipated that the Knysna Estuary Management Plan will adopt these Objectives, and add to them if necessary.

7 PROTECTED AREA POTENTIAL

7.1 Introduction

Defining protected area potential is a complex assessment of the need to protect biodiversity, which inherently requires the protection not only of the species concerned, but a significant portion of its habitat requirements (Whitfield, 1998). This involves the assessment of the particular species food and reproductive requirements, together with external factors, which in turn sustain the habitat (e.g. nutrients, tidal inundation, sediment deposition, etc.). It is thus intentional that protected areas are firstly motivated based on a suite of tangible or intangible values, such as threatened species, overall biodiversity or goods and services. What ever the rationale, the protected area must thus serve its intended purpose, while remaining sustainable and if possible not lead to user conflict (Cowling & Hilton-Taylor, 1993).

It is well established in the literature, that the Knysna system (lagoon & estuary) is considered an extremely valuable natural resource, both in terms of biodiversity and socio-economic benefits. With this in mind, previous management plans have thus focused on the commercial and recreational use of the study area, setting resource use targets based on the capacity of the ecosystem (van der Walt *et al.,* 1990).

This section thus deals with the definition of protect area potential within the Knysna Estuary (and Lagoon), firstly dealing in short with past management plans and then secondly by introducing the latest concept of EPAs (Estuarine Protected Areas) of Turpie & Clark (2007), as a potential conservation tool within the study area.

7.2 Background

Various agencies, Non-Governmental Organisations, conservation/research organisations, as well as local stakeholders have been fundamental in developing conservation or management plans for the Knysna system. These have varied from institutional arrangements within SANParks (formerly National Parks Board), the Municipality and conservation groups such as C.A.P.E. (Cape Action for People and the Environment).

Conservation or correctly stated resource use studies have also focused on individual areas or species of concern. The Invertebrate Reserve and the Water Reserve Determination being conducted are such examples. The Reserve determination, a statutory requirement, which focuses on the ecological and system water quantity and quality needs, is a measure of resource protection. The objective of the Reserve determination, thus being to evaluate the attributes of the biophysical system, based on the water requirements, thus ensuring that there is an equitable allocation of water to sustain the environment, as well as basic human needs. This strategy provides an indirect measure of protection of the system with respect to water quantity / quality.

The objectives of the numerous plans have mostly been based on a single premise, that the Knysna system (lagoon, estuary and surrounding shoreline) is considered a valuable resource, to be utilised in a manner to receive maximum benefit, without impacting on the functioning of system. In current terms, this would be defined as enacting sustainable practices, a topic dealt with in detail in the latest draft of the Spatial Development Framework (SDF – December 2007) for the greater Knysna Municipal area. However, with the exception of a few “zone use” and generic studies few of the proposed plans have resolved the issues between creating a developed environment, which would not impact on the environment. Reasons for limited action with respect to implantation of the various plan, have included the following:

1. Conflict between economic development and the environment. The indirect (secondary) impacts such as the need for infrastructure (roads, stormwater and sewage systems) has possibly been the greatest contributor to impact on the system, after resource use (bait collecting) and developmental expansion.

2. Lack of adequate control or management. This is closely linked the capacity to fund and enforce action plans.
3. Conflict in jurisdiction related to governance. This not only in terms of which overarching mechanisms preside of the area, but also in terms of shared infrastructure, managed by the municipality, but owned by Provincial and National structures.

SANParks has been instrumental in driving conservation initiatives within the region, and with the proclamation of the Knysna National Lake Area in 1985 (In terms of Article 2 of the Lake Areas Development Act 1975 (Act 39 of 1975), proclamation number R.224, 1985, Government Gazette No. 10036., sought to further manage and protect the natural resources within the region. The National Parks Board (now SANParks) developed a strategic master plan document for the Knysna Estuary and lagoon, based on decisions of an internal committee guided by socio-economic principles, i.e.

"an attempt to create an environmental awareness, provide an ecological basis for development, and facilitate the ordering of socioeconomic aspects, and thereby ensure sustainable utilization of the area. The ordering of socioeconomic aspects of utilization of the estuary is considered essential in view of the wide variety of different water users, both commercial and non-commercial, which must be accommodated. In this process the rights of the general public, the potential conflict between different users, and the disruption of ecological processes all need to be taken into consideration. All decisions taken will be after consultation with relevant interest groups and authorities."

Excerpt from the Knysna Lakes Master Plan (1990)

7.3 Estuarine Protected Areas

Whitfield (1998) suggested that the only means of protecting our estuarine resources would be to establish Marine Protected Areas, which also focus on the inclusion of estuaries as a means of conservation. Only through the development of the National Water Act (1998), did scientists focus their attention on prioritising estuaries in terms of the conservation needs, due to pressures arising from the need for water. This Resource Directed approach led to the development of several rating systems, which in essence provided a motivation for selecting key estuaries requiring protection (Turpie *et al.*, 2004). The Knysna system, regardless of the rating / ranking system used has always been rated as one of the most important estuaries along the South African coastline.

As time progressed, it was evident, that although, determining the water reserve of an estuary would be paramount in aiding in its protection, the physical management of the resources within the system, as well as development within the respective catchments would need to be considered, so as to ensure continued sustainability.

The establishment of a core EPA network around the South African coastline was thus revisited. The first of a series of reports has been produced in which a number of conservation orientated goals were established based on a systematic conservation planning strategy. These regional based goals are as follows (Turpie and Clark, 2007):

- Representativeness: all estuarine species within a bioregion should be represented in viable numbers in the protected areas network
- Maintenance of ecological processes: the protected area network should allow for connectivity and interaction with other adjoining ecosystems
- Maintenance of fishery stocks: the protected area network should provide enough protection to exploited species that they are able to act as source areas for surrounding exploited areas
- Minimisation of economic opportunity costs: biodiversity targets should be met at least possible opportunity cost, through careful selection of the estuaries included in the protected area network. Estuaries where protection offers greatest economic benefits or lowest economic costs should be prioritised in the EPA selection process

- Implementabilty: consideration should be given to the practicalities of protection in each estuary

Turpie and Clark (2007) further indicated based on their interaction with other estuarine specialists that the Knysna would need to form part of the core EPA network, and any management / conservation plan should provide the following guidelines:

- Half of the of the Knysna system should be included in a sanctuary
- 50% of the shoreline should remain un-developed
- The water resources should be managed within Class A / B (according to the Reserve determination)
- The priority for rehabilitation of the system is "High"

These aspects, with regards viability will be investigated in this project and the Reserve Determination. However a number of guidelines listed by Turpie and Clark (2007) are listed below, to provide an indication of the level of protection the Knysna system would require.

Conservation targets for the respective habitat types measured in percentage aerial cover of the estuarine habitats are as follow:

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

The study by Turpie and Clark (2007) further concluded that in order for conservation targets and goals to be achieved, 80% of temperate estuaries needed some form of partial protection rather than a few with total protection; in many instances this was because the benefits of partial protection were seen to outweigh the management and opportunity costs. Furthermore it became apparent that a greater level of protection of estuaries would be desirable from a socio-economic perspective than would be necessary just in order to meet biodiversity conservation targets. The partial protection of 80% of estuaries was also deemed desirable from a management perspective, in that it would facilitate the introduction of an almost universal sanctuary zone in each estuary which is marked by standard markers, which in turn would facilitate public awareness about the estuarine protection system.

Initial guidelines for the conservation of estuarine biodiversity (Turpie *et al.*, 2004) required that estuaries be assigned to one of three categories, namely:

- Estuarine Protected Areas (EPAs) – part or all of an estuary is a sanctuary, providing protection from consumptive use; state-run; selected with both biodiversity representation and socio-economic considerations in mind
- Estuarine Conservation Areas (ECAs) – co-managed estuaries in which general regulations are augmented by estuary-specific regulations; initiated by local communities through estuary forums which would also design zonation schemes and bylaws; likened to the role of private nature reserves and conservancies in the protection of terrestrial biodiversity, and are generally not considered to contribute to protected area conservation targets because their contribution to conservation is less secure in the long term
- Estuarine Management Areas (EMAs) – to which general regulations apply; at least must have a management plan in order to facilitate compliance with general regulation and maintain estuarine health at an acceptable level

However, due to complications that arise between fully and partially protected systems with respect to national legislation and the subsequent administration of EPAs and ECAs it has been recommended that the above categories be done away with and that zonation be used instead as a general strategy in the management of estuaries (Turpie and Clark, 2007). Essentially this means that the estuaries selected to form part of an overall protection network should contain a sanctuary zone and should receive sufficient protection and sufficient quantity and quality of freshwater inflows to be maintained in an appropriate state of health.

The zonation strategy means that individual estuaries may contain a fully-protected (sanctuary) area which would include terrestrial margins, and a conservation area that would be zoned according to the vision and objectives/requirements for that estuary. Sanctuary areas would fulfill the same function as an EPA and as such would have to be set up and managed by an organ of the state. Conservation areas may be managed by a wide variety of styles within a co-management setup where the community and an estuary management forum are the main role players. By adopting a system like this on all selected estuaries, it is likely to be easier and more efficient to manage the entire network, especially if similar rules apply and similar markers and mapping styles are used in all estuaries to denote sanctuaries and other types of use zones (Turpie and Clark, 2007).

Several such zones presently exist within the Knysna system, the Invertebrate Reserve and recreational use zones, being the most noticeable. During the course of this project, other species or areas of concern will also be assessed, based on the criteria or targets set above. The viability and implementation will be discussed, in relation to practicality and costs of management.

8 GIS MAPPING

At this stage of the Knysna Estuary Management plan process, only two maps have been produced, one (Figure 8-1) showing the sensitive environments of the Knysna system i.e. saltmarshes, sandbanks, freshwater wetlands and water area, as well as the Knysna erven (data supplied by Dr Tommy Bornman, NMMU), and a second map (Figure 8-2) indicating the recreational use zones (fishing, birding and skiing areas), subsistence fishing areas (preferred and those which subsistence anglers are no longer allowed to fish from), bait exploitation areas, oyster beds, the Invertebrate Reserve and drainage lines and discharge points where rivers and stormwater outlets discharge into the system. The recreational use zones and subsistence fishing areas were identified by stakeholders and users in Knysna. There seems to be some confusion with regards to the skiing zone and which areas are off limits, but the areas shown are those indicated by SANParks that are used by skiers.

Potential protected zones and restricted fishing areas have not been proposed at this stage – these will be suggested in consultation with relevant stakeholders (see Section 9 – Public and Authority Participation and Way Forward), meeting the criteria proposed in Section 7 – Protected Area Potential, and encompassing areas inhabited by the critically endangered invertebrate species identified in Section 3 – Biophysical Description. The sensitive areas identified will be further investigated during the next phase of the process to establish the restoration actions required (if any) and suitability for protection status.

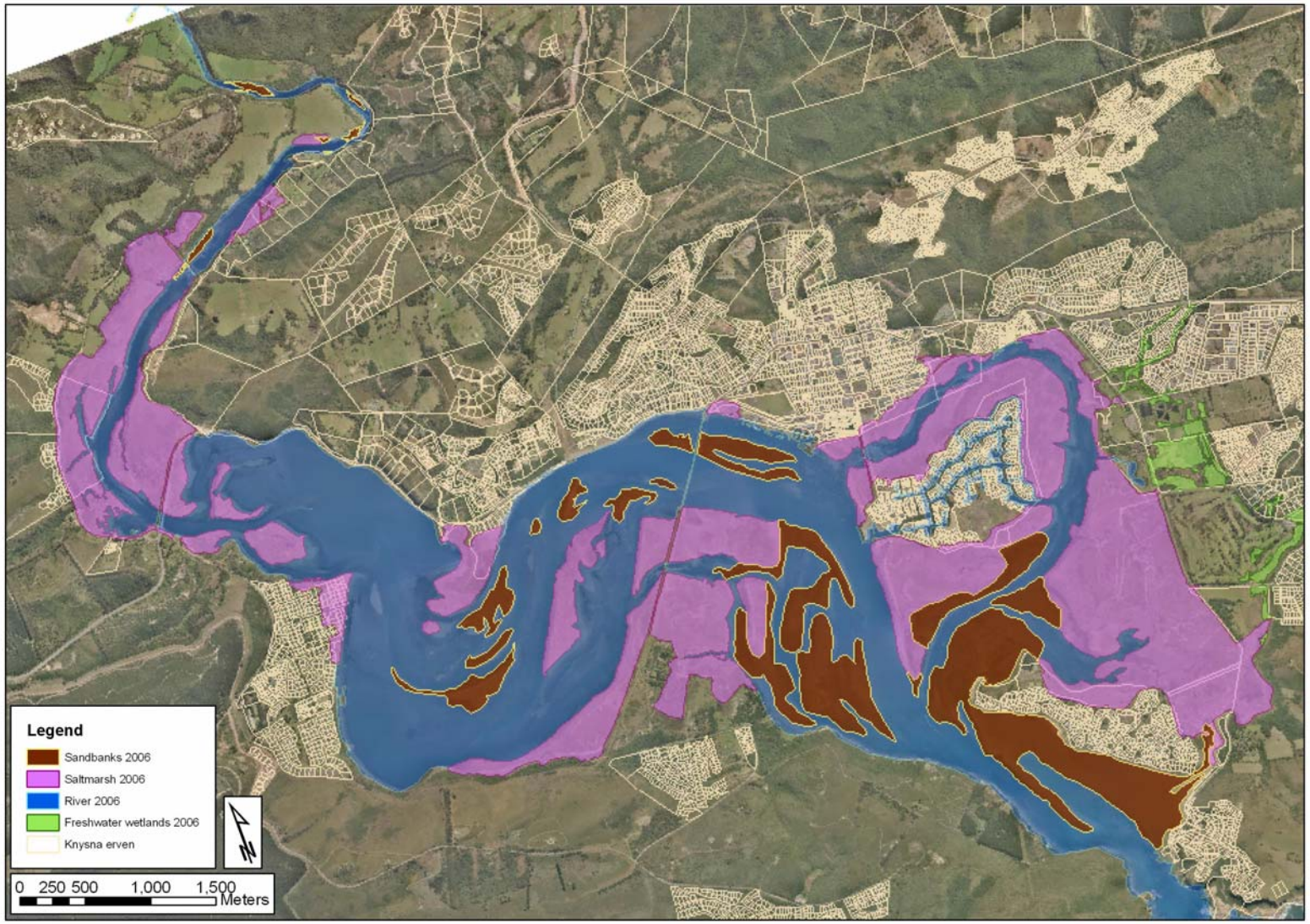

Figure 8-1: Knysna Estuary and Lagoon sensitive areas and Knysna erven

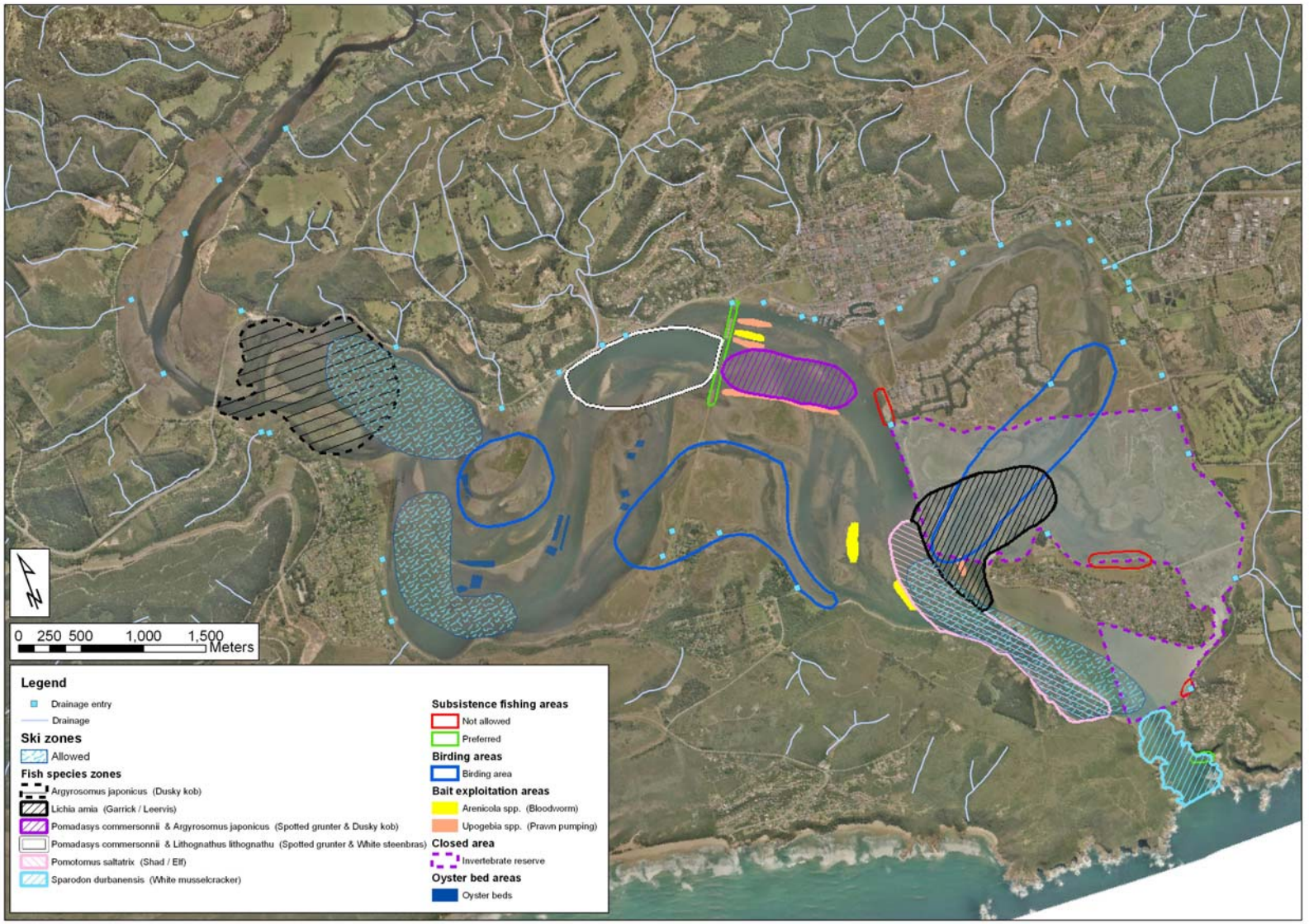

Figure 8-2: Knysna Lagoon resource use and drainage areas

9 PUBLIC AND AUTHORITY PARTICIPATION AND WAY FORWARD

The research for the Knysna Estuary Management Plan: Situation Assessment has involved a thorough examination of the available literature on the system, as well as information gathering through the consultation of various local stakeholders – their input and assistance thus far has been appreciated. To date, the following the groups or organisations consulted:

- Thesen Island Rate Payers Association
- Knysna Angling and Diving Association (KADA)
- Wildlife and Environmental Society of South Africa (WESSA), including representatives of the Knysna Catchment Management Forum and the Knysna Environmental Forum
- Knysna Basin Project
- National Sea Rescue Institute
- SANParks
- Knysna Tourism
- Knysna Municipality

Prior to the above meetings, e-mails about the Knysna Estuary Management Plan was sent to all stakeholders registered as Interested and Affected Parties (I&APs) on other environmental assessments in the Knysna region, and Background Information Documents were distributed. Associated with the e-mails was a preliminary survey form inviting comment about both use and concerns associated with the Knysna Estuary. The information gathered has not only been used in the Situation Assessment, but has given guidance to the anticipated Strategic Objectives that will be identified in the next phase of the Knysna Estuary Management Plan.

The next phase will involve an initial review of comments received on the Situation Assessment. Alternatively, comment can be reserved for the Estuary Management Plan public meeting / workshop, which will be in Knysna in late January / early February 2008. At this workshop the Situation Assessment will be discussed and a Vision and Strategic Objectives for the estuary / lagoon decided on. The Vision for the estuaries of the Cape Floristic Region is:

"Our estuaries are beautiful, rich in plants and animals, they attract visitors, sustain our livelihoods and uplift our spirits."

The Knysna Estuary Vision will be adapted from this, and associated with it will be a list of Strategic Objectives. These are qualitative statements of value and of outcome rather than the process involved to achieve them. These will be prioritized to guide subsequent management decisions, and will be decided on at the public meeting / workshop. At the workshop, members to sit on a Knysna Estuarine Forum will be suggested. This forum will include representative groups from all key institutions and local authorities, and will oversee the implementation of the Estuary Management Plan.

The subsequent phase of the Knysna Estuary Management Plan will be the writing of the Management Plans themselves, based on the Strategic Objectives used to guide focus. As part of this phase, an Estuary Zonation Plan will be developed, incorporating existing information for example in the Knysna Spatial Development Framework, as well as recommendations arising from and as a result of decisions made based on the information in the Situation Assessment. Operational Objectives specifying the quantitative, measurable standards, target values, limits or thresholds of potential concerns will accompany the Estuary Zonation Plan, and together they will be a "blueprint" against which all developments and activities will be tested for compliance. The Management Plans will include the following, per area identified as requiring attention through the Strategic Objectives:

- A prioritised list of management action plans
- Related legal, policy and / or best practice requirements
- Monitoring plans including key indicators

- A detailed work plan identifying when each action should be carried out
- An assignment of responsibility per action
- A resource plan (human and financial) for implementation

Through the above mentioned plans, the estuary can be effectively managed through effective communication, identifying resource requirements, responsibility and action items, which can set the trajectory of the system towards meeting the Vision for the Knysna Estuary.

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