



C.A.P.E. Estuaries Management Programme



OLIFANTS ESTUARY SITUATION ASSESSMENT

April 2008



ANCHOR
ENVIRONMENTAL

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EXECUTIVE SUMMARY (ENGLISH)

Introduction

The Olifants estuary is one of the largest of South Africa's 279 estuaries, with a total area of 702 ha of typical estuarine habitat plus 797 ha of floodplain saltmarsh, together making up 1499 ha. It is one of the most important estuaries in the country from a conservation perspective. The estuary is also noteworthy in that it is perhaps the least developed of the large permanently-open estuaries in South Africa, providing a valuable sanctuary for flora and fauna as well as for visitors. However, mounting pressures could reduce this value, as water abstraction and pollution degrades estuary condition, fish stocks are affected by small-scale fishing, and demand for development proceeds up the West Coast. Nevertheless there is still good opportunity for proactive planning to form a vision for the estuary and set in place a management strategy that will achieve that vision.

Anchor Environmental Consultants cc was tasked with preparing the management plan for the Olifants estuary Cape Action Plan for the Environment (C.A.P.E.) Regional Estuarine Management Programme. This Situation Assessment forms the background material for the development of the management plan.

Geographic and socio-economic context

The Olifants Estuary lies 250 km north of Cape Town on the West Coast and forms the mouth of the Olifants-Doring river system. The Olifants-Doring Catchment straddles the Northern and Western Cape Provinces, and the estuary is located in the Matzikamma Local Municipality, within the West Coast District Municipalities in the Western Cape Province. The estuary extends from its permanently open mouth (31°42'S; 18°11.34'E) some 36 km upstream to the low water causeway near Lutzville (31°33.8'S; 18°19.78'E). The channel, varying from 550 m wide just upstream of the mouth to 20 m at the head of the estuary. Depth is mostly 2-3m. The lateral extent of the estuary is defined by the limit of estuarine vegetation, including floodplain saltmarsh.

The estuary drains one of the largest catchments in the country. Rainfall in the catchment ranges from 1500 mm in the south down to 300 mm in the north. The area is largely arid, dominated by Succulent Karoo vegetation, as well as having Fynbos vegetation in the south and Nama Karoo vegetation in the north. The winter rainfall in the south is the dominant source of flow into the estuary, via the Olifants River, whereas the Doring River, its major tributary, is intermittently dry. The Doring is more saline and carries more suspended solids than the Olifants due to differences in catchment soils. Flow is regulated by the Clanwilliam and Bulshoek Dams on the Olifants River, and there has been a proposal to increase the capacity of the Clanwilliam Dam.

This is the most sparsely-populated catchment in the country, with most of the population in the Koue Bokkeveld and Olifants River Valley. The population is predominantly Coloured (70%) and White (20%), and more than 90% of people are Afrikaans-speaking. The majority are poor, but employment levels and services are reasonable compared with the rest of South Africa. Much of the land around the estuary is communal land belonging to the Ebenhaeser community but is currently held in trust by the state.

90% of the catchment area is untransformed, much of this in nature reserves and the rest used for livestock. There is some dryland farming (e.g. rooibos tea) and significant irrigation along the Olifants River (e.g. citrus, grapes). Mining for gypsum, salt, sand and diamonds also features in the area. Agriculture is the backbone of the area's economy, though tourism is also growing in importance.

Ecological characteristics and functioning of the estuary

The mouth of the estuary is permanently open. The Lutzville bridge marks the extent of tidal water level fluctuations. The mean annual runoff reaching the estuary varies around 715 Mm³/annum, some 33% less than in the natural state. Both low flows and winter flood peaks have been reduced, reducing the input of sediment to the estuary. This is thought to have deepened the channel, allowing tidal penetration further upstream. Unlike under natural conditions, when it was rare, the estuary now experiences a marine-dominated state for about 6

months of the year (November to April), replacing a situation where saline water only extended to the middle reaches. A freshwater-dominated state prevails during winter.

Salinity distribution in the estuary affects the distribution and abundance of plants and animals. Marine dominance in summer means that salinity penetrates far into the estuary, measuring 5ppt some 20km upstream throughout the water column. In winter, freshwater flows out on top of the saline water, and the latter only penetrates a short distance upstream. The estuary is warmer in summer than winter and has lower oxygen concentrations in summer. Oxygen gets depleted in deeper, slower moving water, especially in the middle of the estuary in summer. Water clarity is affected by the relative input from the Olifants catchment (clear), Doring catchment (turbid) and the sea (clear), with the estuary being clearer in summer than winter.

Nutrients (e.g. nitrogen, phosphorus, silica) enter the estuary in sea (especially during upwelling) and river water (especially following first rains), but the contribution by river water has increased enormously in recent decades due to agriculture, leading to problems of weed growth in the estuary.

Microalgae form the bottom of the food chain and comprise the phytoplankton in the water column and the benthic microalgae on the bottom. The phytoplankton is dominated by flagellates in river dominated areas and diatoms in marine-dominated areas, and their abundance is influenced by the concentrations of nutrients. Little is known about the benthic microalgae, but their abundance in winter does reflect the high nutrient loads of the system.

Vegetation of the estuary can be divided into four types of communities: (1) Macroalgae include the seaweeds at the mouth as well as species indicative of nutrient enrichment near the top of the estuary. The latter include the mat-forming duckweed, which is abundant in the upper reaches, and *Enteromorpha*, which fouls boat propellers and pumps. (2) Submerged macrophytes comprise pondweed, which forms dense beds in the upper reaches, and which has increased due to nutrient enrichment, and eelgrass, which grows in the lower reaches, providing important habitat for juvenile fishes. (3) Reeds and sedges are important for function and diversity, but do not tolerate high salinity and have receded upstream due to reduction in freshwater inflows. (4) Salt marsh occurs mainly in open estuaries, and the Olifants contains a high proportion of this habitat in South Africa. It contributes to system productivity and biotic diversity, providing habitat and shelter for numerous invertebrate and bird species. The salt marshes of the Olifants estuary are also fairly unusual, with saltmarsh on the floodplain a remnant of a larger system in the past. Despite grazing and some clearing, disturbance to salt marsh has been only minor.

The invertebrate community comprises zooplankton and the benthic communities in and on the sediments. The invertebrate communities of the Olifants estuary are characterised by high abundance relative to other South African estuaries, and high species richness for the west coast, where diversity is usually fairly low. The dominant invertebrate species are *Pseudodiaptomus hessei* (zooplankton), the amphipod *Melita zeylanica*, the crown-crab *Hymenosoma orbiculare* (hyperbenthos), the polychaetes *Ceratonereis keiskamma*, *Desdemona ornata* and the amphipods *Corophium triaenonyx*, *Grandidierella lutosa* and *Melita zeylanica* (benthos). Zooplankton and hyperbenthos abundance is highest in the middle reaches of the estuary and subtidal benthos is highest at the top of the estuary. These invertebrates are important in the diets of fish and birds.

Fish are particularly reliant on estuaries for sheltered habitat in southern Africa, and different species depend on them to different extents. A total of 38 fish species from 30 families have been recorded in the Olifants River Estuary, of which 18 can be regarded as either partially or completely dependent on the estuary for their survival. These include some highly valuable species such as white steenbras, as well as harders. The estuaries on the west coast are crucial in maintaining the range and stock integrity of estuarine and estuarine dependent species along the entire west coast, and the Olifants estuary is an important nursery area. The decline in the harder stock and marine gill net fishery catches on the west coast has been attributed to recruitment over-fishing in the Berg and Olifants estuary gill net fisheries. It is likely that there have been significant changes in the fish fauna compared with natural conditions, with a reduction in diversity and fish sizes having occurred due to changes in freshwater flows and fishing. Harder and estuarine round herring are now the dominant fish species in the estuary, and elf also make up a significant proportion of fish numbers. The majority of estuary-dependent species are most

abundant from 5-20 km from the mouth, in salinities of 0-20 ppt and water clarity less than 100 cm. Adequate protection need to be applied to the entire estuary, however, to ensure the survival of these species as they are highly mobile moving from the mouth right up to the top of the estuary.

Birds are probably one of the most important components of the estuary's biodiversity. The diversity and numbers of birds are very high, due to the size and diversity of habitats on the estuary, and its lack of disturbance. Some 72 water bird species occur on the estuary (not including vagrant visitors), of which 21 are long-distance migrants that mostly spend the summer on the estuary. Bird numbers swell from 3200 in winter to 5900 in summer, on average, though much higher numbers have been recorded at times. The area near the mouth supports about 80% of the birds of the estuary (apart from the marine cormorants at the rocks), and 90% are found within 9km of the mouth. Different species are characteristic of different habitats. Intertidal habitats support the highest densities. Very low densities of birds occur in the saltpan and supratidal marshes, but the community composition is distinct. The sandbanks in the lower estuary are important roosting areas for terns and gulls. The upper reaches are home to waterfowl which tend to prefer fresh or brackish habitats. Apart from the marine cormorants, the birds on the estuary include invertebrate feeders (mostly waders), piscivores (mostly terns), herbivores (waterfowl) and generalist feeders (gulls), with the first two groups being dominant in summer. The bird community is highly responsive to change reflecting wet and dry years on the estuary.

Ecosystem services

Estuaries can provide a range of services that have economic or welfare value. In the case of the Olifants estuary, the most important of these are the small-scale fishery, the recreational value and the nursery value of the estuary. There may be additional values, such as carbon sequestration, but these are not well understood and are probably fairly minor.

The estuary currently supports a small-scale gill net fishery involving about 45 permit holders and their crew, as well as a number of unlicensed fishers. The fishery lands about 100-200 tons of harders, plus some 0.4 – 1.2 tons of by-catch species per annum. Fishing mainly takes place during the summer low-flow period. The fishery provides a substantial portion of income to fisher households, and is estimated to be worth over R0.5 million per year in total. However, evidence suggests that the current catches are not sustainable. MCM plans to terminate the small-scale fishery within a few years.

The estuary provides a nursery area for several fish species that are caught in the commercial and recreational inshore fisheries along the west coast, including harders, white steenbras and dusky kob. The latter two species once made up a substantial proportion of these catches but their stocks have since collapsed. Estuarine fish make up about 25% of the value of the gill- and seine-net fisheries and 0.3% of the value of the commercial boat fisheries on the west coast, or about 8% of the overall value of West Coast inshore marine fisheries, and the Olifants contributes about 23% of the estuarine habitat. Taking into account the degree to which these fish are dependent on estuaries, the nursery value of the Olifants estuary is estimated to be some R3.45 million per year.

The estuary is striking against its arid backdrop, and with its fishing and birdwatching opportunities, provides a high quality recreational experience which is generally uncongested. Unlike most large estuaries in South Africa, there is no major urban settlement around the mouth of the Olifants estuary, though Strandfontein village is nearby, and visitors can also stay at a guest house or camping area beside the estuary at Papendorp. The bulk of the Olifants estuary linefish catch is made within 500 m of the mouth and comprises silver kob (collapsed), Angolan kob, white steenbras (collapsed), west coast steenbras (overexploited) and elf (overexploited). The status of these stocks is due to the general decline in the country. Recreational anglers value the sport and experience, and expend considerable sums on this activity, largely irrespective of their catch returns. Although small, the Olifants estuary recreational fishery is probably worth R0.6 – R1.3 million per annum.

Legislation and management issues

Little legislation has been designed for estuaries in particular. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are affected by a large number of policies and laws. There is no specific provision for Estuarine Protected Areas. Estuary management falls mainly under two national government departments: the Department of Water Affairs and Forestry, responsible for water resources, and the Department of Environmental Affairs and Tourism (DEAT), responsible for everything else, e.g. land use, living resources. Environmental management in most instances is devolved to provincial level. Management and conservation of marine living resources is an exception in this respect, with responsibility residing with the Branch Marine & Coastal Management (MCM) of DEAT. At a municipal level, by-laws are passed which cannot conflict with provincial and national laws. The Olifants estuary lies wholly within the Western Cape Province, within the West Coast District Municipality and the Matzikama Local Municipality.

Water quality and quantity are mainly controlled under the *National Water Act 36 of 1998*. This makes provision for an environmental Reserve which provides the quantity and quality of water flow required to protect the natural functioning of each water resource, including estuaries. The extent to which an estuary's functioning is catered for is determined by the designated future management "class" (where classes A – F describe state of health), called the Ecological Reserve Category (ERC). In future this will be determined in a recently-developed, holistic classification process. Meanwhile it is decided by DWAF on the basis of a recommendations made from a reserve-determination study ("Resource Directed Measures") and socio-economic considerations. Such a study was completed for the Olifants estuary in 2006. The study determined that the estuary is currently a C-class estuary (= moderately modified). Implications of several possible future flow scenarios were determined, and on the basis of this and the national importance of the estuary, the recommendation has been made to provide enough flow (i.e. restore some flows) to raise the estuary to a B-class (= largely natural). Water quality specifications were also recommended based on maintaining a B-class estuary, which means taking measures to control inputs of organic and inorganic pollutants entering the river and estuary. A final decision on the ERC has yet to be taken by DWAF.

Exploitation of living resources in the estuary is governed by the *Marine Fisheries Policy for South Africa (1997)* and the *Marine Living Resources Act (1998)*. The policy supports sustainable use of resource and use of these resources for economic growth and development as well as ecosystem and biodiversity protection. There are serious concerns that the negative impacts of the fishery may outweigh its benefits. Gill net fisheries are particularly efficient in estuaries and can thus erode stocks to the point where there are serious impacts on estuarine health as well as on the value of the estuary as a nursery area to the far more valuable coastal fisheries. MCM devised a policy in 2003 to eliminate commercial fishing in estuaries, rescinding all permits on the Berg estuary, but giving the Olifants estuary a period of 10 years to phase out gill net fishing because of its importance to Ebenhaesar community. Since then, independent research has asserted that the fishery is sustainable, although operating well below maximum economic yield, which is characteristic of open access or lack of management. The community has expressed a willingness to engage in co-management with MCM, perhaps because of the opportunity this could present to improve the economic value of the fishery, but MCM stands firm with its intentions out of concern for the recovery of collapsed stocks.

Under the Seashore Act of 1935, the estuary up to the high-water mark belongs to the state. The Coastal Management Bill requires that a management plan be developed for each estuary. The Bill also requires a development setback of 100m from the high tide mark (including in estuaries) in areas zoned for residential, industrial or commercial land use and a much larger development setback of 1km for public land and land zoned for agricultural use. In the case of the Olifants, all land surrounding the estuary falls into the latter categories, and thus in terms of this bill a setback of 1km will be required around the whole estuary. Within this setback, no new land transformation or development may take place without a permit issued by the minister. There is also provision to create a larger setback line under the Integrated Coastal Management Bill where necessary. Note though that an exemption has been afforded to landowners afforded in respect of land clearance activities on the land below the irrigation canal and certain other areas adjacent to the Olifants estuary in terms of the Conservation of Agricultural Resources Act of 1983 & National Environmental Management Act of 2006. It is likely that this

exemption will be applicable in terms of the Coastal Management Bill as well when it is finally enacted, but is probably applicable to land clearance for agriculture only. This needs to be confirmed.

The Municipal Systems Act (2000) requires the identification of development priorities for each province, district and local municipality, and the expression of development plans in a spatial layout. The latter in turn, has to be formalised in a detailed land use and management plan. Thus the key land-use decision-making is undertaken by the local municipalities, in this case the Matzikama Municipality. Their plans have to fit in with broader scale plans of the district and province.

The Western Cape SDF highlights the conservation importance of the Olifants estuary at a national level but offers little of specific relevance to the management of the Olifants estuary. The district IDP and SDF advocate conservation of environment and natural resources as well as historical buildings and structures, but do not specifically mention the estuary. The Matzikama Municipality SDF acknowledges the importance of the estuary within the region but provides little specific guidance for the management thereof. However, there exists a Management Plan Guideline document (Urban Dynamics 1998) developed specifically for the lower Olifants River that was prepared for the West Coast District Municipality as part of the original IDP development process. This document was designed to provide the framework for the IDP, and includes a management framework, zonation plan and guidelines for conservation and development of the estuary and surrounds. It proposes a biosphere reserve-type approach for the area, incorporating a small core conservation area surrounding the mouth of the estuary, a transition zone surrounding the Olifantsdrif settlement, and the remainder of the study area being proposed as buffer zone. It was proposed that the entire area be gazetted as a Protected Natural Environment under the Environment Conservation Act (1989), with attendant regulations governing use of natural resources (e.g. land use and activities in the core being restricted to those that further the conservation objectives of this zone, all development below the 10 m contour being banned in this zone). It also proposes that application be made for Ramsar Status for the area considering its conservation importance. While this proposal is now somewhat dated it does none the less provide a good starting point for the development of the current management plan.

There is currently little development and use of the estuary margins, though there has been some loss of saltmarsh. Nevertheless, applications for development around the estuary margins have been made and are likely to increase in the future, bringing associated challenges for managing use of the estuary. Recreational use is low, but will probably increase, and will need to be managed to limit disturbance. Key concerns are light aircraft, quad bikes and speedboats which cause disturbance to habitats and fauna.

The area falls within a strip of diamond mining concessions along the west coast, with offshore and terrestrial concessions straddling the estuary mouth area. These have been mined in the past and are not active at present. Any activity would have to be preceded by an environmental impact assessment and would require an environmental management plan. The commercial salt pan has no significant impact on the estuary.

The Olifants estuary does not have protected area status, but is worthy of such, being rated as the second most important estuary in South Africa from a conservation perspective. It has been identified as a priority for protected area status in previous and recent estuary conservation planning exercises, including the recent estuary conservation planning exercise completed under the CAPE Estuaries Management Programme. The latter study recommended the partial (no-take) protection of some 80% of temperate estuaries as a more efficient and practical strategy than selection of a few whole systems. Given the importance of the Olifants estuary, it is specific recommendations are made as follows, to be further developed in consultation with stakeholders, are as follows:

1. Establish a nature reserve encompassing most of the estuary including supratidal estuarine habitats;
2. Establish the entire estuary below the high tide mark as a Marine Protected Area;
3. Develop a zonation plan in which 50% of the MPA (not necessarily contiguous) is declared a no-take zone;
4. The whole protected area to be managed by the provincial authority (CapeNature);

5. Incorporate Papendorp as a heritage site, putting restrictions on the extent and type of development allowed in that area in order to retain its character

The Olifants estuary has also been identified as one in which there is a need for rehabilitation. In the case of the Olifants estuary restoration of the estuary to a better state of health would be very straightforward, and would mainly entail (in order of priority):

1. Reduction in fishing catch;
2. Restoration of the quantity of freshwater inflows;
3. Restoration of water quality; and
4. Removing the barrier effect of the Lutzville causeway.

In general, the degree to which these factors should be managed to restore the health of the system depends largely on the vision that is developed for the estuary, and on its future protection status.

ALGEHELE SAMEVATTING (AFRIKAANS)

Inleiding

Die Olifants getyrvier is een van die grootste van Suid-Afrika se 279 getyrviere. Die bepaalde totale area van 1499 ha bestaan onderskeidelik uit 702ha kenmerkende getyrvier habitat en 797 ha vloedplein soutmoeras. Vanuit 'n bewaringsperspektief is dit een van die belangrikste getyrviere van Suid-Afrika. Ondermeer is die getyrvier noemenswaardig in dat dit 'n waardevolle toevlug vir flora, fauna en die mens, insluitende dat dit seker die mees onderontwikkelde van die groter permanent-oop riviermondings van Suid-Afrika is. Sulke waardes kan in gedrang wees a.g.v. aktiwiteite soos wateronttrekking en besoedeling wat die algehele getyrvier kondisie afbreek, 'n kleinskaalse visserye wat staande visgetalle verlaag en behoefte vir ontwikkeling teen die Weskus. Daar is wel geleentheid om 'n visie saam te stel vir hierdie getyrvier en om 'n bestuurstrategie in plek te kry.

Anchor Environmental Consultants cc was aangestel om 'n bestuursplan vir die Olifants getyrvier, Kaap Aksieplan Vir Die Omgewing (Cape Action Plan for the Environment – C.A.P.E.) Streeks Getyrvier Bestuursprogram (Regional Estuarine Management Programme) saam te stel. Die toestand skatting vorm die agtergrond materiaal vir die ontwikkeling van die bestuursplan.

Geografiese- en Sosio-Ekonomiese konteks

Die Olifants getyrvier lê ongeveer 250 km noord van Kaapstad op die Weskus en vorm die mond van die Olifants-Doringrivier sisteem. Die Olifants-Doring opvangsgebied dreineer die Oostelike en Westelike Kaaprovisinsies, waar die getyrvierseksie deur die Matsikama Plaaslike Munisipaliteit vloei wat in die Weskus Distrik Munisipaliteite in die Weskaapse Provinsie is. Die getymond strek van sy permanente opemond (31°42'S; 18°11.34'E) tot ongeveer 36km stroomop tot by die laagwater kruising naby Lutzville (31°33.8'S; 18°19.78'E). Die hoofkanaal wissel van soveel as 550m breed net bokant die mond van die getyrvier tot so min as 20m in die boonste areas van die sisteem. Die totale diepte wissel van 2 tot 3m. By definisie strek die getyrvier van sy aansluiting met die atlantiese oseaan tot en met die grense van die getyrvier plantegroei en vloedvlakke soutmoeras.

Die getyrvier dreineer een van die grootste opvangsgebiede in die land. In die opvangsgebied wissel die reënval van 1500mm in die suide, tot 300mm in die noorde. Die area is 'n dorre gebied en word oorheers deur vetplante sowel as fynbos plantegroei in die suide en nama karoo plantegroei in die noorde. Die winterreënval in die suide voed die getyrvier via die Olifantsrivier, waar die Doringrivier, sy grootste sytak, meestal droog is. Die Doringrivier sytak is hoofsaaklik sout in gehalte en dra baie opgeloste vastestowwe in vergelyking met die Olifants wat toegedra kan word in verskille in opvangsgebied grondstowwe. Die Clanwilliam Bulhoek damme op die Olifantsrivier reguleer vloei. Daar was onlangs voorgestel dat die kapasiteit van die Clanwilliam Dam verhoog word. In vergelyking daarmee huisves die Olifantsrivier opvangsgebied die mees ylverspreide populasie in die land waarvan 70% kleuring en 20% wit en 90% van hierdie mense is Afrikaanssprekend is. Die meeste van die mense is arm, werkskeppingsgeleenthede vergelyk goed met die res van Suid-Afrika. 'n Groot gedeelte van die grond om die getyrvier is gemeenskapsgrond wat aan die Ebenhaeser Gemeenskap behoort.

90% van die opvangsgebied is onbewerk waarvan 'n groot gedeelte natuurreserve is en die res gebruik word vir veeweiding. Langs die Olifantsrivier is daar droëland boerderye, sowel as gewigtige besproeiings aktiwiteite, maar daar word ook vir 'gypsum', sout, sand en diamante gemyn. Boerdery is egter die ruggraat van hierdie area se ekonomie, maar toerisme begin 'n al belangriker rol speel.

Die funksionering en Ekologiese karaktereenskappe van die getyrvier

Die Sondags getyrvier het 'n permanente ope mond. Inkomende getye strek slegs sover as die Lutzville brug. Die gemiddelde aantal vloei per jaar vir die sisteem wissel van ongeveer 715 m³/jaar, wat ongeveer 33% minder is as die beraamde jaarlikse vloei per jaar onder natuurlike kondisies. Oor tyd was beide die lae vloei sowel as die winter piek vloede verminder wat die fluks van sand in die sisteem in laat verminder. Daar is beraam dat dit die kanale kon verdiep het, wat ook veroorsaak dat getye hoër op in die sisteem kan penetreer. Onder normale kondisies was die proses raar. Daar word nou gevind dat die sisteem redelik gedomineer word deur

mariene kondisies gedurende ongeveer 6 maande van die jaar (November tot April). In vergelyking het mariene water slegs tot die middel areas van die getyriewer gepenetreer in die verlede. Gedurende die wintermaande kan die getyriewer wel gedomineer word deur varswater kondisies.

Die bevolkingsgetalle en verspreiding van plante en diere in getyriewer word geaffekteer deur die soutgehalte verspreiding. Mariene dominansie gedurende somermaande beteken dat soutwater die getyriewer ver op penetreer, waar 5ppt sowat 20 km stroomop reg deur die water kolom gemeet is. Gedurende wintermaande vloei varswater uit bo-op die soutwater, wat dan keer dat soutwater te ver die sisteem op penetreer. Die getyriewer is warmer gedurende die somer in vergelyking met winter met laer suurstof konsentrasies in somer. Suurstof gehaltes is laer in dieper, stadig bewegende water, veral in die middel van die getyriewer gedurende somer maande. Die water helderheid word onderskeidelik geaffekteer deur die relatiewe inset vanaf die Olifants opvangs (helder), Doring opvangs (turbulent) en die see (helder), waartydens die getyriewer helderder is gedurende die somermaande in vergelyking met wintermaande.

Voedingstowwe (bv. Stikstof, fosfaat, silika) beland in die getyriewer deur die see (veral gedurende opwelling aktiwiteite) en die rivier water (veral net na die eerste reënval). Van belang is die feit dat bydrae deur rivier water grotendeels toegeneem het oor die laaste dekades a.g.v. landbou in die distrik, wat dan lei tot probleme soos oormatige groei van onkruid in die getyriewer.

Mikro-alge vorm die primêre vlak van die voedselketting en bestaan grootliks uit fitoplankton in die waterkolom en bentiese mikro-alge op die bodem. Die fitoplankton was gedomineer deur flagelvorms in die water meestal vars was, terwyl die diatome in die areas was met hoër soutgehaltes. Die fitoplankton getalle was grotendeels beïnvloed deur die aantal voedingstowwe beskikbaar in die water kolom. Huidiglik is baie min inligting beskikbaar oor bentiese mikro-alge, nietemin kan hier gerapporteer word dat hul hoë getalle in winter ooreenstem met die hoë voedingstof lading van die sisteem gedurende die tyd.

Die plantegroei van die getyriewer kan in vier tipe gemeenskappe gedeel word: (1) Makro-alge sluit die seewiere naby die mond sowel as spesies wat aanduidend is van voedingstof lading in die boonste riviergety areas in. Die laasgenoemde sluit die mat-vormende "eendekroos" of "paddaslyk" in wat ryklik in die boonste areas van die getyriewer voorkom, so wel as *Enteromorpha*, wat gedurig boot skroefblaaië en pompe vervuil. (2) Onderwater makrofiete bestaan uit "fonteinkruid" wat digte lae vorm in die boonste areas, vermoedelik a.g.v. hoër voedingstof lading, en seegrass (eelgrass), wat in die laer gedeeltes van die sisteem groei waar dit 'n belangrike habitat vorm vir jong visse. (3) Riete en waterbiesies is belangrik vir algehele funksie en diversiteit, maar kan nie te hoë soutgehaltes hanteer nie en het gevolglik hoër die met die sisteem op beweeg a.g.v. onttrekking van varswater. (4) Die soutmoerasse van die Olifants getyriewer is redelik ongewoon aangesien dit 'n soutmoeras huisves op 'n vloedvlakte wat egter in die verlede deel was van 'n groter sisteem. Menslike inpak het weinige invloed op die soutmoeras van die getyriewer met die uitsondering van sekere areas waar dele gevel is en waar wydning toegelaat is.

Die invertebraat gemeenskap bestaan hoofsaaklik uit die soö-plankton en die bentiese komponent in en op die sediment. Die invertebraat gemeenskappe van die Olifants getyriewer word grootliks geken deur hoë getalle in vergelyking met ander getyriewer in Suid Afrika. Die aantal hoeveelheid spesies wat hier opgeneem is was hoog vir 'n weskus sisteem, waar die diversiteit gewoonlik redelik laag is. Die dominante invertebraat spesies was, *Pseudodiaptomus hessei* (soö-plankton), die amphipod *Melita zeylanica*, die krap *Hymenosoma orbiulare* (hiperbentos), die polychaete *Ceratonereis keiskamma*, *Desdemona ornata* en die amphipode *Corophium triaenonyx*, *Grandidierella lutosa* en *Melita zeylanica* (bentos). Die hoogste getalle vir soö-plankton en die hiperbentos was aangeteken in die middel gedeeltes van die sisteem, waar die hoogste getalle vir die bentos aangeteken was in die boonste area van die getyriewer. Hierdie invertebrate is van hoë belang in die dieët van visse en voëls.

Visse is in besonder afhanklik van getyriewer vir beskermende habitate in Suider Afrika, waar verskillende spesies staat maak op hierdie sisteme tot verskillende mates. In totaal was 38 vis spesies van 30 families aangeteken in die Olifants getyriewer waarvan 18 bestempel kan word as absoluut of gedeeltelik afhanklik van die getyriewer vir oorlewing. Hierdie sluit sekere waardevolle spesies soos die wit steenbras en harders in. Die getyriewer langs die weskus speel 'n

belangrike rol met die handhaaf van die verspreiding en voorraad integriteit van getyrvier en getyrvier-afhangeende vis spesies langs die weskus, en die Olifants getyrvier spesifiek is veral 'n belangrikke beskermende area vir sulke diere. Die afname in die harder getalle en mariene kieu-net vissery vangste op die weskus was toegeskryf aan oormatige vangste op visse deur die kieu-net vissery in die Berg- en Olifants getyrviere. In vergelyking met natuurlike omstandighede het die vis fauna waarskynlik drasties verander in terme van die algehele diversiteit en grotes van die visse wat redelik laer mag wees, wat toegeskryf kan word aan drastiese veranderinge in varswatervloei en vangste. Harders en die rivier-rondeharing is nou van die dominante vis spesies in die sisteem. Die elf kom ook in groot getalle voor. Die meerderheid van die getyrvier-afhangeende spesies het meestal van 5 tot 20 km van die mond voor gekom, waar die soutgehalte gewissel het van 0-20ppt en die helderheid van die water kolom minder as 100cm was. Voldoende bewaring moet aan die hele getyrvier toegedien word sodat die oorlewing van die spesies verseker word siende dat hulle hoogs beweeglik is, en aktief kan beweeg tussen die mond en die boonste areas van die getyrvier.

Voëls is sekerlik een van die belangrikste komponente van die getyrvier se biodiversiteit. Die hoë getalle en diversiteit van voëls in die sisteem kan grootliks toegeskryf word aan die grote en verskeidenheid van beskikbare habitate sowel as die lae vlakke van menslike invloed in die omgewing. Sowat 72 watervoël spesies is aangeteken op die getyrvier (uitsluitende besoekende spesies); waarvan 21 langafstands migrerend is wat in die somer tyd hier spandeer. Op gemiddeld styg voëlgetalle vanaf 3200 in die winter- tot so veel as 5900 in die somer maande, alhoewel baie hoër getalle al opgemerk is. Die area naaste aan die mond huisves 80% van die voëls (uitsluitende die mariene kormorante by die rotes), en tot 90% kan binne die eerste 9km vanaf die mond aangetref word. Verkillende voëls gebruik verkillende habitate in die sisteem. Die hoogste nommers was in intergety areas aangeteken. Lae voël nommers was aangeteken in die soutpan en supra-gety moerasse, alhoewel die gemeenskappe hier uitdruklik was. Die sandbanke in die onderste gedeelte van die getyrvier vorm belangrike broei areas vir sterretjies en seemeue. Die boonste gedeelte van die getyrvier is tuiste vir waterhoenders wat gewoonlik vars of brakwater verkies. Die voëls op die getyrvier (uitsluitende die mariene kormorante) sluit ondermeer invertebraat vreters (meestal waadvoëls), visvreters (meestal sterretjies), herbivore (waterhoenders) en algemene vreters (seemeue), waar die eerste twee groepe dominant gedurende die somer maande is. Voël gemeenskappe is hoogs sensitief vir verandering wat deurslaggewend is gedurende droë en nat jare op die getyrvier.

Ekosisteem Dienste

Getyrviere verkaf verskeie dienste van ekonomiese en welsyn waarde. Wat die Olifants getyrvier aanbetref, is die mees belangrike waardes ondermeer die klein-skaalse vissery, die rekreasionele waardes en die beskermende waarde van die getyrvier. Ander waardes soos koolstof sekwestrasie is ook noemenswaardig, alhoewel daar min van die prosesse verstaan word?

Huidiglik ondersteun die getyrvier 'n kleinskaalse kieu-net vissery met sowat 45 permit houers en hul spanne insluitende 'n aantal ongelisensieerde vissers. Per jaar land die vissery ongeveer 100-200 ton harders insluitende sowat 0.4-1.2 ton byvangste. Die vissery handel meestal gedurende die somer maande tydens die lae varswater vloei periode. Die vissery voorsien 'n gewigtige deel van die inkomste van die visser-huishoudings, wat na beraaming sowat R 0.5 miljoen per jaar bereik. Onlangs is beweer dat huidige vangste nie volhoubaar is nie. MCM beplan om die kleinskaalse vissery binne die volgende paar jaar te beëindig.

Die getyrvier funksioneer as 'n beskermings area vir baie van die kommersiele en rekreasionele vis spesies wat deur die kusvissery langs die weskus benut word wat spesies soos harders, steenbras en kabeljoue insluit. Eens het die laasgenoemde twee spesies 'n groot gedeelte van die vangste opgemaak wat sederdien drasties afgeneem het. Getyrvier visse maak ongeveer 25% van die kieu- en trek-net visserye op en 0.3% van die waarde van die kommersiële boot visserye op die weskus, of te wel sowat 8% van die algehele waarde van die Weskus nalandige mariene visserye, en die Olifants dra sowat 23% van die algehele Weskus getyrvier habitat by. As die mate waarop die vis spesies op getyrviere staatmaak in ag geneem word, kan die beskermings van die Olifants getyrvier tot so veel as R3.45 miljoen per jaar beraam word.

Die getyrvier staan uit teen die dorre omgewing, en tesame met die potensiaal wat hengel en voëlkykery geleenthede bring, bied die sisteem 'n gulde geleentheid vir 'n unieke rekreasionele

ondervinding wat selde oorlaai is deur besoekers. Die Olifants getyrvier verkil van die meeste groot getyrviere in Suid Afrika aangesien daar geen groot stedelike nedersettings in die omgewing van die mond van die gety is nie. Strandfontein is 'n klein nabygeleë dorpie en besoekers kan graag tuis gaan in van die gastehuse of kamp by kampeerterreine op die bank van die riviergety naby die Papendorp setting. Die meerderheid van die Olifants getyrvier lynvis vangste word binne 500 m van die mond gemaak, wat vangste van die silwer kabeljou (uitgeput), angolese kabeljou, wit steenbras (uitgeput), weskus steenbras (oorbenut) en elf (oorbenut) insluit. Die huidige status van die getalle in die area kan toegeskryf word aan die uitputting van getalle op 'n nasionale vlak. Rekreasionele hengelaars heg baie waarde aan die sport, en bestee aansienlike bedrae aan die aktiwiteit, gewoonlik afgesien van hul vangste. Alhoewel die Olifants getyrvier vissery beskryf kan word as klein, is die vissery nog steeds ongeveer R0.6-R1.3 miljoen werd per jaar.

Wetgewing en Bestuurskwessies

Nie veel wetgewing is tot hede ontwerp vir getyrviere nie. Die feit dat getyrviere varswater, terrestriële en mariene komponente omhels, en omdat dit geweldig beïnvloed word deur aktiwiteite in baie breër opvanggebiede sowel as die omliggende kus areas beteken dat dit geaktiveer word deur 'n aantal beleidsrigtinge en wette. Huidiglik is daar geen vermaning vir Getyrvier Beskermende Areas nie. Die bestuur van getyrviere val in die algemeen onder twee Nasionale Regerings Departemente: die Departement van Waterwese en Bosbou (DWAF), wat verantwoordelik is vir water hulpbronne, en die Departement van Omgewingsake en Toerisme (DEAT), verantwoordelik vir byna alles, bv. land gebruik en lewens hulpbronne. In die meeste gevalle is omgewingsbestuursontwikkel op provinsiale vlak. Die bestuur en bewaring van ons mariene lewende hulpbronne is in die geval 'n uitsondering, waar die verantwoordelikheid by Marine & Coastal Management (MCM), 'n afdeling van DEAT lê. By-wette word geslaag op munisipale vlak wat nie met provinsiale en nasionale wette in konflik kan wees nie. Die Olifants getyrvier lê geheel en al in die Westelike Kaap Provinsie waar dit deel is van die Weskus Distrik Munisipaliteit en die Matzikama Plaaslike Munisipaliteit.

Die Nasionale Water Wet van 1998 kontroleer grotendeels die water kwaliteit en kwantiteit. Dit maak voorsiening vir omgewings bewaring wat die kwaliteit en kwantiteit van water vloei wat benodig is om die natuurlike funksionering van elke water eenheid te beskerm, te voorsien, wat getyrviere insluit. Die mate waartoe 'n getyrvier se funksionering bevredig word, word bepaal deur 'n toegekende toekomstige bestuurs "klas" (waar klasse A – F die status van gesondheid beskryf), wat die Ekologiese Bewarings Kategorie (Ecological Reserve Category – ERC) genoem word. In die toekoms sal die proses deur 'n onlangs-ontwikkelde, holistiese klassifikasie proses bepaal word. Tot dan word die besluitneming deur DWAF gemaak wat grotendeels gebaseer is op aanbevelings wat gemaak word op 'n bewarings-beraming studie ("Resource Directed Measures") terwyl sosio-ekonomiese prosesse ook in ag geneem word. So 'n studie was vir die Olifants getyrvier in 2006 voltooi. Die studie het bepaal dat die getyrvier 'n klas-C getyrvier is (=gedeeltelik veranderd). Implikasies van verskeie toekomstige vloei scenarios was bepaal en tesame met die feit dat die getyrvier van nasionale belang was, kon daar voorgestel word dat die getyrvier se vloei verhoog (m.a.w. herstel vloei patrone) word tot so 'n mate dat die getyrvier se status verhoog kan word tot 'n klas-B status (= grootliks natuurlik). Water kwaliteit spesifikasies was voorgestel gebaseer op om die getyrvier 'n klas-B te behou, wat beteken dat sekere maatreëls wat die inname van organiese en anorganiese besoedeling wat die sisteem mag binnetree in ag geneem moet neem. Die finale besluit op die ERC moet nog geneem word deur DWAF.

Die benutting van lewende hulpbronne in die getyrvier word deur die *Beleid op die Mariene Vissery van Suid Afrika* (Marine Fisheries Policy for South Africa - 1997) en die *Wet op lewende Mariene Hulpbronne* (1998) beheer. Die beleid ondersteun volhoubare gebruik van hulpbronne en die gebruik van sulke hulpbronne vir ekonomiese groei en ontwikkeling sowel as die beskerming van ekosisteme en biodiversiteit. Dit is kommerwekkend op die stadium dat die negatiewe inpak van die vissery die voordele sal oorskry. Die kieu-net vissery op die stadium is veral suksesvol in die getyrvier en kan oor tyd vis getalle verder verminder tot so 'n mate dat die proses ernstige nagevolge kan hê op die algehele gesondheid en beskermings funksie van die sisteem na gelang van die vër meer waardevolle kus visserye. MCM het in 2003 'n beleid geformuleer in 'n poging om kommersiële visserye in getyrviere te elimineer. In die Berg getyrvier was alle permitte terug getrek, terwyl 'n 10 jaar periode toegelaat is in die Olifants getyrvier om kieu-net vissery uit te wis, aangesien die vissery vir die Ebenhaesar gemeenskap so belangrik is.

Sederdien het navorsing gevolglik vasgestel dat die vissery onderhoudend is, alhoewel die vissery vër onder sy maksimum ekonomiese potensiaal funksioneer, wat kenmerkend is van ope toeganklikheid en/of die afwesigheid van bestuur. Die gemeenskap het 'n gewilligheid van samewerking met MCM gewys om sake gesamentlik te bestuur, miskien aangesien dit die algehele ekonomiese waarde van die vissery kan verbeter. MCM staan nogtans sterk by hul besluit, uit bekommernis vir die alreeds oorbenutting van die vissery.

Onder die Strandwet van 1935 behoort 'n getyrvier tot en met die hoogwater merk aan die staat. Die Geïntegreerde Kusbestuurswetontwerp benodig vir elke riviermond dat 'n bestuur plan moet ontwikkel word. Die wetsontwerp vereis 'n geen-bousone tot 100m van die hoogwatermerk (insluitende getyrviere) in areas gesoneer vir residentiele, industriële of kommersiële landbou gebruik, met 'n groter geen-bousone van tot 1km vir publieke landgoed of landgoed gesoneer vir landbou gebruik. In die geval van die Olifants, val alle grond om die getyrvier in die laasgenoemde kategorie, wat dus in terme van die wetsontwerp 'n geen-bousone van 1km om die hele getyrvier vereis. Binne die verplasing mag geen nuwe grond transformasie of ontwikkeling plaasvind sonder dat 'n permit uitgereik word deur die Minister nie. Daar is voorsiening gemaak om, waar benodig, 'n groter geen-bousone lyn onder die Geïntegreerde Kusbestuur-Wetsontwerp te ontwikkel. Noteer dat 'n vrystelling by die grondsitters aangestuur het teen alle grond opruiming aktiwiteite op die grond onder die besproeiing kanaal en sekere ander areas aangrensend by die olifantsriviermond na beding van die bewaring van landbou hulpbronne handel van 1983 en die nasionale omgewing bestuur handel van 2006. Daar is 'n waarskynlikheid dat hierdie vrystelling will toepaslik wees na die beding van die kus bestuur bill en as dit uiteindelik bepaal is, maar dis slegs vir vermoedelik toepaslik na grond opruiming vir landbou. Hierdie moet uitgesproke wees.

Die vereis dat 'n bestuursplan ontwikkel word vir elke getyrvier. In baie gevalle stem dit ooreen met die area tot en met die hoogwater merk, maar vir getyrviere met supra-gety soutmoerasse; soos die geval is met die Olifant getyrvier, strek die getyrvier area verder as die hoogwater merk. Ook moet die bestuur van die areas reg langs die getyrvier ook in ag geneem word, aangesien dit die sisteem direk beïnvloed. Die bestuur van getyrviere poog soms om areas anders as staats-besette land in te sluit. Die *Geïntegreerde Kusbestuurswetontwerp* bied riglyne om onderhoudende ontwikkeling van die kusgebied te ondersteun. Ontwikkeling van die kusgebied oorsien deur die *Munisipale Wet op Stelsels (2000)* word hierby ingesluit. Hierdie stap vereis dat ontwikkelings prioriteite vir elke provinsie, distrik en plaaslike munisipaliteit geïdentifiseer word, en dat die ontwikkelings planne in 'n breë uitleg uitgedruk word. Laasgenoemde moet weer in 'n gedetailleerde landgebruik en bestuursplan geformuleer word. Dus word die sleutel landgebruik besluitneming wat deur die plaaslike munisipaliteite gemaak word, soos in die geval die Matzikama Munisipaliteit is. Hulle planne moet by groter skaals beplanning van die distrik en die provinsie aansluit.

Die Westelike Kaap SDF lig uit dat die belangrikheid van die bewaring van die Olifants getyrvier op 'n nasionale vlak erken word, maar dat min gedoen is in verband met die bestuur van die sisteem. Die distrik se IDP en SDF verkondig die beskerming van die omgewing en natuurlike hulpbronne so wel as historiese geboue en strukture, maar geen spesifieke vermaning word gedoen leidende die getyrvier nie. Alhoewel die Matzikama Munisipaliteit SDF die belangrikheid van die getyrvier in die area erken word min leiding tot bestuur van die sisteem gebied. Afgesien hiervan bestaan daar 'n Bestuursplan Riglyn dokument (Urban Dynamics 1998), wat spesifiek vir die laer dele van die getyrvier ontwikkel was, vir die Weskus Distrik Munisipaliteit as deel van die oorspronklike IDP, wat 'n bestuursraamwerk, verdelings plan en riglyne vir die beskerming en ontwikkeling van die getyrvier en omliggende areas insluit. Die dokument stel 'n biosfeer bewarings-styl benadering vir die area, wat 'n klein kern bewaringsgebied wat die mond-gedeelte van die getyrvier insluit, wat 'n tussengangs area van die Olifantsdrif nedersetting en die res van die voorgestelde studie area as buffer-sone voorstel. Dit was voorgestel dat die hele area as 'n Bewaarde Natuurlike Omgewing onder die *Wet op Omgewingsbewaring (1989)* verklaar word, met voorgestelde regulasies wat die gebruik van natuurlike hulpbronne kan bestuur (bv. waar landgebruik en aktiwiteite in die kern beperk tot die wat die bewarings objektiewe van die sone bevorder, waar alle ontwikkeling benede die 10 m kontoer verban is in die sone). Dit pleit ook dat aansoek gedoen moet word om die area tot Ramsar Status te lig leidende die gebied se bewarings belang. Alhoewel die aansoek aansienlik verouderd is, bied dit steeds 'n goeie beginpunt vir die ontwikkeling vir die huidige bestuursplan.

Daar is huidige min ontwikkeling en gebruik van die riviergety grenslyne, alhoewel in sekere areas inpak op die soutmoeras opgemerk is. Tot hede was daar wel verskeie versoeke vir ontwikkeling in die sones (wat moontlik toe sal neem) wat nuwe uitdagings mag bring vir bestuursformate. Alhoewel die rekreasionele gebruik van die sisteem tot hede as laag beraam is, kan voorspel word dat sulke aktiwiteite ook sal toeneem in die toekoms, wat gevolglik goed bestuur sal moet word om versteuring van die sisteem minimaal te hou. Die toeganklikheid van ligte vliegtuie, vierwiel motorfietse en motoraangedrewe bote op en om die sisteem is van die grootse kommernisse wat heelwat versteuring kan veroorsaak.

Die area val binne 'n diamant myn konsessiestrook wat langs die weskus op strek, wat seewaartse en landelike konsessies naby die mond van die getyrvier insluit. Alhoewel van die areas al gemyn was in die verlede is sulke aktiwiteite nie huidige aktief nie. Enige soortgelyke aktiwiteite moet voorafgegaan word deur 'n omgewings inpak waardeuring en sal 'n omgewings bestuursplan benodig. Die kommersiële soutpan het geen negatiewe inpak op die getyrvier nie.

Die Olifants getyrvier het huidige nie 'n beskermings gebied status nie, maar verdien dit wel aangesien dit as die tweede mees belangrike getyrvier in Suid Afrika van 'n bewaringsoogpunt gelys is. Die sisteem is geïdentifiseer as 'n kandidaat vir bewarings area status in onlangse getyrvier bewarings beplanning prosesse, wat die onlangse bewarings beplanning proses wat deur die CAPE Getyrvier Bestuurs Program (CAPE Estuaries Management Programme) voltooi is. Die laasgenoemde studie het 'n gedeeltelike (geen-vat) bewaring van sowat 80% van die matige getyrviere as 'n meer effektiewe en praktiese strategie in stede van slegs 'n paar groot heel sisteme. Die volgende spesifieke aanbevelings word gemaak na gelang van die belangrikheid van die Olifants getyrvier vir verder ontwikkeling deur konsultasie met insethouders:

1. Vestig 'n natuurbewaringsgebied wat die meeste van die getyrvier en sy supra-gety getyrvier habitate insluit;
2. Verklaar die hele getyrvier onder die hoë gety-merk as 'n Mariene- Bewaringsgebied (Marine Protected Area – MPA);
3. Ontwikkel 'n verdelings plan waarin 50% van die MPA (nie noodwendig aangrensend) 'n geen-vat sone is;
4. Dat die hele beskermingsarea deur die provinsiale autoriteit (CapeNature) bestuur word;
5. Inkorporeer Papendorp as 'n erfenis gebied, waar limiete geplaas moet word op die tipe en mate van ontwikkeling in die gebied sodat die unieke karakter van die area behou kan word.

Die Olifants getyrvier was ook geïdentifiseer as 'n sisteem wat restorasie benodig. In die geval van die Olifants getyrvier sal die restorasieproses tot 'n status van beter gesondheid moontlik eenvoudig wees. Die proses mag die volgende stappe (in orde van belangrikheid) in ag neem:

1. Afname in visvangste;
2. Restorasie van die kwantiteit van varswater vloei;
3. Restorasie van die water kwaliteit; en
4. Verwydering van die afsluiting effek wat die Lutzville Brug teweegbring.

Oor die algemeen hang die graad tot wat die bogenoemde faktore geïnkorporeer word in die bestuursraamwerke om die gesondheid van die sisteem te restoreer grootliks af van die visie wat ontwikkel is vir die getyrvier, sowel as die toekomstige bewarings status.

ABBREVIATIONS AND ACRONYMS

WMA	Water Management Area
BAS	Best Attainable State
C.A.P.E.	Cape Action Plan for People and the Environment
Chla	Chlorophyll a
CPUE	Catch per unit effort
DEA&DP	Department of Environmental Affairs and Development Planning (provincial)
DEAT	Department of Environmental Affairs and Tourism (national)
DIN	Dissolved Inorganic Nitrogen
DRP	Dissolved Reactive Phosphate
DRS	Dissolved Reactive Silicate
DWAF	Department of Water Affairs and Forestry
ERC	Ecological Reserve Category
EHI	Estuary Health Index
EWR	Ecological Water Requirement
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Disease Syndrome
IDP	Integrated Development Planning
NEMA	National Environmental Management Act
NWA	National Water Act
MAR	Mean Annual Runoff
MCM	Marine & Coastal Management
MEC	Member of provincial Executive Council
Mm ³	Million cubic metres
MSL	Mean Sea Level
PES	Present Ecological Status
RDM	Resource Directed Measures
REI	River-Estuary-Interface
RSA	Republic of South Africa
RQO	Resource Quality Objectives
SDF	Spatial Development Framework
TPC	Threshold of Potential Concern
WCNCB	Western Cape Nature Conservation Board

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1. INTRODUCTION

The Olifants Estuary is one of 279 functional estuaries in South Africa (Turpie 2004) and one of 4 permanently open estuaries on the west coast (Whitfield 2000). It is the 12th largest estuary in the country, with a total area of 702 ha. The estuary would have been considerably larger in the recent geological past, when the Orange River flowed into the Olifants estuary (Morant 1984). This is evident from the additional 797 ha of floodplain saltmarsh area around the estuary which brings the total area of interest here to 1499ha. The estuary is one of the most important in the country in terms of its conservation value. Based on an index which takes size, estuary type rarity and biodiversity (plants, invertebrates, fish, birds) into account, the estuary is ranked second overall (Turpie *et al.* 2004a). It has been identified as an Important Bird Area (Barnes 1998) and a desired protected area (Turpie *et al.* 2002, Turpie 2004, Turpie & Clark 2007).

The estuary cuts a striking band of green in an otherwise arid landscape. What is perhaps most unique about it is the fact that it is a large estuary which has not yet been beset by development around its margins. Set in a rural landscape, the few signs of habitation around the estuary include the small historic hamlets associated with the Ebenhaeser community and a small channel cut for launching fishing dinghies in the lower estuary. The gill-net fishers in the estuary are most often the only users on the water, apart from occasional visitors appreciating the birdlife, fishing and beauty of the area. The Olifants estuary and the Doring River, which flows into the Olifants River, are among the few major aquatic systems in South Africa that have been relatively unaffected by human development and offer an unofficial wilderness sanctuary for flora and fauna and for visitors.

However, there are some mounting pressures that could change the status quo. Increasing demand for water in the catchment for irrigation farming has already led to problems of water quality and weed proliferation in the upper reaches, as well as reducing inflows and gradually changing the balance of flora and fauna throughout the system (Taljaard *et al.* 2006a). Sustained pressure on the fish resources has been gradually reducing and changing the nature of the fish stocks (Lamberth 2005). As development proceeds up the West Coast, there will be increasing pressure to develop the lands around the estuary, and that will bring new pressures on resources as well as changing the character of the area. However, with so little development having occurred in the area up to now, there is an almost unequalled opportunity for proactive planning: to form a vision for the estuary and set in place a management strategy that will achieve that vision.

This study forms part of the Cape Action Plan for the Environment (C.A.P.E.) Regional Estuarine Management Programme. The main aim of the overall programme is to develop a strategic conservation plan for the estuaries of the Cape Floristic Region (CFR), and to prepare detailed management plans for each estuary. The estuary programme is divided into three phases. The first phase involved the establishment of a regional conservation plan (Turpie & Clark 2007), the development of guidelines for estuary management plans (van Niekerk & Taljaard 2007), and the preparation of detailed management plans for a few selected systems. Of these, Anchor Environmental Consultants cc was tasked with preparing the management plan for the Olifants estuary. These studies will then pave the way for preparation of management plans for the remaining systems in the region in the second phase of the programme.

This document is the Situation Assessment report for the Olifants estuary. It provides detailed background information on the Olifants estuary including the geographic and socio-economic context, a description of the ecosystem functioning and biodiversity, the legal and planning context, its current health status, threats to the system, and its conservation importance. This document will form the basis of the development of a vision and strategy for the management of the estuary in a participatory process involving stakeholders. Terms of Reference for the study are in Appendix 1.

2. GEOGRAPHIC AND SOCIO-ECONOMIC CONTEXT

2.1 Location and extent of the estuary and its catchment

The Olifants Estuary is located approximately 250 km north of Cape Town on the West Coast of South Africa, at the southern boundary of Namaqualand (Morant 1984). The estuary forms the mouth of the Olifants-Doring river system. The Olifants-Doring Catchment which forms the greater part of the Olifants-Doorn Water Management Area (WMA 17). The Olifants-Doorn WMA also includes the coastal area lying to the north and south of the estuary, but these have no hydrological relationship with the estuary.

The Olifants-Doring Catchment straddles the Northern and Western Cape Provinces and lies within the Namakwa, Central Karoo, Boland and West Coast District Municipalities. The estuary is located within the latter, in the Matzikama Local Municipality.

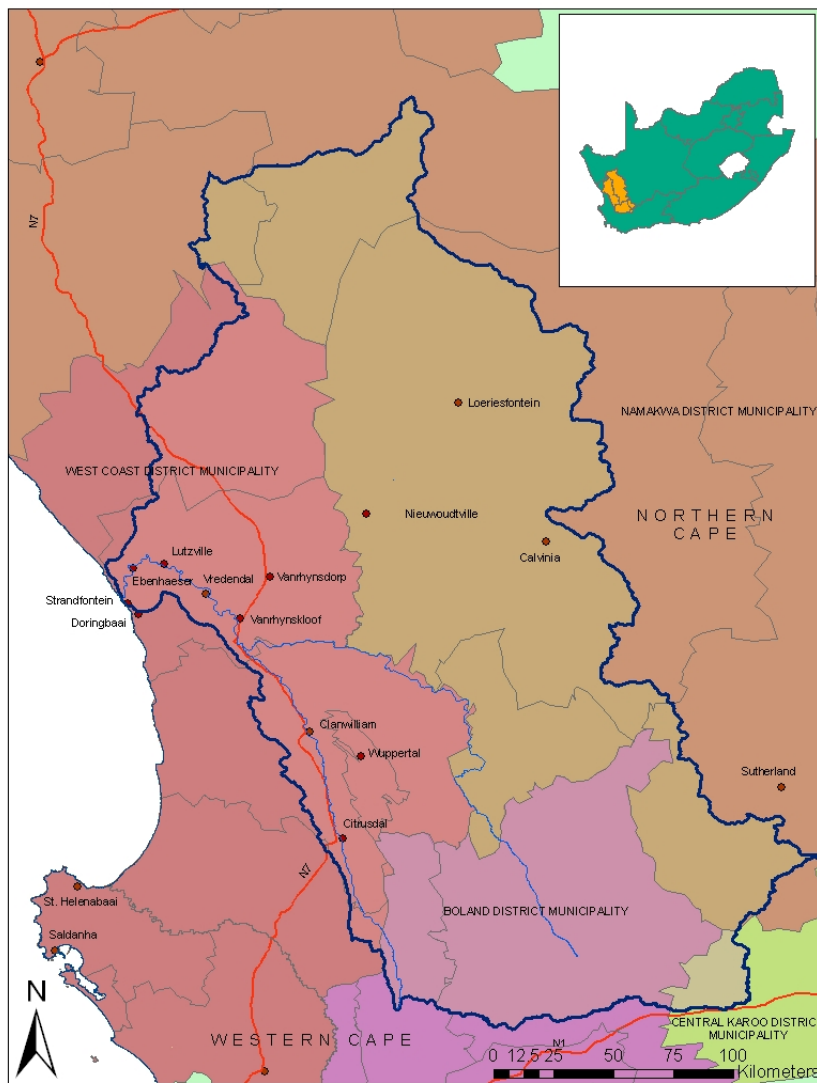


Figure 1. Location of the Olifants-Doring Catchment in relation to administrative boundaries, showing the river and the main settlements. The main stem Olifants and Doring Rivers are shown.

The mouth of the estuary (31°42'S; 18°11.34'E) is permanently open, being bounded by a rocky bluff on the northern side and a large sand spit to the south .

Based on the area of tidal influence, the estuary extends approximately 36km upstream of the mouth to the low water causeway near Lutzville (31°33.8'S; 18°19.78'E). Although the causeway was constructed over a natural rocky obstruction in the system, it is thought that tidal intrusion probably extended further upstream under natural conditions (Taljaard *et al.* 2006a).

The channel depth varies between 0.9 and 6.6 m below MSL but is generally in the range of 2-3 m below MSL. The deepest point in the estuary is located at 18.5 km from the mouth (Taljaard *et al.* 2006b). The channel varies in width from approximately 550 m at its widest point just upstream of the mouth, to 20 m at the head of the etuary. Channel configuration varies, especially near the mouth, where channels once formed an island. The channel to the south of the island has since become a blind arm and is gradually sedimenting up. The lateral boundaries of the estuary are defined by the presence of estuary-associated vegetation including the paleo-saltmarsh in the floodplain (described in the following chapter), amounting to some 1500ha in total. However, it is important to note that the area of influence on the estuary includes the entire catchment.

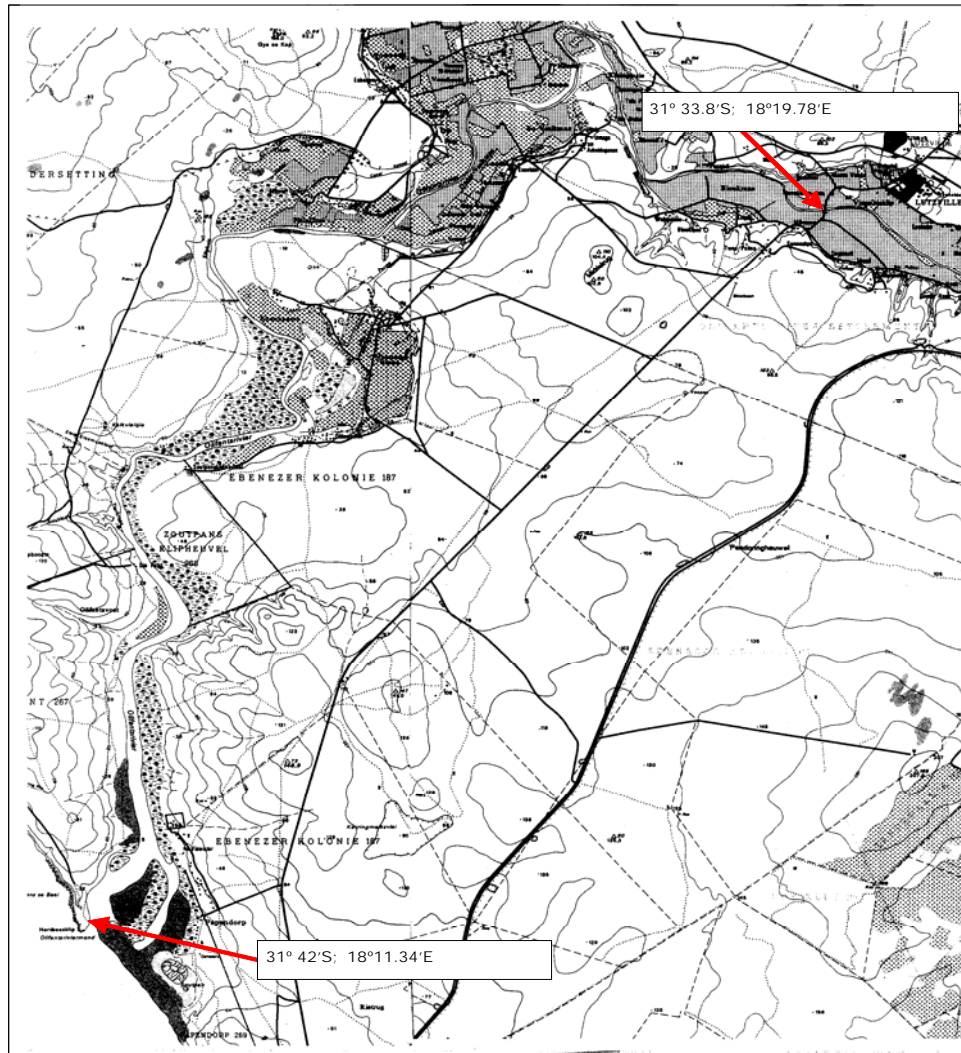


Figure 2. Geographical boundaries of the Olifants Estuary.

2.2 *Catchment climate, vegetation and drainage*

The Olifants-Doring Catchment is amongst the largest in the country, with a total area of 49 066 km² (Turpie *et al.* 2006a). It extends from the Bokkeveld Plateau and Cedarberg mountains in the east and to the coastal plains in the west and from the Hex River Mountains in the south to the Knersvlakte in the north. The area is physiographically complex, with several high mountain ranges running in a north-south direction and smaller ranges and valleys running in a north-easterly direction.

The catchment is generally arid, with an average annual rainfall of less than 300mm per annum, although this varies considerably. The northern part of the basin is extremely arid, with an average rainfall of less than 100mm, whereas the mountainous regions in the south receive an average of up to 1500 mm. The catchment lies predominantly in the summer rainfall area, but the highest rainfall occurs in the winter rainfall area, which dominates its hydrology. Nevertheless, the mean annual runoff (MAR) is low, with the natural MAR to the estuary estimated to be only 1 070 Mm³, corresponding to about 2% to the country's natural MAR (Taljaard *et al.* 2006a).

The vegetation of the basin is dominated by the Succulent Karoo biome, and to a slightly lesser extent, the Fynbos biome in the west. The northern-most part of the catchment falls within the Nama Karoo biome (Figure 3).

The Olifants River is the main river in the catchment, and is a perennial river which rises 280 km from the mouth at about 800 m altitude on the Witzenberg plateau - a winter rainfall area. Two major tributaries, the Doring and Hol Rivers, join the river near Klawer and Vredendal, respectively (Figure 3).

The Doring subcatchment occupies the greater part of the total catchment area and drains the eastern slopes of the Cedarberg, the Swarttruggens and the western Roggeveldberge - a more arid, summer rainfall area area. The Doring River rises in the Hex River Mountains and flows north east into the dry region to the east of the Cedarberg Mountains. It is joined by several small tributaries in its upper reaches. Along the first 150 km the river is naturally seasonal, but now flows for much of the year as a result an interbasin transfer from Lakenvlei Dam near Ceres (DWAf 2004a). 150km from its source, the Doring River is joined by the perennial Groot River, and becomes a large, often-braided river which flows strongly in winter and maintains some flow for most of the year. Further downstream, it is joined by the seasonally-flowing Tankwa River which drains a large area of the Karoo, and by the seasonal Tra-tra River that drains the Cedarberg. After flowing through a deep gorge for about 60km, the Doring is joined from the west by the Biedou, Brandewyn and Koebee Rivers before entering the Olifants River just upstream of Klawer. The lower sections of the Doring stop flowing for periods of up to several weeks during summer, being reduced to a series of pools (DWAf 1997).

The Olifants River mainly drains sandstones and quartzites of the Table Mountain Group in its upper reaches, and Bokkeveld Group shales in its middle reaches and Tertiary to Quaternary sands, together with some Nama Group outcrops in its middle and lower reaches (DWAf 2003a). The Doring drains Table Mountain Group sandstones and quartzites, Bokkeveld Group shales and Witteberg Group quartzites and shales in the western and extreme southern part of its catchment, as well as the easily-eroded Dwyka Formation tillites and the Ecca Group shales and sandstones in the eastern part of the catchment (DWAf 2004a). The Doring thus has different chemical characteristics to the Olifants, and contributes a very large proportion of the silt carried down to the Olifants River (Morant 1984).

There are two major dams on the main stem of the Olifants River - the Clanwilliam Dam (with a capacity of 127 x 10⁶ m³) and the Bulshoek Dam (with a capacity of 7.5 x 10⁶ m³). There has also been a proposal to raise the Clanwilliam Dam to increase its capacity (DWAf 2005b).

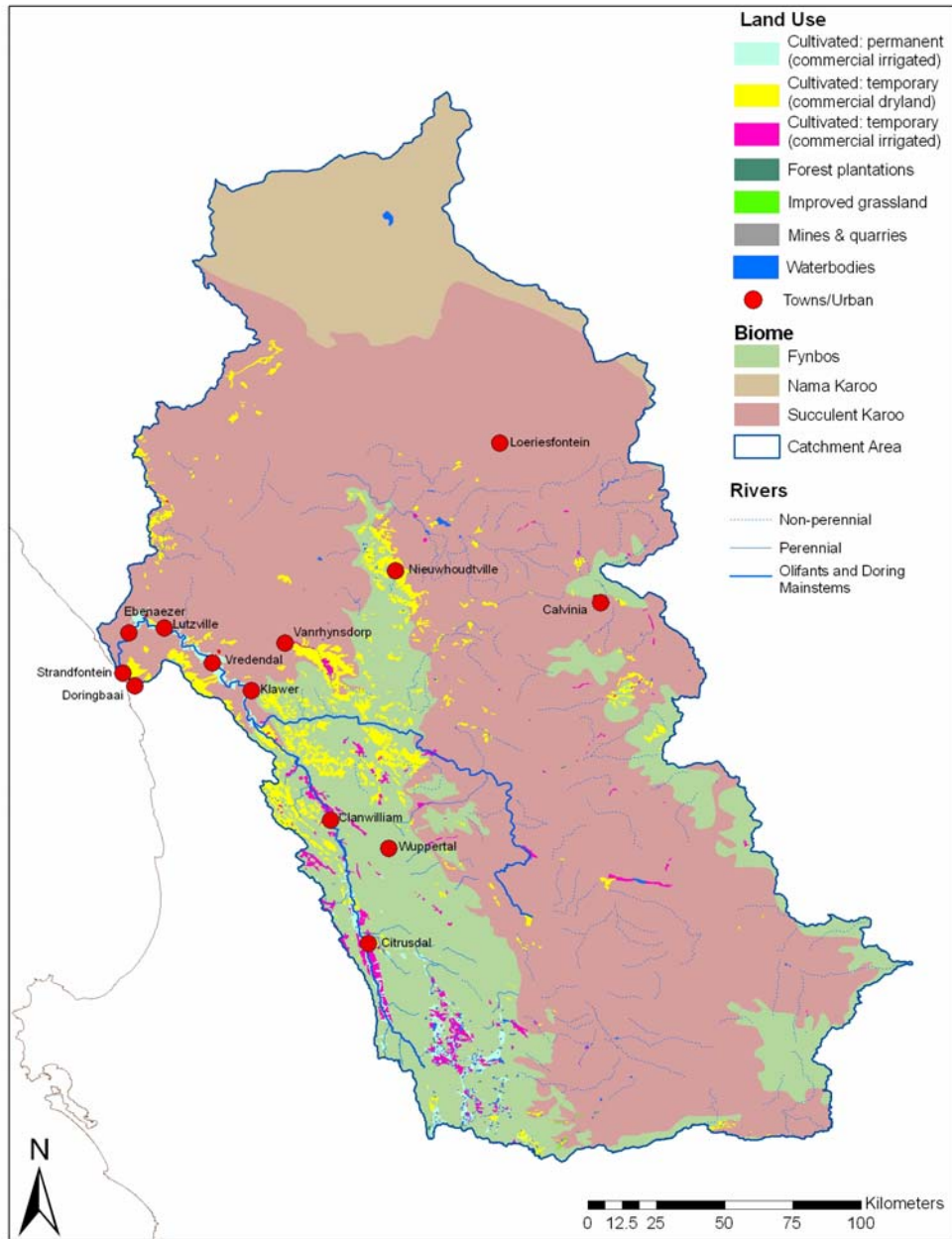


Figure 3. Vegetation, land-use and drainage of the Olifants-Doring Catchment.

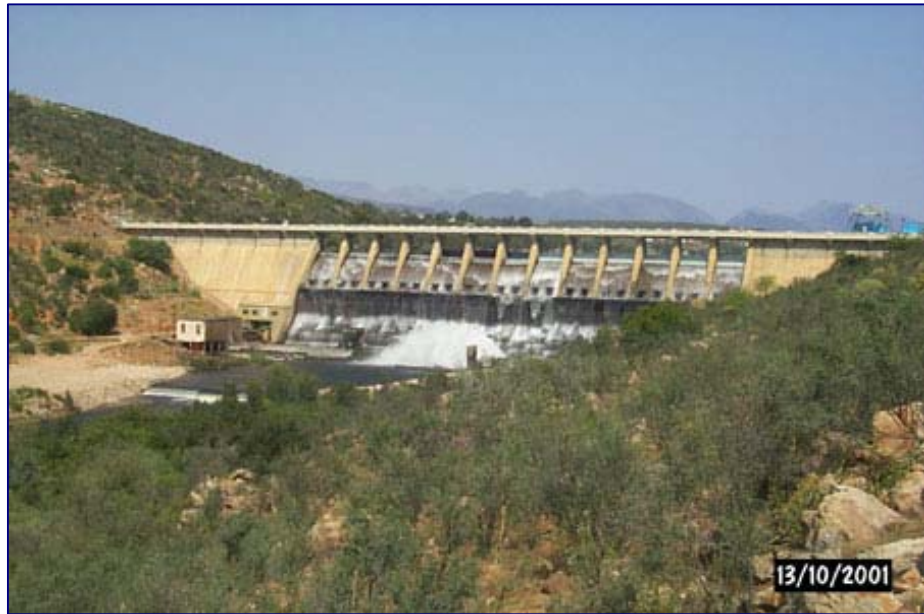


Figure 4. Clanwilliam (top) and Bulshoek dams (Source: DWAF Website)

2.3 Catchment population, land-use and economy

2.3.1 Population and socio-economic status

The Olifants-Doorn WMA is the most sparsely populated WMA in the country (DWAf 2002). The 1995 population of the WMA and of the Olifants/Doring catchment is estimated to be about 104 000 and 83 200 people, respectively, based on estimated population per quaternary catchment (DWAf 2001, 2002). The catchment population is less than 0.5% of the national population. Due to HIV/AIDS and movement to urban areas beyond the catchment, a general decline is expected in the population of the area, particularly in the rural population (DWAf 2003b).

The population of the WMA is concentrated in the south-western part, in the Koue Bokkeveld and the Olifants River Valley, as well as the Sandveld (outside of the Olifants/Doring catchment), corresponding with the areas of most economic activity (Figure 5). Only 30% of the population live in the arid areas of the Doring River catchment, the catchments of the northern tributaries of the Olifants River, and the Namaqualand coastal catchments (though these areas account for 80% of the WMA) (DWAf, 2002).

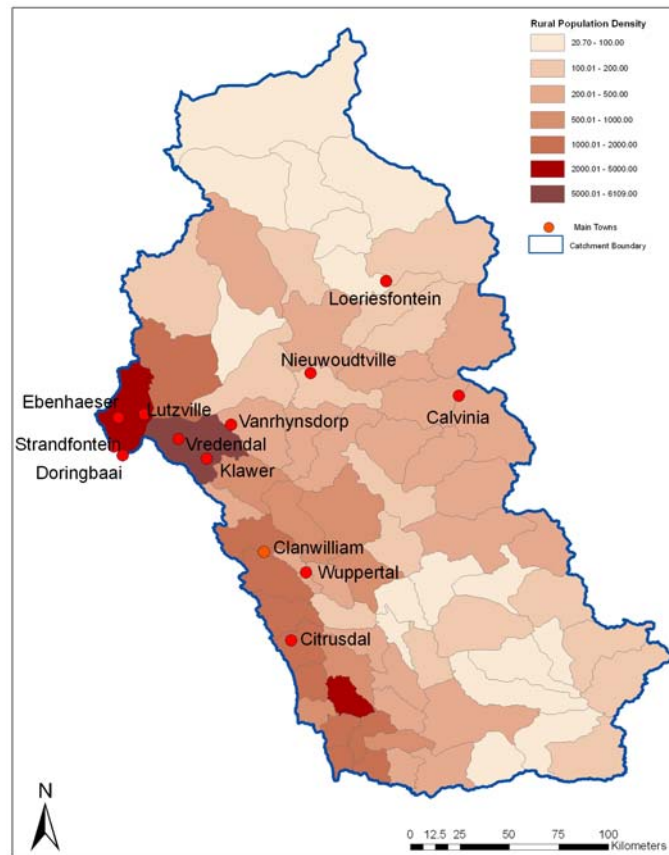


Figure 5. Rural population densities (based on the 1996 census) in the quaternary catchments within the Olifants/Doring catchment

More than half of the population of the WMA is classified as urban¹, despite the strongly agricultural base of the economy. The urban population is based mainly in Vredendal (Matzikama Local Municipality (LM)) and Calvinia (Hantam LM), as well as Citrusdal, Clanwilliam, Vanrhynsdorp, Nieuwoudtville, Loeriesfontein, Ebenhaesar, Wuppertal and other small settlements. Based on analysis of the municipal populations (DWAF, 2004b), the population is predominantly Coloured (77%), with 20% White and 3% African. More than 90% of the population are Afrikaans speaking.

Socio-economic indicators from 2001 census data for different zones within the Olifants-Doring catchment (Figure 6) are summarised in Table 1. More than half of the population is concentrated in the lower and upper Olifants River zones (about 29 000 and 19 000 people, respectively). The dryland farming zone, Doring Rangelands and Koue Bokkeveld zones each have about 9000 – 11 000 inhabitants, the Knersvlakte is very sparsely populated (<5000) and about 3500 people live in the vicinity of the estuary. Communities are predominantly rural in all the zones apart from the Lower Olifants zone, where most people are in towns (Table 1). The estuary zone only considers the largely rural population of the Ebenhaesar community.

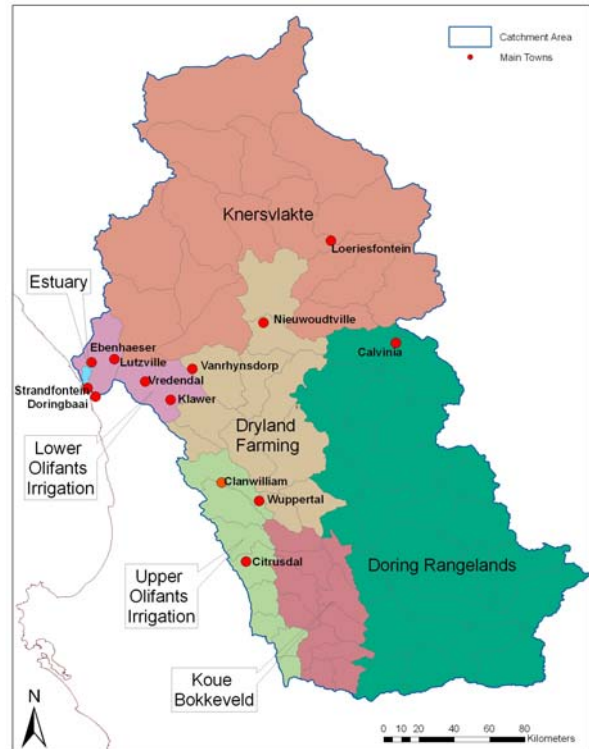


Figure 6. Socio-economic zones of the Olifants-Doring catchment. Source: Turpie *et al.* 2006.

Table 1. Summary of population characteristics for each zone. All are % households except education, which is % individuals. Source: Turpie *et al.* 2006a.

	Koue Bokkeveld	Doring Range-lands	Kners- vlakte	Upper Olifants	Dryland farming	Lower Olifants	Estuary
% rural	94	57	57	53	61	33	100
% poor *	85	82	84	77	84	73	71
% with Matric education	9	13	13	17	15	18	23
% without flush toilets	15	32	55	28	23	16	17
% in rent-free housing	84	40	33	38	41	33	0

* earning less than R38 000 per household per year

Poverty levels are extremely high throughout the catchment, with more than 70% of households earning less than R38 500 per year in all areas (Table 1). The eastern parts of the catchment, which are more sparsely populated, are characterised by high levels of poverty (over 80%). About 10% of the labour force is unemployed, which is lower than the national average, and about 2% of the employed are seasonal labourers. There is also a strong immigration of seasonal workers during the harvest and planting seasons.

¹ Note that DWAF (2002) defined functional urban areas (although populations in many of these had been defined as rural in the census).

Education levels are low throughout, being higher in the Lower and Upper Olifants zones and highest in Ebenhaesar (Table 1). Very few (about 4%) are educated beyond matric, and those are mainly white. Educated young people tend to leave the area.

The majority of households have flush toilets (Table 1), but significant proportions of households still rely on chemical or pit latrines and 9% of the population are without sanitation (Turpie *et al.* 2006a). Sanitation conditions are worst in the Knersvlakte area, but are relatively good in the main irrigation zones (Koue Bokkeveld, Lower Olifants) and around the estuary.

More than a third of households in each zone occupy rent-free dwellings (e.g. labourer cottages), with as many as 84% in the Koue Bokkeveld. Much of the land around the estuary is communal land belonging to the Ebenhaesar community but is currently held in trust by the state.

2.3.2 Land-use

Because of the low rainfall, most of the catchment is unsuitable for dryland cropping. As a result, more than 90% of the land is untransformed, retaining its indigenous vegetation cover (Figure 3). Most untransformed land is under low intensity grazing for livestock. Some 11 780 large stock (mainly cattle), 336 000 small stock (sheep and goats) and 10 930 pigs are estimated to occur in the Olifants/Doring catchment (DWAF 2002, based on 1994 livestock census).

Substantial areas of untransformed lands fall within nature reserves or wilderness areas (DWAF 2002). The wildlife areas are dominated by the unique rugged landscapes of the Cedarberg Wilderness Area and the wide arid plains of 'Bushmanland'. These, together with wild rivers and the spring displays of wildflowers throughout the region, form the basis of an expanding tourism industry in the region. The Olifants estuary remains largely undeveloped as a tourist attraction, however.

Up to 4% of the catchment is used for dryland farming, although precise areas are unknown, and would be expected to vary from year to year, depending on rainfall. Dryland crops are mainly wheat and rooibos tea.

An estimated 33 700 ha is under irrigation in the Olifants-Doring catchment, although probably only about 85% of this area is harvested on average (DWAF 2002). Estimates of the total area vary, however. For the WMA as a whole, the area has been estimated as: 40 000 ha (DWAF 2002); 32 400 ha (DWAF 2003b); 28 600 ha (DWAF (2004b)); and 49 700 ha (DWAF 2005a). An additional 134 500 ha have been identified as having potential for irrigation in the WMA (DWAF 2003b).

Irrigated agriculture is found mainly along the Olifants River and in the southern elevated areas of the catchment area (the Koue Bokkeveld), with about a quarter to a third of the irrigated area occurring in the Doring catchment. The main irrigated crops are citrus, deciduous fruits and grapes.

There is very little plantation forestry in the catchment, with a total of 997 ha of tree plantations in the high-rainfall, mountainous parts of the catchment. These are located at the headwaters of the Olifants River (380 ha of pine), in the Cedarberg (385 ha) and on the mountain slopes fringing the Koue Bokkeveld (232 ha of pine). Alien infestation is a problem in most water courses in the catchment.

Mining is relatively limited, and includes gypsum mining, a salt works near the estuary mouth, sand and diamond mining. Apart from the Namakwa Sands heavy minerals mine on the north-western coast of the WMA, mining operations are small and mainly comprise quarrying or dredging marine diamonds (DWAF 2002).

Urban areas are small and only cover about 31 km² (DWAF 2005a).

2.3.3 Economy

The Olifants/Doorn WMA contributes almost 3% of the agricultural output of the national economy, and 1.5% of trade output, with most other sectors contributing less than 0.3% (DWAf 2001). Overall, the Olifants/Doorn WMA makes the smallest contribution of any WMA in the country, contributing under 0.5% of the national economic output, and less than 1% of formal employment (DWAf 2001, DWAf 2003b).

The economy of the Olifants-Doring catchment is dominated by the agricultural sector (Schlemmer 2001, DWAf 2005a), which contributed an estimated 36% of the economic output of the catchment in 2001 (Turpie *et al.* 2006a). This is in stark contrast to the national agricultural contribution of 3.4% to the economy. The regional significance of this sector is thus about ten times higher than in the national economy. Nevertheless, growth in the agricultural sector is limited by the availability of water for irrigation, and will require improved water use efficiency and further value adding through increased processing. Tourism, which contributes to the second largest sector (trade), has been identified as the sector 'with the greatest anticipated growth between 2000 and 2025' (DWAf 2001:15).

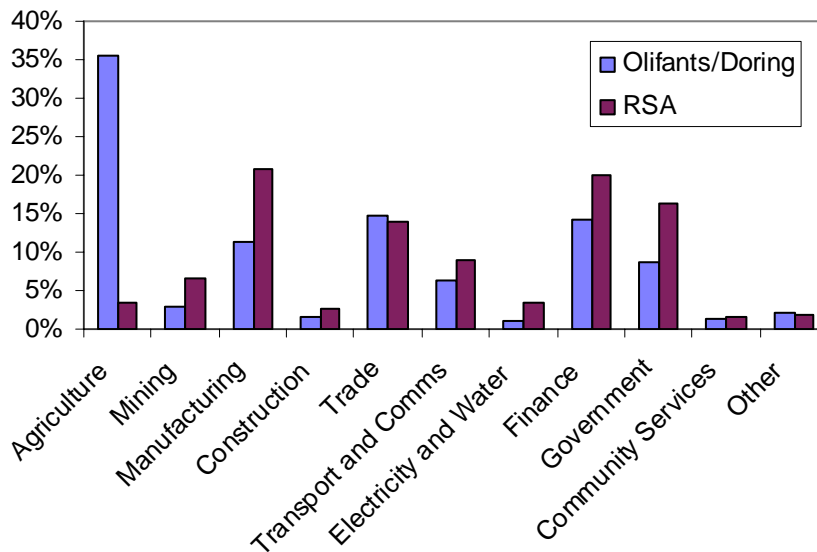


Figure 7. Proportional contribution by sector to the Olifants/Doring catchment and national economy (source: Turpie *et al.* 2006a)

3. ECOLOGICAL CHARACTERISTICS AND FUNCTIONING OF THE ESTUARY

3.1 Mouth dynamics, hydrology and channel shape

The mouth of the Olifants River estuary remains permanently open throughout the year, maintained as such by strong tidal flows, a protected outflow channel and the relatively high run-off of the system. Water level fluctuations due to tidal influences extend all the way up the estuary, with water level variations of almost one metre evident at springtide at the low water bridge at Lutzville (Taljaard *et al.* 2006b).

Freshwater flow reaching the Olifants estuary from the catchment is estimated to be approximately 715 Mm³/annum, but varies considerably from year to year with the occurrence of different sized floods in each year. Although the hydrological regime looks superficially similar to the reference (natural) condition (Figure 8), mean annual runoff (MAR) is estimated some 33% less than is estimated for the reference condition (1070.1 Mm³/annum). Most noticeable are the reductions in low flows evident in summer and winter, and a reduction in the size of the winter flood peaks (reduced by about 18% from natural conditions, Figure 8, Taljaard *et al.* 2006b).

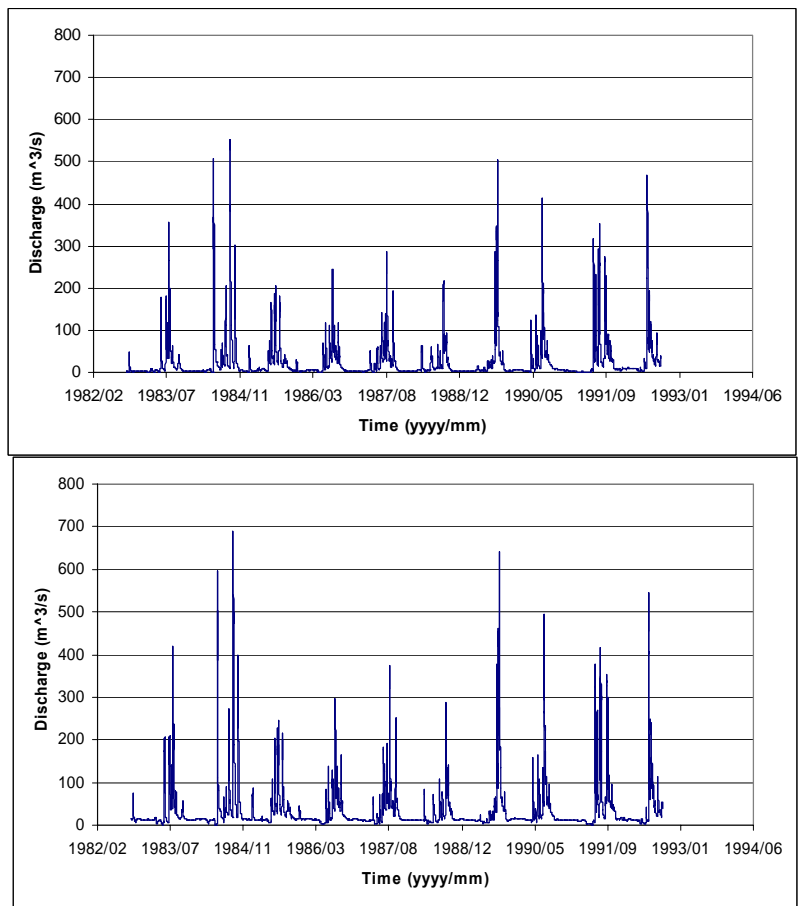


Figure 8. Freshwater flows reaching the estuary in the present day (to) and under the reference (natural) condition (i.e. no freshwater abstraction, bottom) (Source: Taljaard *et al.* 2006b).

Taljaard *et al.* (2006b) estimate that these flow reductions have reduced the amount of sediment carried by the river at the point where it enters the estuary from an estimated 275 000 tonnes/annum in the reference condition to 177 000 tonnes/annum at present (36% reduction). The effect of this has been to increase the channel depth by an estimated 0.5 m and to reduce the channel width by about 10% in the upper reaches of the estuary with the result that the tidal effect penetrates noticeably further upstream at present than in the reference condition.

Effects of these changes in flow have been further quantified by Taljaard *et al.* (2006b) by examining occurrence of different abiotic states in the estuary. These authors have identified four abiotic states for the Olifants Estuary, of which the occurrence and duration varies depending on river inflow (Table 2).

Table 2. Description of different states of the estuary under different flows (based on Taljaard et al. 2006b)

Flow (m ³ /s)	State (salinity)	Water residence time in middle reaches
< 2	Marine dominated	> 4 weeks
2 – 5	Saline penetration extends to middle reaches	1 – 4 weeks
5 – 20	Saline penetration limited to lower reaches	3 days – 1 week
> 20	Freshwater dominated	1 – 3 days

The marine dominated condition reportedly seldom occurred under natural conditions, and if so, only for short periods during droughts. Now it typically occurs all the way from November to April (6 months). The second state typically occurred in summer (December to March) under reference (natural) conditions, but now occurs in autumn (April to May). The third state usually only occurs for relatively short periods (e.g. a few weeks to a month) during the transition periods between summer and winter, i.e. autumn (April - May) and spring (October to December). The freshwater-dominated state, in which saline water intrusion is confined to the lower 2-7 km of the estuary, is typical of winter high-flow conditions (June to September) and occurs to the same extent now as under natural conditions.

A summary of occurrence of the different abiotic states under the present day and reference (natural) conditions is provided in Table 3.

Table 3. Average monthly flow and occurrence of the abiotic states under the present day and reference (natural) conditions.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
<i>Reference</i>	17.21	9.06	4.36	2.27	2.41	2.76	5.51	19.34	57.95	63.32	50.62	34.87
<i>Present</i>	6.49	0.76	0.74	0.75	0.70	0.57	0.51	2.19	21.22	40.66	43.61	24.82

3.2 Water chemistry

The distribution of saline water in an estuary (the longitudinal salinity distribution) is of fundamental importance in the estuary as it affects the distribution of all biota in the system due to their differing salinity tolerances. Longitudinal salinity distributions in the Olifants estuary were studied by (Taljaard *et al.* 2006b) and are shown in Figure 9. A marked difference exists between summer and winter salinity distribution patterns due to changes in freshwater inflow. In summer freshwater inflow is low (1.8 m³/s), the water

column in very well mixed (i.e. no vertical change in salinity evident), and sea water penetrates a long way upstream, such that there is measurable salinity (5 ppt) approximately 20 km upstream. In winter freshwater inflow into the estuary is much higher (in the region of 17 m³/s), and pushes much further into the estuary, riding over the top of the more dense seawater. At this time the estuary shows strong vertical stratification (fresh water on top, salt water below), with the 5 ppt contour approximately 5 km from the mouth at the surface but reaching nearly 15 km upstream near the bottom.

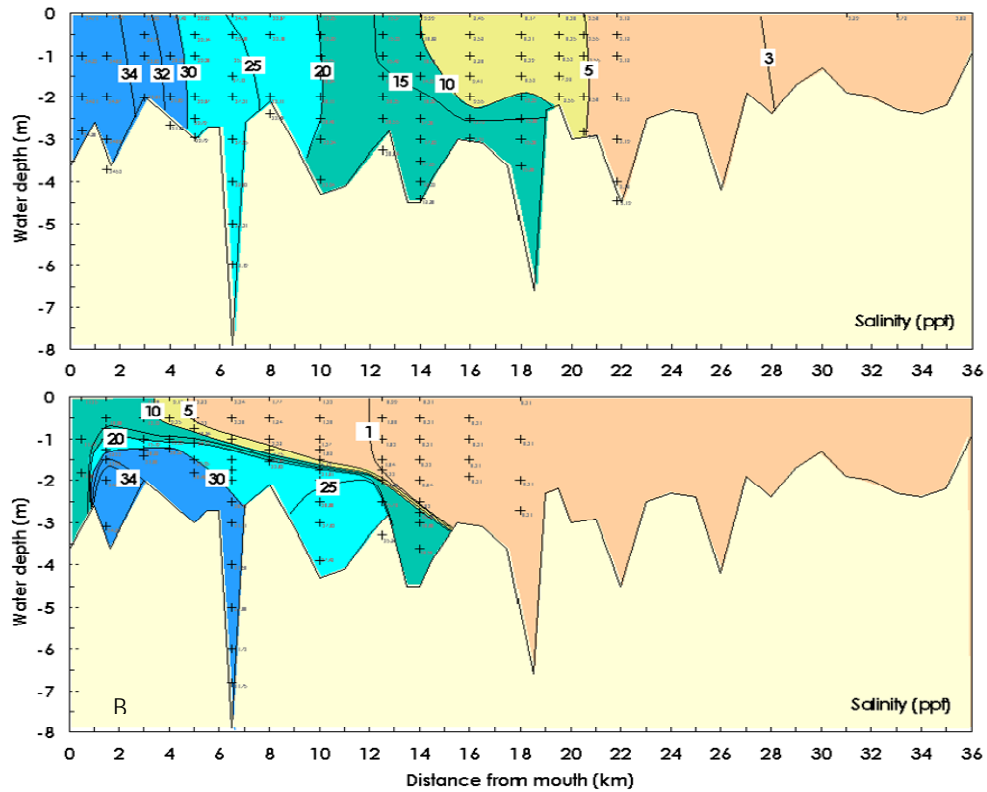


Figure 9. Typical longitudinal salinity distribution patterns in the Olifants Estuary in summer (top) and winter (bottom). Source: Taljaard *et al.* (2006b).

Water temperature in the estuary also varies strongly on a seasonal basis (Figure 10), with much warmer conditions prevailing during summer (mostly above 20°C) than winter (13-14°). This has important implications for other water chemistry parameters (oxygen and nutrients) and for the biota living in the system.

Oxygen concentrations in the estuary tend to be lower in summer than winter (Figure 11). This is due to the longer residence times for water in the estuary at this time (due to reduced freshwater inflow) and increased biological activity (due to higher temperatures). Oxygen concentrations tend to be higher at the surface (due to dissolution of oxygen into the water from the air) and near the mouth (due to tidal flushing) than near the bottom, particularly in the middle reaches of the estuary where water movement is lowest. Note that oxygen levels below 4 mg/l (as is evident in bottom water near the middle of the estuary in summer) are lower than that required for many species of fish and other animals.

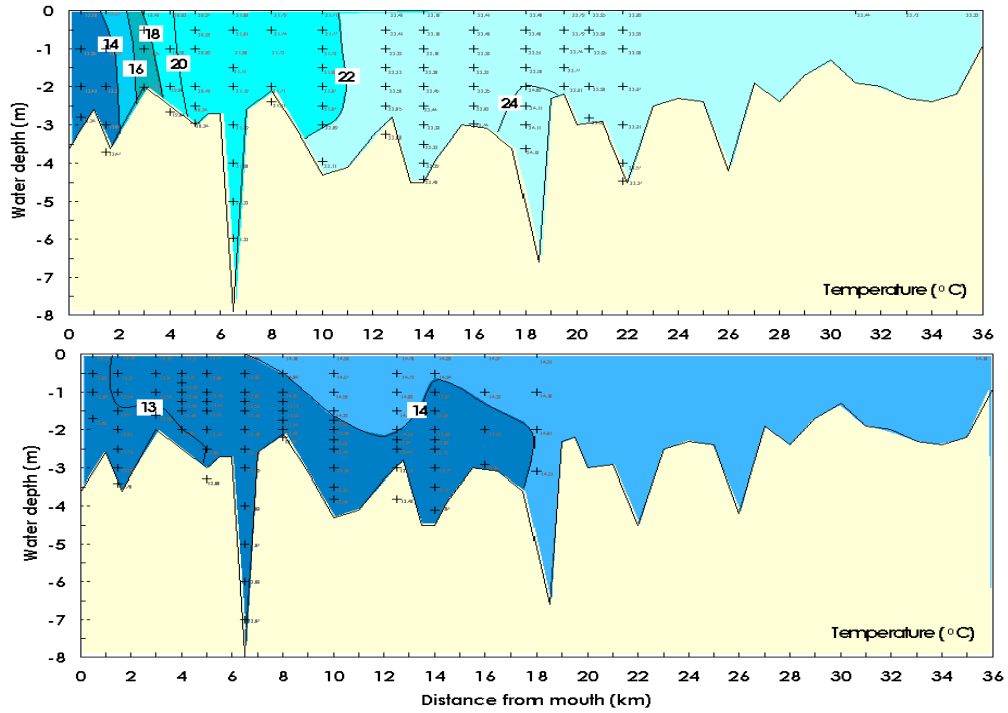


Figure 10. Typical longitudinal temperature distribution patterns measured in the Olifants Estuary in summer (top) and winter (bottom). Source: Taljaard *et al.* (2006b).

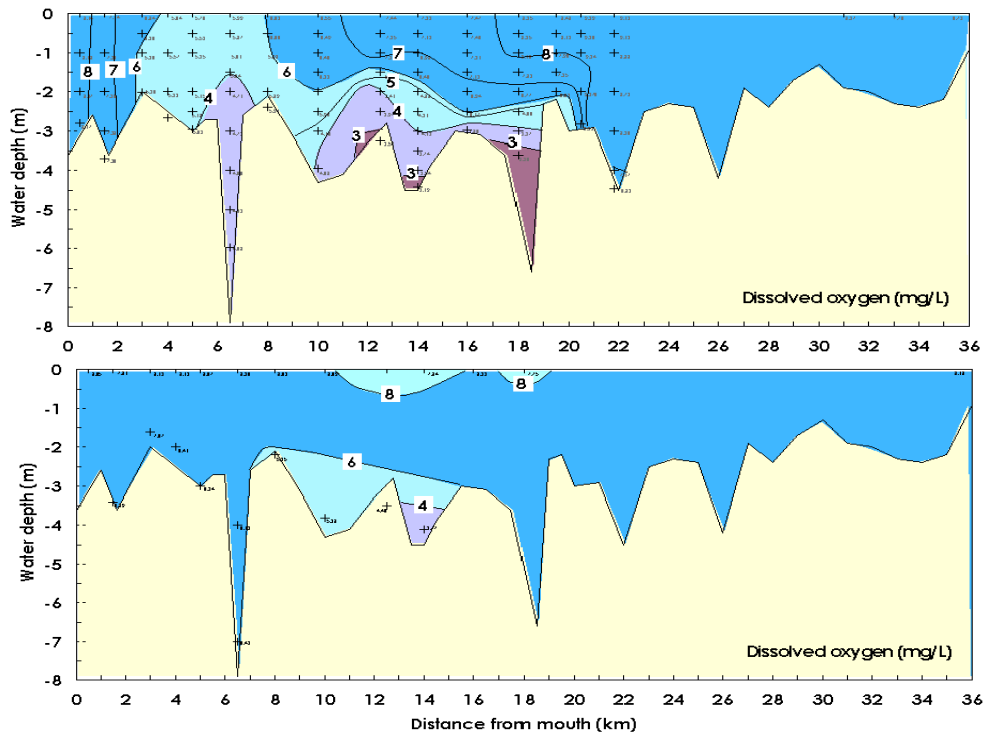


Figure 11. Longitudinal distribution of dissolved oxygen concentrations in the Olifants estuary during summer (top) and winter (bottom). Source: Taljaard *et al.* (2006b).

Water clarity (turbidity) in the estuary is influenced by the relative contributions of freshwater inflow from the Olifants and Doring catchments and the salt water inflow from the sea. The water flowing in from the Olifants catchment is fairly clear (draining hard, well-leached sandstone and quartzites of the Table Mountain Group) while that from the Doring River and other tributaries further downstream is more turbid, as it drains mainly soft, leachable shales (DWAF 1997). Seawater water entering the system is generally very clear. Thus water clarity tends to be much lower in winter than summer (due to higher freshwater inflows during winter particularly from the Doring catchment), and tends to decrease with distance upstream during both seasons (Taljaard *et al.* 2006b).

Concentrations of inorganic nutrients in an estuary are largely determined by concentrations in the source waters, i.e. the river and the sea, as well as any physical (e.g. evaporation) or biochemical processes (e.g. biological uptake and remineralisation) that occur within the estuary. Concentrations of various dissolved inorganic nutrients in the Olifants estuary (nitrogen, phosphorus, and silica) have been studied by Eagle & Bartlett (1984) and Taljaard *et al.* (2006b). Considerable change in the concentrations of these nutrients have been observed since the first measurements were taken in 1975. Patterns for the three dominant nutrients (nitrogen, phosphorus, and silica) are all similar, and are well illustrated by changes in dissolved inorganic nitrogen (DIN), as follows.

The input of DIN to the Olifants Estuary via the river is largely influenced by agricultural activities which have expanded considerably over the last few decades. Most of the DIN from this source enters the estuary in winter (when the rains flush accumulated nutrients from fertilizer inputs from the soil), with inputs having increased from less than 100 µg/l in the 1980s to 400-600 µg/l in the present day (Taljaard *et al.* 2006b). Nutrient inputs into the estuary from the sea mostly occur during summer, with peak inputs corresponding to periods of oceanic upwelling. These inputs are of a similar order of magnitude to the present day inputs from the river, but have not changed over time (Taljaard *et al.* 2006b). Thus, in winter, river-dominated DIN concentrations are high throughout the system but decline slightly towards the mouth due to dilution with nutrient-poor seawater. In summer, DIN concentrations are typically low throughout most of the system particularly in the middle reaches due to nutrient uptake by aquatic plants. They are slightly (or occasionally highly) elevated near the mouth due to the influx of newly upwelled, nutrient rich seawater, and are generally slightly elevated at the head of the estuary due to the influx of nutrient-rich river water (Taljaard *et al.* 2006b).

3.3 *Microalgae*

Microalgae in estuaries comprise unicellular algae that either live suspended in the water column (termed phytoplankton) or benthically on rock or sediments in the estuary (termed microphytobenthos or benthic microalgae). These microalgae (i.e. phytoplankton and microphytobenthos) are very important in estuarine systems as they are generally the main source of primary production in the estuary.

Phytoplankton communities in estuaries are influenced by salinity, generally dominated by flagellates where river flow dominates and by diatoms in marine dominated situations. The area of the estuary where the salinity is in the region of 10-15 ppt, often referred to as the River Estuary Interface (REI) zone, diatoms are commonly dominant. Phytoplankton biomass in an estuary is also generally at its maximum in this region. Biomass of phytoplankton in estuaries varies very widely and may range from 0-210 µgChla/l (Adams *et al.* 1999). If nutrient concentrations in an estuary are high (particularly in the case of nitrogen) then phytoplankton biomass in the estuary is generally high too. Under extreme conditions, when nutrient levels are very high, certain toxic dinoflagellate species may form dense blooms known as red tides.

Less is known about benthic microalgae (microphytobenthos) in estuaries than phytoplankton. Values for benthic microalgae biomass are often reported in different units which makes comparisons between estuaries difficult. Bate (2006) summarised

data from five different estuaries in South Africa where benthic microalgae biomass ranges from 9.5-21.8 $\mu\text{g Chl-a/g}$ dry mass of sediment.

Bate (1996) studied microalgae in the Olifants estuary between 2001 and 2004, and reported phytoplankton biomass to be around $10 \mu\text{g.l}^{-1}$ at the head of the estuary in summer, declining rapidly downstream to around $3 \mu\text{g.l}^{-1}$ towards the mouth. Biomass values measured in winter were similar, except that the high biomass values at the head of the estuary were maintained for a much longer distance downstream (Figure 12). These values are on the low end of the range reported above but comparable to other estuaries, but are similar to freshwater-deprived systems such as the Kromme estuary. Benthic microalgae biomass in the Olifants estuary in summer ($1-15 \mu\text{g Chl-a/g}$ dry mass of sediment) is comparable to that reported for other South African estuaries, but is on the high end of this range in winter ($0.4 - 27 \mu\text{g Chl-a/g}$ dry mass of sediment) (Figure 13, Bate 2006).

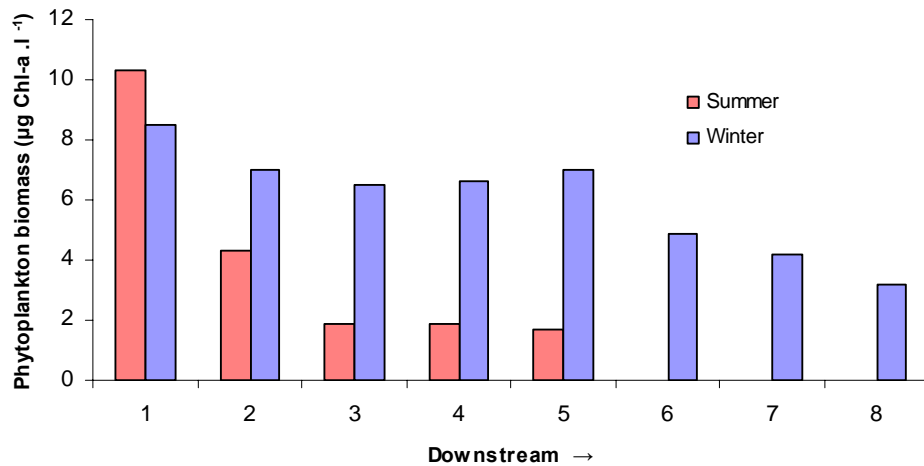


Figure 12. Variation in the phytoplankton biomass with distance downstream in the Olifants estuary, during summer and winter. (Data from Bate 2006).

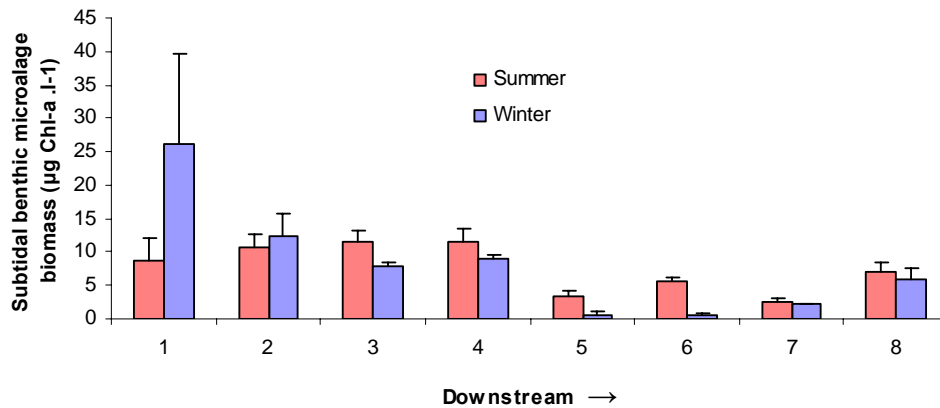


Figure 13. Variation in the biomass of subtidal (bottom) benthic microalgae with distance downstream in the Olifants estuary, during summer and winter. (Data from Bate 2006).

3.4 Vegetation

There are four main vegetation communities associated with the Olifants estuary: macroalgae, submerged macrophytes, reeds and sedges, and salt marsh. The distribution of these communities is shown in Figure 14 and Figure 15.

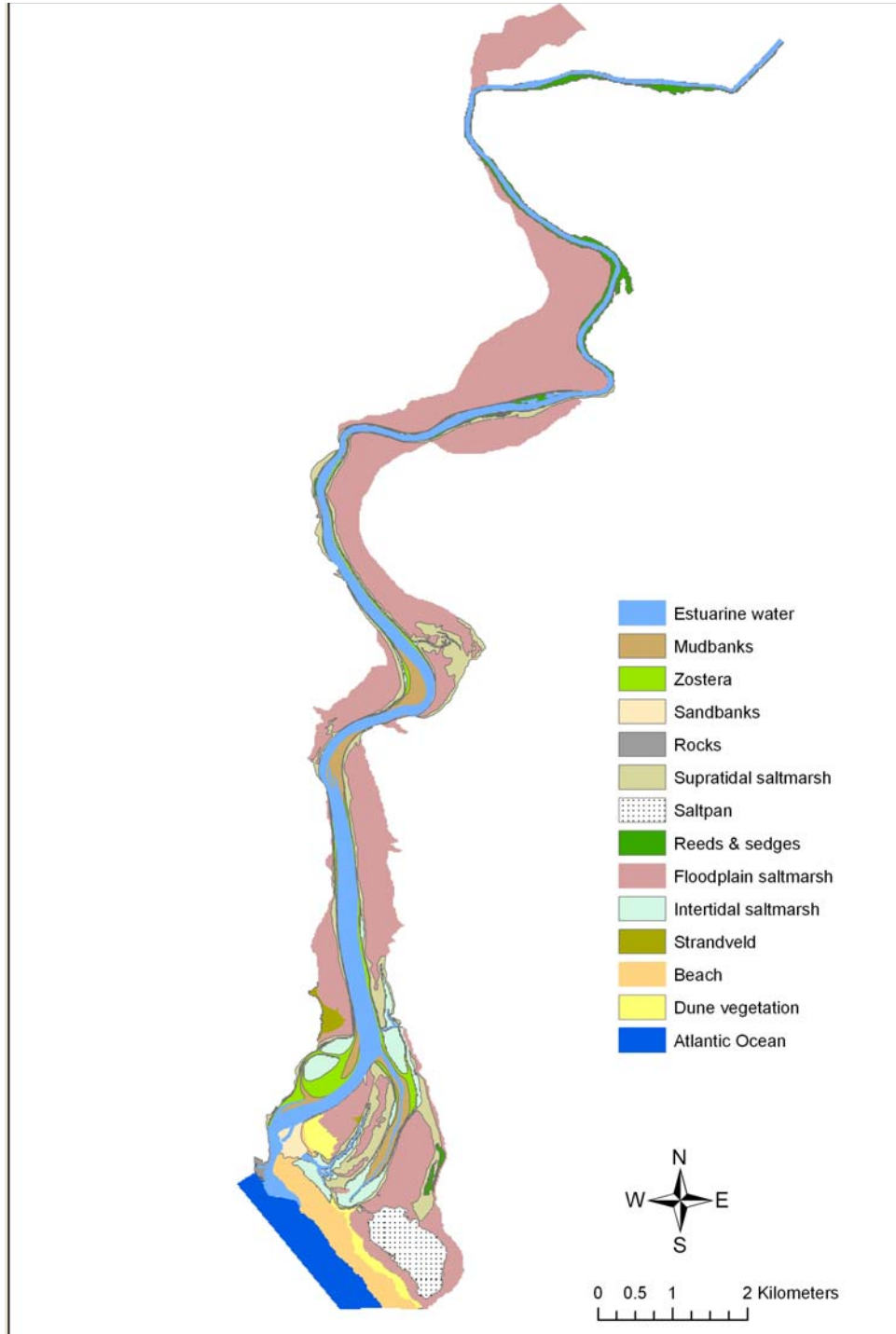


Figure 14. Distribution of different plant community types up the length of the Olifants Estuary (from Adams *et al.* 2006).

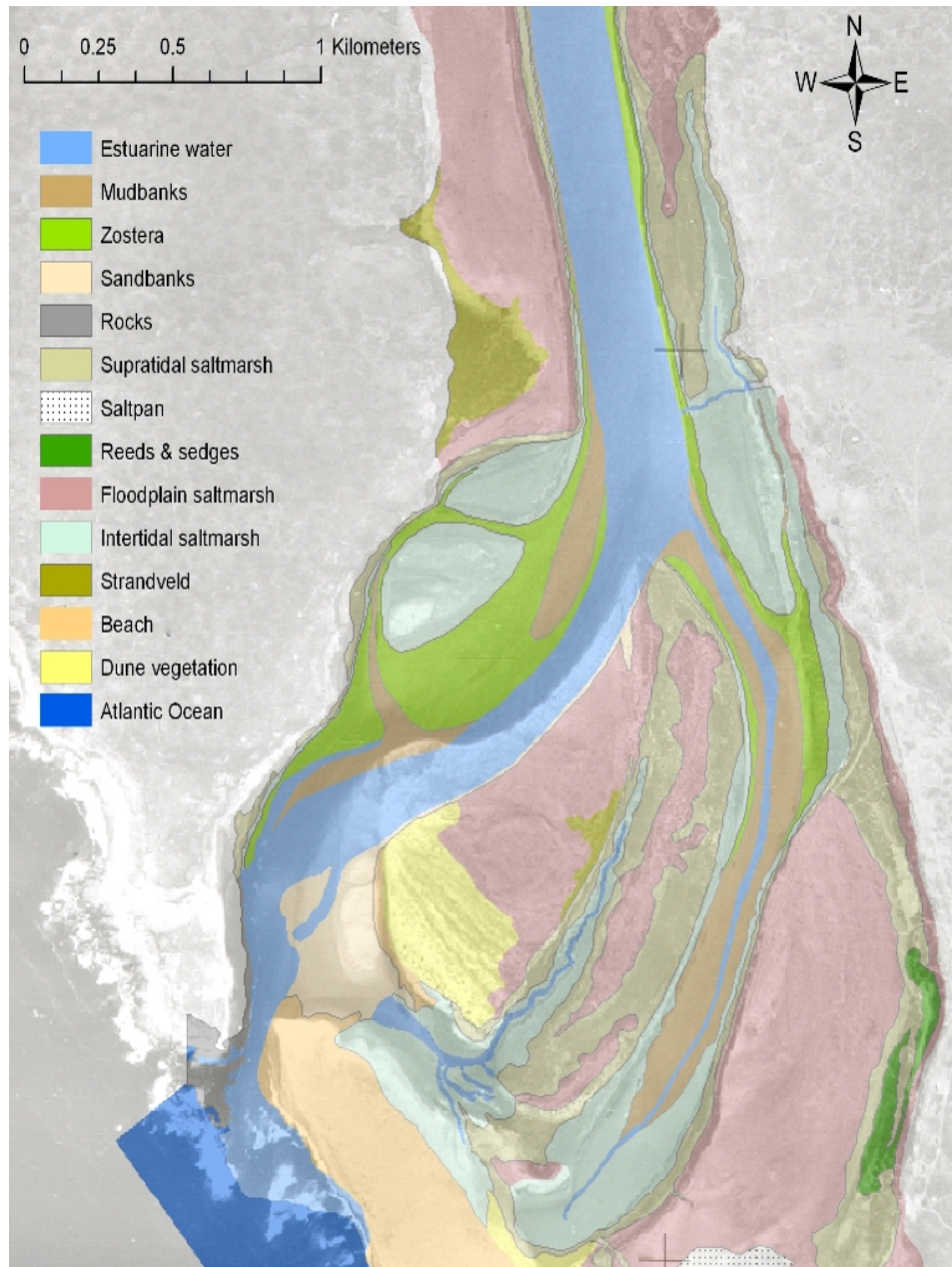


Figure 15. Lower reaches of the Olifants Estuary indicating the present distribution of vegetation in relation to the 1942 aerial photograph (from Adams *et al.* 2006).

A brief summary of the importance and health status of each of these vegetation types on the Olifants estuary is provided below. Most of this information is drawn from a report by Adams *et al.* (2006).

3.4.1 Macroalgae

A total of 12 species of macroalgae and one floating macrophyte species were recorded on the Olifants estuary during a survey conducted in 2006 (Adams *et al.* 2006). Many of the species found in the upper reaches of the estuary are indicative of nutrient enrichment. Of particular concern in this respect is the duckweed or water fern species

known as *Azolla filiculoides*. It is a mat-forming, free-floating fern that has been known to form dense mats in South African water bodies resulting in economic losses to water users due to increased siltation, canal clogging, loss of water quality and loss of biodiversity (McConnachie *et al.* 2003). *Azolla filiculoides* is a declared weed (Category 1) and is prohibited in South Africa. It is very abundant in the upper reaches of the Olifants estuary in both summer and winter, and is thus of some concern. The middle reaches of the estuary also support a range of species indicative of organically-polluted stagnant water. Some species (e.g. *Oscillatoria* sp.) are able to produce toxins that may be harmful to animals or humans, while others (e.g. *Enteromorpha* sp.) are known to form large, dense accumulations, especially under increased nutrient loads. This can lead to a reduction in water quality, clogging of pipes, inlets, and pumps, and fouling of propellers. The presence of these species in the Olifants estuary is thus also of concern. Macroalgae in the lower estuary are mostly of marine origin, none of which are of concern in respect of the health of the estuary.

3.4.2 Submerged macrophytes

Submerged macrophyte beds support diverse and abundant invertebrate and juvenile fish communities (Whitfield 1984, 1989). Primary productivity of submerged macrophytes is high and on par with the most productive plant habitats in marine and terrestrial ecosystems (Day 1981, Fredette *et al.* 1990). Two species of submerged macrophytes occur in the Olifants estuary, with pondweed *Potamogeton pectinatus* forming dense beds in the upper reaches and *Zostera capensis* (eelgrass) distributed in the lower and middle reaches of the estuary. Differences in their salinity tolerances are responsible for the spatial separation of these species in the estuary, with pondweed flourishing where salinities are less than 10 ppt and eelgrass at salinity between 25 – 40 ppt (Adams *et al.* 2006). Pondweed seems to have responded positively to increases in nutrient concentrations in the estuary, having increased its spatial coverage by up to nine times that in the natural state. Such high densities of submerged macrophytes are of concern as this can have detrimental effects on fish by reducing available habitat and oxygen concentrations (Adams *et al.* 2006).

3.4.3 Reeds and sedges

Reeds and sedges act as natural biological filters, they are important for bank stabilisation and they contribute to the diversity of aquatic life, particularly avifauna (Coetzee *et al.* 1997). *Pragmatism australis* and *Schoenoplectus scirpoides* are the dominant reed and sedge species in the Olifants estuary, respectively. They are very sensitive to variations in salinity and usually occur in the upper reaches of estuaries where salinity is less than 15 ppt. In the Olifants estuary the reeds are presently found from 8.5 km upstream, but historically would probably have extended down to about 6.5 km from the mouth (Adams *et al.* 2006). This represents a potential loss of 6.5 km of this vegetation type in the estuary, due to reduced freshwater flows and increased upstream penetration by saline water.

3.4.4 Salt marsh

Salt marshes in estuaries are a source of primary production and provide habitat and food for a variety of faunal species (Adams *et al.* 2006). The degree of tidal flushing is important in determining how much of nutrients they release into the water column (Childers & Day 1990). An open mouth is important as this maintains the intertidal salt marsh community. Salt marsh plants are distributed away from the water's edge along an inundation gradient. Intertidal salt marsh occurs between the limits of the high and low tide ranges, while supratidal marsh occurs above the intertidal zone and is only normally flooded during spring tide and other associated high water levels. Floodplain marshes are normally elevated above the rest of the estuary, and are normally only covered with water during large flood events. In the case of the Olifants estuary, these marshes have not been flooded for a long time and can be considered to be a paleo-floodplain.

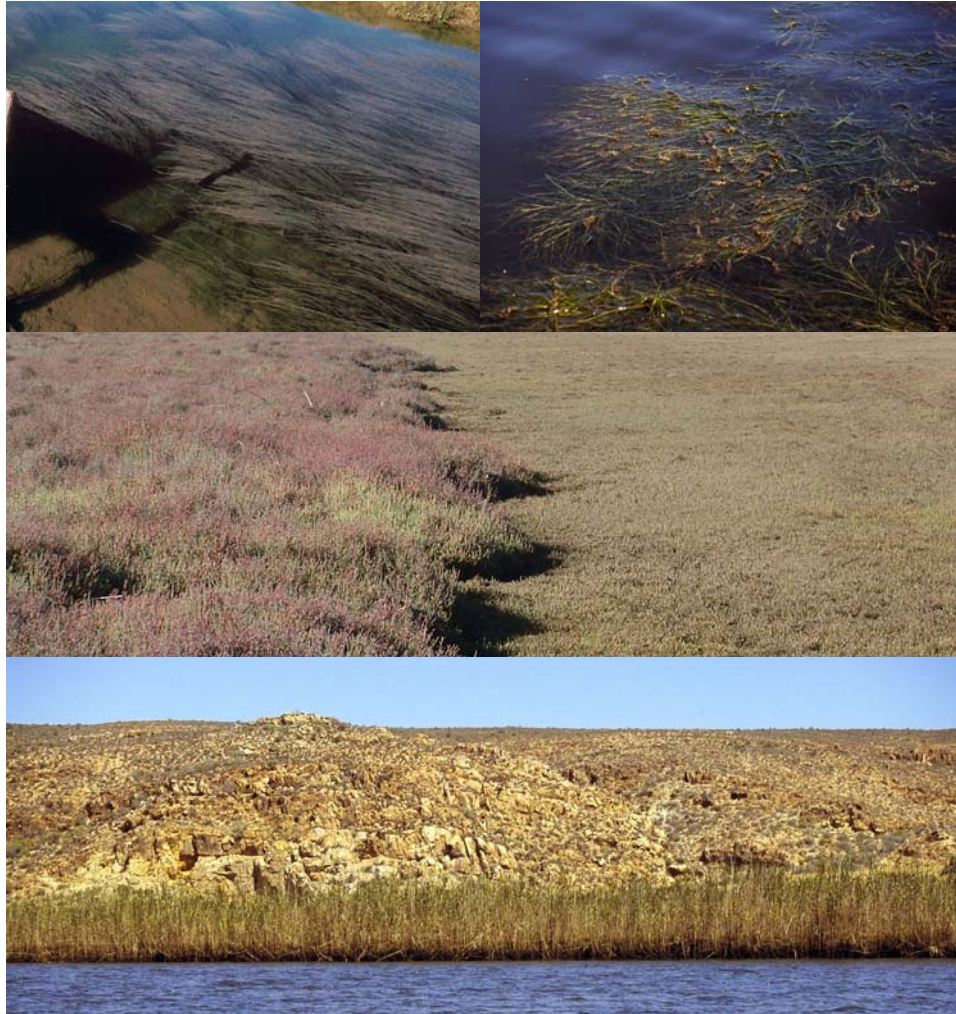


Figure 16. Dominant vegetation communities in the Olifants estuary: eelgrass *Zostera capensis* forms dense in the lower estuary (top left) while pondweed *Potamogeton pectinialis* (top right) forms similarly dense beds in the upper estuary restricting water movement and is a potential hazard to boating; intertidal (middle right) and supratidal (middle left) salt marsh are highly tolerant of salt water and are the dominant vegetation types in the lower reaches of the estuary; *Phragmites australis* (bottom) is the dominant reed species found lining the banks of the estuary in the middle and upper reaches.

The supratidal and floodplain salt marshes in the Olifants Estuary are the largest in South Africa, while the intertidal salt marsh area is relatively small. Each of these marsh types has a distinctive species assemblage associated with it, with differing inundation level and water chemistry requirements. These plants are all very sensitive to changes in groundwater depth and salinity. Any changes in these parameters would have a negative influence on these communities. A change in flood frequency, for example, would lead to die off and possible desertification (Bornman *et al.* 2004, Adams *et al.* 2006). The conservation value of this vegetation lies in the fact that halophytes are the only plants adapted to grow in these harsh environments and the loss of this vegetation would lead to the formation of bare, dry salt pans that are more easily eroded by wind and water.

Adams *et al.* (2006) analysed changes in vegetation cover and structure on the Olifants estuary floodplain over the last 60 years through comparisons between recent and historic (1942) aerial photographs. They report that very little change has taken place, with most of the observable change having occurred in the dynamic lower and mouth reaches of the estuary (Figure 15). Reeds and sedges have also expanded their

distributions in the upper and middle reaches of the estuary, presumably due to increased nutrient inputs to the system.

Adams *et al.* (2006) and Bornman (2002) state that they found that human physical disturbance to estuarine vegetation communities was fairly limited relative to other estuaries in South Africa. Local fishermen have reportedly cleared some of the supratidal salt marsh as an access channel, to build windbreaks, and as a source of firewood; in the lower reaches of the estuary the salt marsh is used for grazing sheep (Figure 17), while both cattle and sheep graze the salt marsh in the middle reaches of the estuary. Construction of a salt pan near the mouth has also resulted in the loss of a substantial area of salt marsh in this area.

Four permanent monitoring transects have been established in the Olifants estuary (two in the middle and two in the lower reaches of the estuary) by Adams *et al.* (2006) to monitor spatial and temporal variations in vegetation cover and sediment characteristics in response to potential future changes in flow.



Figure 17. Channels cut through the salt marsh in the lower estuary to facilitate access by fishers to the estuary channel (left) and grazing by sheep on salt marsh vegetation of the flood plain of the Olifants Estuary (right) may have important impacts on these important vegetation community.

3.5 Invertebrates

Invertebrates inhabiting estuaries are conveniently divided into a number of sub-groups based on where they reside in the estuary. Zooplankton live mostly in the water column, benthic organisms live in the sediments on the bottom and sides of the estuary channel, and hyperbenthic organisms live just above the sediment surface. Benthic organisms are frequently further subdivided into estuarine intertidal (those living between the high and low water marks on the banks of the estuary) and subtidal groups (those living below the low water mark). Invertebrate communities in the Olifants estuary have been studied by Brown (1969) and Wooldridge (2006).

Brown (1969) describes the invertebrate fauna of the Olifants estuary as being the richest on the West Coast, far richer than the nearby and superficially-similar Berg estuary. His observations on the richness of the invertebrate fauna of the Olifants apply mostly to the abundance of organisms in this estuary rather than the numbers of species, as he notes that only a handful of marine species were collected from the Olifants estuary that did not occur in the Berg. Wooldridge (2006) concurs with Brown (1969) in respect of the abundance of invertebrates in the Olifants, but not in respect of species richness. He notes that in comparison to the Berg estuary, the Olifants clearly reflected fewer species in all groups investigated. He goes on to say that invertebrates recorded over most of the Olifants estuary can generally be described as typical estuarine species that are tolerant of wide variation in the physico-chemical environment. Many of the species present in the Olifants also occur in estuaries on the south and east coasts of southern Africa. It should also be noted that numbers of invertebrate species present in estuaries

on the west coast are generally low compared to communities on the south and east coasts. Wooldridge (2006) attributes this to high river dominance of the estuaries on the west coast which frequently reduces salinity levels in the lower reaches of the estuary to levels below that suitable for many marine species. This prevents stable stenohaline benthic marine communities (with narrow range of salinity tolerance) from establishing themselves in the lower reaches of these estuaries. The lower reaches of these estuaries are thus inhabited by an incursive marine zooplankton component that enters the lower reaches of these estuaries on the incoming tide, but leaves again on the outgoing tide.

Wooldridge lists the dominant invertebrate species in the Olifants estuary as being *Pseudodiaptomus hessei* (zooplankton), the amphipod *Melita zeylanica*, the crown-crab *Hymenosoma orbiculare* (hyperbenthos), the polychaetes *Ceratonereis keiskamma*, *Desdemona ornata* and the amphipods *Corophium triaenonyx*, *Grandidierella lutosa* and *Melita zeylanica* (benthos). These invertebrates are important in the diets of fish and birds. The abundance of these species varies up the length of the estuary. Zooplankton and hyperbenthos abundance is highest in the middle reaches of the estuary and subtidal benthos peaks at the top of the estuary (Figure 18).

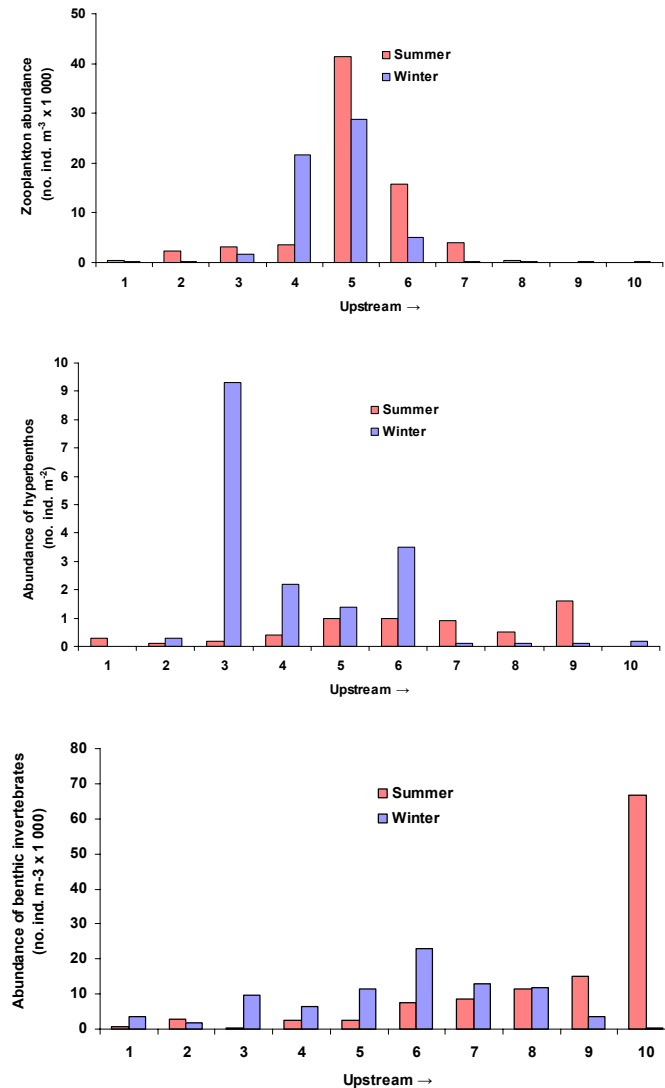


Figure 18. Variation in abundance of zooplankton (top), hyperbenthos (middle) and subtidal benthos (bottom) at ten stations up the length of the Olifants estuary.

3.6 Fish

Estuaries provide an extremely important habitat for fish in southern Africa. The vast majority of coastal habitat in southern Africa is directly exposed to the open ocean, and as such is subject to intensive wave action throughout the year (Field & Griffiths 1991, Beckley 1984). Estuaries in southern Africa are thus disproportionately important relative to other parts of the world, in that they constitute the bulk of the sheltered, shallow water inshore habitat in the region. Juveniles of many marine fish species in southern Africa have adapted to take advantage of this situation, and have developed the necessary adaptations to enable them to persist in estuaries for at least part of their life cycles. There are at least 100 species that show a clear association with estuaries in South Africa (Whitfield 1998). Most of these are juveniles of marine species that enter estuaries as larvae, remain there for a year or more before returning to the marine environment as adults or sub-adults where they spawn, completing the cycle. Several other species also use estuaries in southern Africa, including some that are able to complete their entire life cycles in these systems, and a range of salt tolerant freshwater species and euryhaline marine species. Whitfield (1994) has developed a detailed classification system of estuary associated fishes in southern Africa. He recognized five major categories of estuary associated fish species and several subcategories:

- I: Estuarine species breeding in estuaries, further divided into:
 - Ia: Resident species not recorded spawning in marine or freshwater environment
 - Ib: Resident species also having marine and/or freshwater breeding populations
- II: Euryhaline marine species usually breeding at sea with juveniles showing varying degrees of dependence on estuaries, further divided into:
 - IIa Juveniles dependent on estuaries as nursery areas
 - IIb Juveniles occurring mainly in estuaries, but also found at sea
 - IIc Juveniles occur mainly at sea, but also found in estuaries
- III: Marine species that occur in estuaries in small numbers but are not dependent on estuaries
- IV: Euryhaline freshwater species whose penetration into estuaries is determined primarily by salinity tolerance. Includes some species which may breed in both freshwater and estuaries
- V: Catadromous species which use estuaries as transit routes between the marine and freshwater environments but may also occupy estuaries in certain regions, further divided into:
 - Va Obligate catadromous species which require a freshwater phase in their development
 - Vb Facultative catadromous species which do not require a freshwater phase in their development but use estuaries as nursery areas

Fish species in categories I, II, and V as defined by Whitfield (1994) are all wholly or largely dependent on estuaries for their survival and are hence the most important from an estuary conservation perspective. These species need to receive most attention from a management perspective.

Lamberth (2006) reports that a total of 38 fish species from 30 families have been recorded in the Olifants River Estuary.

Eight of these are likely to be **breeding** in the Olifants estuary, including:

- estuarine round-herring *Gilchristella aestuaria*,
- Cape silverside *Atherina breviceps*,
- prison goby *Caffrogobius gilchristi*,
- commafin goby *Caffrogobius saldanha* and
- longsnout pipefish *Syngnathus temminckii*;

Four species are likely to be **dependent** on the estuary as a **nursery area** for at least their first year of life:

- white steenbras *Lithognathus lithognathus*,
- leervis *Lichia amia*,

- freshwater mullet *Myxus capensis* and
- flathead mullet *Mugil cephalus*.

Another 7 species are at least **partially dependent** on estuary as a **nursery area**, including

- harder *Liza richardsonii*,
- elf *Pomatomus saltatrix*,
- blackhand sole *Soleo bleekeri* and
- white stumpnose *Rhabdosargus globiceps*.

Finally, seven **euryhaline freshwater species**, whose penetration into estuaries is determined by salinity tolerance, have been recorded from the Olifants Estuary:

- Clanwilliam yellowfish *Labeobarbus capensis* (an endemic, red data species),
- sawfin *Barbus serra* (indigenous), and
- Cape galaxias *Galaxias zebratus* (indigenous),
- smallmouth bass *Micropterus dolomieu* (introduced)
- bluegill sunfish *Lepomis macrochirus*, (introduced)
- banded tilapia *Tilapia sparmanii* (introduced) and
- Mozambique tilapia *Oreochromis mossambicus* (introduced).

In all, 18 species (50 % of the fish species recorded from the Olifants Estuary) can be regarded as either partially or completely dependent on the estuary for their survival. Similarly high dependence ratios have been reported for other west coast estuaries (e.g. the Berg and Orange, Bennett 1994, Harrison 1997, Lamberth 2003, Clark 2007). Bennett (1994) when studying the Berg estuary, made the observation that dependence ratios for west coast estuaries are much higher than that observed in estuaries on the south, east and KwaZulu-Natal coasts respectively (25-54, 22 and 9% of species being estuarine dependent, respectively), and concluded that estuaries on the west coast must be disproportionately important from a fish conservation perspective than those elsewhere in the country. Bennett (1994) further argues that the high reliance of the local fish on west coast estuaries means that any degradation of the estuarine habitat will have worse consequences for fish on the west coast than elsewhere in South Africa. These arguments are strongly supported by the work of Lamberth (2006) who highlights the fact that there are only nine functional estuaries on the west coast, and that of these, only the Berg and Olifants are permanently open, the Orange now being intermittently closed. The Olifants lies between the Orange, 380 km to the north and the Berg, 125 km to the south. Consequently, each of these estuaries is crucial in maintaining the range and stock integrity of estuarine and estuarine dependent species along the entire west coast. In turn, the Olifants is an important nursery area for exploited marine and estuarine species before they recruit into the marine fisheries. The decline in the *L. richardsonii* stock and marine gill net fishery catches on the west coast has been attributed to recruitment over-fishing in the Berg and Olifants estuary gill net fisheries (Hutchings & Lamberth 2003).

Seine net data collected by Lamberth (2006), shows that two fish species are overwhelmingly dominant in the system, these being the harder *Liza richardsonii* (contributing 55% of the catches) and the estuarine round herring *Gilchristella aestuaria* (contributing 42 %). Only two other species, nude goby *Caffrogobius* spp. (1.3 %) and silverside *Atherina breviceps* (1 %), contributed more than 1% to the total catch. Gill net surveys, which provide a more accurate representation of the larger fish in the estuary, confirmed the predominance of harders *L. richardsonii* (98% of total numbers) and added elf *Pomatomus saltatrix* as the only other species contributing more than 1% of the catch. Surveys conducted by Lamberth (2006) show that fish distribution patterns in the Olifants estuary are variable, but that on the whole, the majority of completely and partially estuary-dependent species were most abundant from 5-20 km from the mouth, in salinities ranging from 0-20 ppt and water clarity less than 100 cm. Adequate protection need to be applied to the entire estuary, however, to ensure the survival of these species as they are highly mobile moving from the mouth right up to the top of the estuary.

Lamberth (2006) speculated on likely changes between fish fauna present in the estuary in the present day and that which might have existed under reference (natural) conditions. He concluded that the Olifants estuary would have harboured a much more diverse fish fauna in the past dominated by estuarine resident species (37% of total numbers, compared with 1% at present) or dependent species that are tolerant of, or prefer, lower salinities (such as the flathead mullet *Mugil cephalus* and harder *L. richardsonii*). These small species would have been preyed on by adults and juveniles of the large piscivorous kob *Argyrosomus inodorus*, leervis *Lichia amia* and elf *Pomatomus saltatrix* which are likely to have been abundant, and the dominant predators in the system. Juveniles of most estuarine dependent benthic feeders such as white steenbras *Lithognathus lithognathus* and white stumpnose *Rhabdosargus globiceps* are likely to have been abundant but the adults are likely to have had a shorter residence time within the system. Indigenous freshwater species such as sawfin *Barbus serra* and Clanwilliam yellowfish *Labeobarbus capensis* are likely to have been abundant in the lower reaches during the winter months and frequently throughout the year. Changes between the reference (natural) and present day conditions would most likely have been a function of reduced freshwater flows into the system and associated changes in water chemistry and food supplies as well as impacts from the gill net fishery. More details on the latter are provided in Section 5.4.

Based on the distribution of the main linefish species in the estuary (Figure 19), the area from 4 to 24km upstream is the main area for these fishes, and the area from 6 - 14 km upstream is considered to be the best core area to conserve for these species (this study).

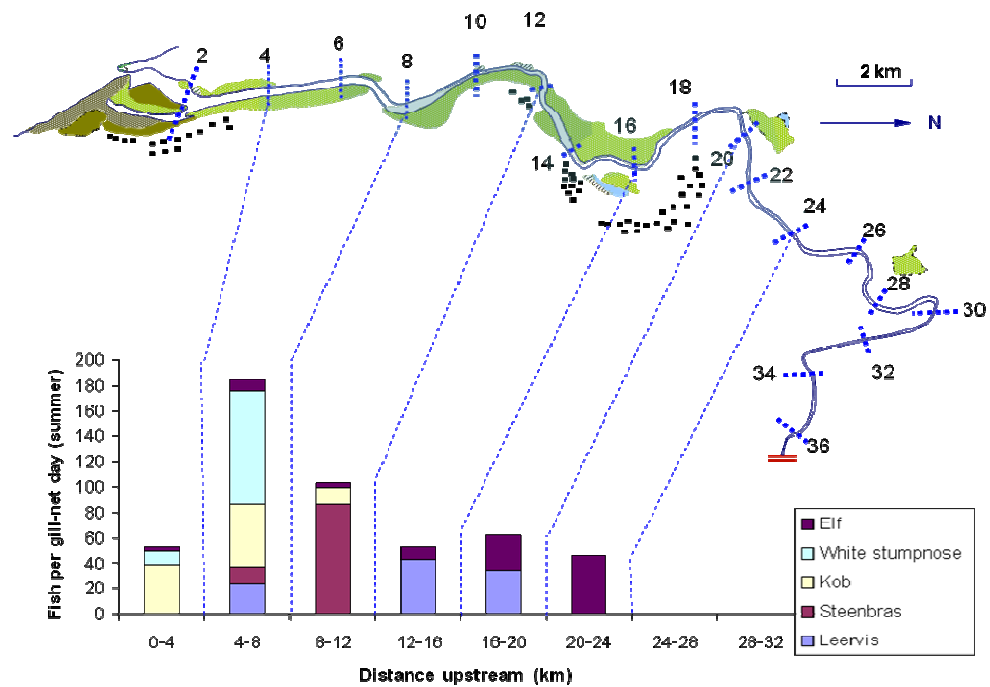


Figure 19. Distribution of linefish along the estuary

3.7 Birds

Being a large, permanently open estuary with a high diversity of habitats, the Olifants estuary supports a high diversity and number of birds. A large proportion of bird species that occur on South African estuaries have been recorded, including important and/or red data species such as African Black Oystercatcher, Caspian Tern, Chestnut-banded Plover, Lesser Flamingo and African Marsh Harrier.

A total of 72 non-passerine² waterbird species (excluding vagrants) have been recorded on the estuary, representing nine orders of birds, with Charadriiformes (waders, gulls and terns), making up 41% of the waterbird species recorded on the estuary (Table 4). Other groups are relatively evenly represented. A total of 21 species are long-distance migrants.

Table 4. Numbers of species of different groups that have been recorded on the estuary (Non-passerine waterbirds, excluding vagrants).

Order	Common names	Total	Migratory
Podicipediformes	Grebes	3	
Pelecaniformes	Cormorants, darters	5	
Ciconiiformes	Hérons, egrets, ibis, spoonbill	8	
Pheonicopteriformes	Flamingos	2	
Anseriformes	Ducks	12	
Falconiformes	Birds of prey	2	1
Gruiformes	Rails, crakes, coots..	3	
Charadriiformes	Waders	24	15
	Gulls	3	
	Terns	7	5
Alcediniformes	Kingfishers	3	
		72	22

No monthly counts have been carried out at the Olifants estuary, but based on trends at other estuaries such as the Berg, bird numbers are expected to be maximal in December - March and minimal in mid-winter, with numbers of some bird species being highest in spring.

About 5 900 birds occur in summer and 3 200 in winter (Turpie 2006). Numbers in summer have reached much higher levels in past counts, with numbers of around 16 000 birds being recorded in both January and December 1980 (Underhill & Cooper 1984). These high counts were due to high numbers of terns and waders compared with more recent counts.

While species richness is similar in summer and winter, there are marked changes in community composition and numbers. Apart from the large number of marine cormorants that roost on the rocky point at the mouth and occasionally spill over into the lowest part of the estuary, the avifauna in summer is numerically dominated by waders (about 36%) and terns (about 45%), the majority of which are long-distance migrants (Turpie 2006). It must be noted, though, that the numbers of waders and terns vary considerably between years, as do numbers of flamingos. Terns are dominated by Common Tern, with up to 12 000 of these having been recorded in the estuary. Apart from terns, the avifauna in summer is consistently dominated by waders (plovers, sandpipers, etc), particularly the smaller species such as Curlew Sandpiper (Figure 21). Just over 90% of the waders using the estuary in summer are Palaearctic migrants (from sub-Arctic and Arctic breeding grounds). The remaining waders are resident species (e.g. White-fronted Plovers, Kittlitz's Plover, Water Dikkop). High numbers of Avocets have been recorded in the past (ca 1980).

² This excludes passerine birds which are perching- or song-birds such as warblers, bishops and weavers.



Figure 20. Flamingos (top) and pelicans (bottom) are amongst the more charismatic avifauna on the Olifants estuary.

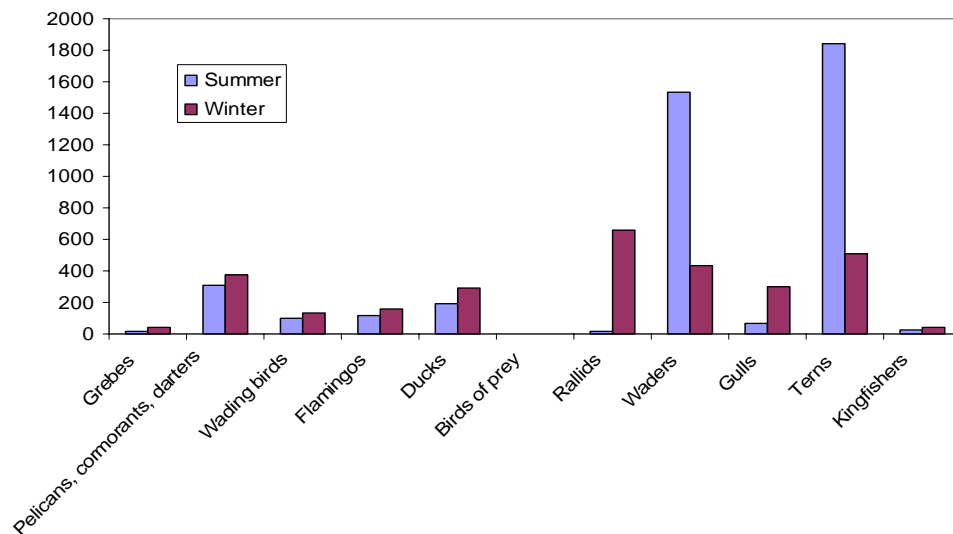


Figure 21. Avifaunal community composition in summer and winter in terms of broad taxonomic groupings (Source: Turpie 2006).

In winter, avifauna is dominated by resident species and there is a far more even spread in terms of community composition (Figure 21). While waders and terns made up about 32% of birds, waterfowl (ducks, rails and grebes) make up about 35% of birds, pelicaniformes (pelicans, cormorants and darters) and ciconiiformes (herons, egrets etc) make up about 4% of birds. Kingfishers and birds of prey are present in small numbers.

About 28% of the Palaearctic waders remain on the estuary during winter (the first-year birds of the longest-distance migrants), whereas numbers of resident waders increase by about 50%. Nevertheless, Palaearctic waders continue to dominate, making up about two-thirds (67%) of waders. Migratory terns from the northern hemisphere are replaced

by migratory terns from the Antarctic, though in much smaller numbers. Numbers of the other groups tend to increase in winter.

Bird numbers are highest in the northern arm and blind arm of the estuary (Figure 22). About 80% of birds are found in this area, with bird densities decreasing progressively upstream. 91% of summer numbers and 74% of winter numbers are found within the first 9km of the estuary (sections 1-5). The density gradient is much steeper in summer than in winter, since most migratory waders and terns occur in the lower estuary. Very low densities of waders occur in the saltpan and supratidal marshes, but the community composition tends to be different than elsewhere.

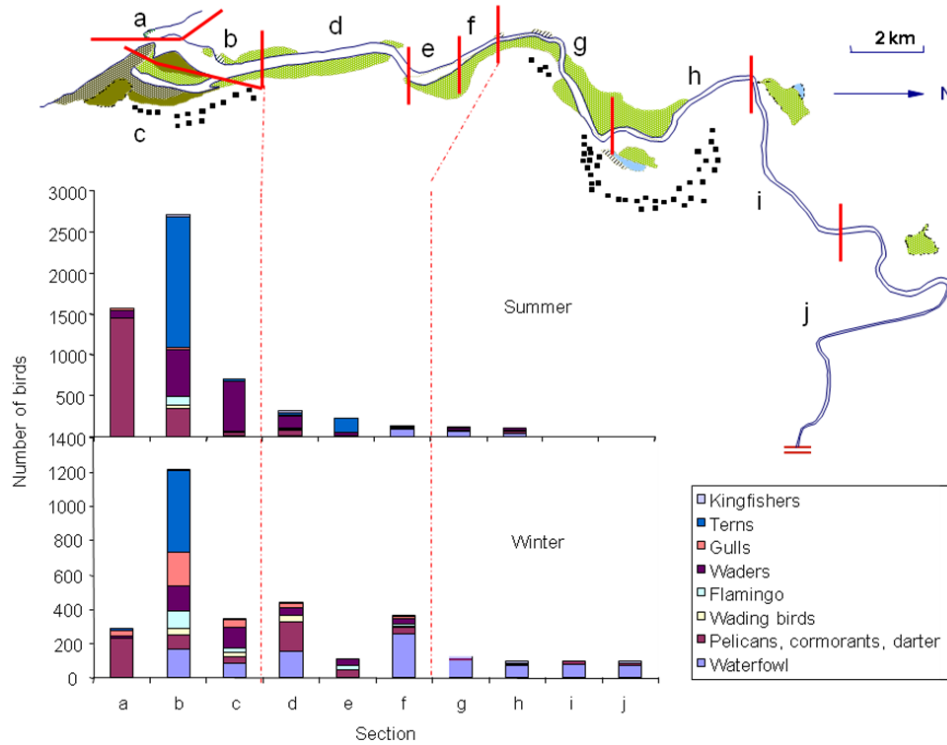


Figure 22. Detailed distribution of different groups of species along the estuary. Note differences in scale, and that sections 9 and 10 were not included in the summer count.

Whereas numbers of birds in the lower estuary are dramatically reduced in winter, numbers increase slightly in the middle to upper reaches (Figure 22).

There are three main bird communities along the estuary: the rocky headland at the mouth, the lower 9km of the estuary and the upper estuary above 9km (Turpie 2006). Spatial variation in community composition along the estuary is linked to habitat differences.

The rocky headland serves as a roosting site for marine seabirds such as Cape and Bank Cormorants.

The lower estuary is characterised by large areas of intertidal sand- and mudflats and channels fringed with rocky (shale) banks, and a large saltmarsh with creeks. The intertidal areas are dominated by waders, terns and gulls, with the latter two groups being mainly restricted to the sandier banks, and waders making more use of muddy areas. The saltmarshes in the lower estuary also support wading birds such as egrets and herons, as well as coots in winter when conditions are fresher.

From about 9km from the mouth, the estuary becomes narrow and more brackish, with heavily vegetated banks (mainly reed marsh *Phragmites australis*). These reaches tend to feature resident waders, wading birds, cormorants, kingfishers and more freshwater-loving waterfowl.

While most species feed in the estuary, some of the more abundant species do not use the estuary as their main feeding area, or feed there at all. These include most of the terns, and probably some gulls. The sandbanks in the lower estuary are important roosting areas for terns and gulls. These areas are thought to be attractive to the birds in that they provide relatively safe roost sites. 'The Island' would probably have been a popular roosting area for gulls when it was an island. Egyptian Geese use the estuary for resting and breeding, but not as a feeding habitat.

Excluding the marine cormorants, the avifauna is dominated by invertebrate feeders (mostly waders) and piscivores (mostly terns) in summer (Figure 23). There is a more even distribution of trophic groups in winter.

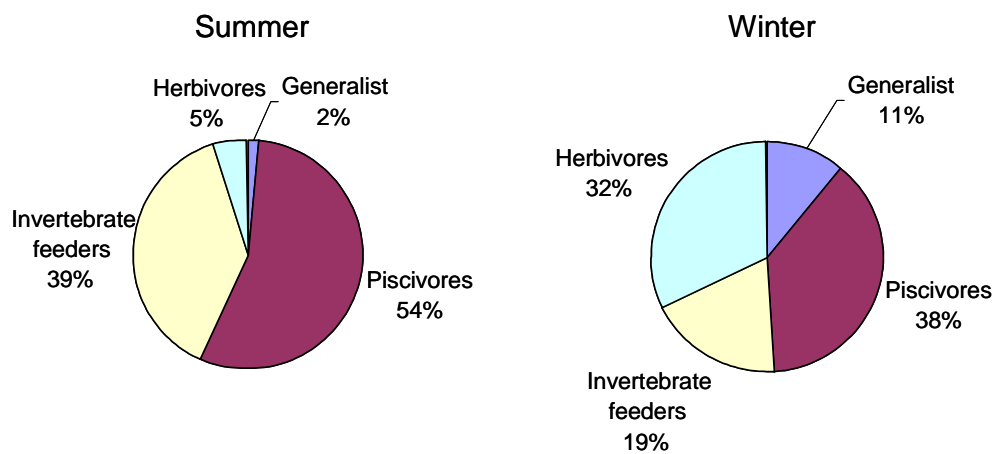


Figure 23. Guild composition of birds on the estuary in summer and winter

The large number of invertebrate feeders is due to the relatively large intertidal area of the estuary, although the areas where estuarine muds predominate (including areas covered with *Zostera*) are most important, not the extensive sandy areas near the mouth. Waders are opportunistic foragers whose diets reflect the macroinvertebrate fauna, and are typically dominated by prawns (*Upogebia*), crabs (e.g. *Hymenosoma*), polychaetes (e.g. *Ceratonereis*), and amphipods.

Saltmarshes tend to be less favourable as feeding habitats for waders, except for the muddy creeks within them that are highly productive. The relatively moist saltmarshes around the blind arm were fairly extensively used by waders, however.

Reed marshes support a characteristic suite of species from a range of dietary guilds that use the reeds for food or shelter. Reed marsh habitat is abundant on the Olifants, and supports species such as Purple Heron, Purple Gallinule and Moorhen, as well as passerine reed bed species such as Red Bishop.

The river channel is dominated by piscivorous waterbirds (e.g. pelicans, cormorants, darters and kingfishers) and waterfowl. Fish Eagles have not been recorded on the estuary during any of the counts.

Regular summer and winter counts of part of the lower estuary over the last ten years suggest that bird numbers have remained relatively constant over this period. However, there are substantial differences in community composition over this period (Figure 24).

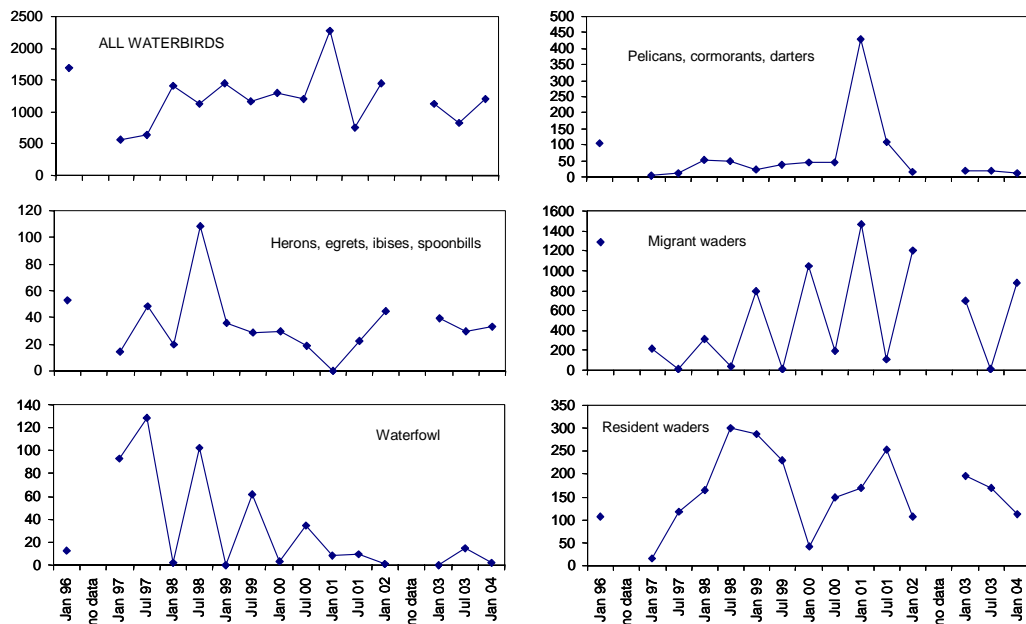


Figure 24. Variation in the numbers of waterbirds on the south bank of the lower Olifants estuary (based on CWAC data).

Variations in total numbers and community composition suggest that the estuary conditions in summer can vary in terms of the amount of freshwater wetland habitats and shallower habitats and exposed shorelines. In some years, waterbirds more characteristic of freshwater or brackish habitats become numerous, while in other years, species typical of exposed shorelines are more numerous than usual. These differences could reflect differences in conditions between wetter and drier years, or simply differences in the timing of rainfall and freshwater inflows.

4. ECOSYSTEM SERVICES

4.1 What are ecosystem services?

Ecosystems can be viewed as natural capital which contributes to economic production. They provide **goods, services and attributes**, collectively known as **ecosystem services**, that contribute to human welfare (Barbier 1994):

- Goods are harvested resources, such as fish.
- Services are processes that contribute to economic production or save costs, such as water purification.
- Attributes relate to the structure and organisation of biodiversity, such as beauty, rarity or diversity, and generate less tangible values such as spiritual, educational, cultural and recreational value.

The Millennium Ecosystem Assessment (2003) recently recategorized the services obtained from ecosystems as follows:

- Provisioning services such as food and water;
- Regulating services such as flood and disease control;
- Cultural services such as spiritual, recreational, and cultural benefits; and
- Supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

The first three align well with the definitions of goods, services and attributes described above, while the fourth underlies these and need only be considered inasmuch as changes in these affect the values of the first three (Turpie 2007).

4.2 Goods and services provided by the Olifants estuary

The main types of ecosystem services that are associated with temperate South African estuaries are listed in Table 5.

Table 5. Ecosystem goods, services and attributes based on definitions by Costanza *et al.* (1997) that are likely to be provided by temperate South African estuaries (Turpie 2007)

	Ecosystem Goods, Services & Attributes	Description	Importance in estuaries
Goods	Food, medicines	Production of fish and food plants; medicinal plants	High
	Raw materials	Production of craftwork materials, construction materials and fodder	Medium
Services	Gas regulation	Carbon sequestration, oxygen and ozone production,	Low
	Climate regulation	Urban heat amelioration, wind generation	Low
	Erosion control and sediment retention	Prevention of soil loss by vegetation cover, and capture of soil in wetlands, added agricultural (crop and grazing) output in wetlands/floodplains	Low
	Waste treatment	Breaking down of waste, detoxifying pollution; dilution and transport of pollutants	Medium
	Refugia	Critical habitat for migratory fish and birds, important habitats for species	High
	Nursery areas	Critical breeding habitat, Nurseries for marine fish	High
	Export of materials and nutrients	Export of nutrients and sediments to marine ecosystems	High
Attributes	Genetic resources	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species	Low
	Structure and composition	Species diversity and habitats providing opportunities for recreational and cultural activities	High

A recent assessment was carried out on goods and services provided by the Olifants estuary for the determination of the river and estuary Reserve (Resource Directed Measures; Turpie *et al.* 2006a) and the results of this study were also used in the development of a Classification System for aquatic ecosystems (Turpie *et al.* 2006b). Ecosystem services provided by aquatic systems generally were assessed for the Olifants-Doring Catchment, largely on the basis of existing information. Information on the estuary is distilled from these sources.

4.3 Small-scale fishery

There are 45 gill-net permit holders in the Olifants estuary, and an estimated additional 10-30 people operating without permits (Sowman *et al.* 1997, Turpie *et al.* 2006a). Annual effort is about 15 300 net days/year (Lamberth 2006).

The Olifants gill-net fishery targets harders. Mean annual landings of harders by the fishery are in the region of 100 - 200 t with a further 400-1200 kg of by-catch species such as elf *Pomatomus saltatrix*, flat head mullet *Mugil cephalus*, white steenbras *Lithognathus lithognathus*, leervis *Lichia amia*, barbell *Galeichthys feliceps*, gurnard *Chelidonichthys capensis* and silver kob *Argyrosomus inodorus* (Fielding *et al.* 2007, Lamberth & Hutchings 2003, MCM Netfish System). Fishery statistics for the Olifants River Estuary gill net fishery over the period 2004-2006 are summarised in Table 6.

Table 6. Fishery statistics for the Olifants Estuary gill net fishery over the period 2004-2006 (source: Fielding *et al.* 2007)

Year	CPUE (kg/trip)	Total catch (t)*	Average TL (cm)	Average mass (g)
2004	32	157	23.9	125
2005	22	108	23.5	116
2006	42	206	22.3	103

*Note: These values are those estimated by Fielding *et al.* (2007) based on community monitoring data. These values differ somewhat from the official catch return data in the MCM netfish data base and the authors concede that effort and hence total catch may be slightly over estimated.*

CPUE: Catch per Unit Effort; TL: Total Length

The annual tonnage from the Olifants Estuary comprises 1 – 2 % of the national catch by the inshore beach-seine and gill-net fisheries (Lamberth *et al.* 1997). The nets used are restricted to 45 m in length and a minimum mesh size of 48 mm. All the fishers use rowing boats, the use of motors being frowned upon either because the fishers cannot afford them or due to the perception that they scare the fish.

Sixty percent of the fisher households rely on fishing for 25-50% of their summer income, whereas for the remaining 40%, fishing comprises 75% of household income (Sowman *et al.* 1997). A large part of the catch is consumed with more than 50% of households eating fish very day. Based on estimated catches of the gill-net fishery and the national average value per kg (Lamberth & Turpie 2003), the fishery is estimated to be worth about R490 000– R630 000 per annum (2005 rands).

Fishing is seasonal, being confined mostly to summer (October - April) during low flows. Although abundance and/or catchability of harders may be lower in the winter months, making fishing un-worthwhile, any attempt at setting nets is usually impeded by water borne debris. The low flow experienced during 2004 saw the fishery active throughout the winter months. However, despite the overall increase in effort throughout the year, total catch was 100 – 120 t, similar to the annual average. This suggests that catches were spread out over a longer period and that catch per unit effort declined with the increase in effort. Consequently, it appears that recruitment is low, fishing mortality high and the 45 operators are above the sustainable effort maximum, most fish entering the system being caught. While decreased flows are likely to lead to decreased catches, prolonged high flows or floods in winter may also result in extreme hardship for the families reliant on fishing for a livelihood. In any event, Marine and Coastal

Management plans to terminate the small-scale fishing permits on the Olifants estuary within a few years.



Figure 25. The Papendorp (top) and Ebenhaeser communities (bottom) are home to a community of subsistence gill net fisher on the Olifants estuary.

4.4 Raw materials

There is no recorded use of building materials (e.g. reeds, sand) gathered from the estuary for subsistence or commercial purposes. The lack of subsistence use is unsurprising because of the population make-up and the lack of traditional dwellings in this catchment.

There has been diamond mining and prospecting in the mouth region during the past 50 years or so. Salt mining occurs in a saltpan south of the estuary mouth. Issues relating to the mining and salt harvesting are addressed in more detail in section 77.

4.5 Carbon sequestration

Carbon sequestration is measured in terms of the net storage or loss of carbon that takes place as a result of a long-term increase or decrease in biomass. The contribution made by estuaries to carbon sequestration is unknown but is unlikely to be significant apart from in mangrove systems.

4.6 Waste treatment

Waste treatment is likely to be an important ecological service provided by the aquatic ecosystems of the Olifants-Doring catchment, particularly in that agricultural return flows are diluted and assimilated by the system. The value of this function is usually estimated in terms of the cost savings of treating the water before it is released. However, the quantity of pollutants released into the system is unknown (Turpie *et al.* 2006a). It is important to note that the value of the system is only measured in terms of the amount assimilated by the system. This capacity could be reduced under certain circumstances, resulting in decreased water quality downstream and exacerbating the negative impacts on downstream users that would already be caused by increased pollution loads due to agricultural expansion.

4.7 Refuge areas

Refuge areas are areas that help to maintain populations in a broader area. For example, wetlands within relatively arid areas may play an important seasonal role in the maintenance of wild herbivores that are utilised in tourism operations well beyond the wetland. This is probably not important in the study area apart from for fish. In the rivers, some of the smaller tributaries have become important as refuge areas for endemic fish, although their ability to repopulate the rest of the river system is low at present (see discussion below). In the estuary, some inshore marine fish populations may utilise the estuary as a warmer refuge during upwelling events (Lamberth 2005). The extent of this function in its contribution to marine populations is unknown.

4.8 Export of materials and nutrients

The export of sediments and nutrients to the marine zone is an important function of some river systems. For example, the prawn fisheries of KwaZulu-Natal depend on such exports (DWAF 2004c). However, this function is far more important on the east coast, which is relatively nutrient-poor, than on the west coast, where the outputs of estuaries do not compete with the nutrients supplied by the Atlantic upwelling systems (Turpie & Clark 2006). Sediment exports could be important, however, but there is no information on this.

4.9 Nursery value

4.9.1 Introduction

Nursery areas are breeding habitat for populations that reside elsewhere. Estuaries provide nursery areas and habitat for numerous species of fishes which are exploited by recreational and commercial harvesting in the inshore marine environment. Different species are dependent on estuaries to different degrees for stages of their development and growth. The nursery function of the Olifants estuary is considered to be significant, in that many marine species caught in the surrounding marine fisheries are dependent on estuaries as nursery areas, because it is one of only four permanently open systems, and it accounts for 23% of the estuarine area on the west coast.

4.9.2 The West Coast fisheries

There are about 431 000 recreational fishers and well over 21 000 commercial fishers active in the inshore marine environment in South Africa. Commercial net fisheries (beach seine and gill net) on the west coast are likely to be the fisheries that benefit most from the Olifants estuary. The commercial line fishery, recreational shore angling and recreational boat angling fisheries could also benefit to a small extent.

The West Coast net fisheries comprise 28 beach-seine operators, and about 118 marine gill-net operators, from Yzerfontein northwards. In addition there are an estimated 268 illegal gill-nets on the west coast. These fisheries target harders and St Joseph sharks *Calorhynchus capensis*, as well as species on the "bait list" such as maasbanker *Trachurus trachurus*. There are approximately 2 700 people who derive some sort of income in the legal inshore net fisheries along the west and south coasts, with a total effort of approximately 32 000 net-days per year.

There were about 9000 commercial line fishers operating from registered boats on the West Coast (Brouwer *et al.* 1997, Sauer *et al.* 1997), though at least half of these may have become recreational line fishers since the number of licences were reduced in 2003.

Some 26 000 regular shore anglers fish along the West Coast (Brouwer *et al.* 1997, Sauer *et al.* 1997). The majority of anglers come from the upper two quintiles of income earners in South Africa (McGrath *et al.* 1997). In addition there are about 210 recreational boat anglers on the West Coast (Brouwer *et al.* 1997, Sauer *et al.* 1997). In many cases, the distinction between commercial and recreational boat fishermen is blurred. The situation has changed since the allocation of fishing rights began in 2001, with many "part-time" fishers being removed from the fishery.

The total inshore marine catch in South Africa is estimated to be 28 107 tons per year (Lamberth & Turpie 2003). Of this 60% is made up by the commercial line fish sector and 23% by the commercial net fishery, the remainder being made up of recreational fisheries. Inshore fishery catches on the West Coast account for about 15 000 tons, and make up 53% of the total catch. In contrast to the rest of the country, these catches are predominantly commercial, whereas recreational catches are more important than commercial catches in the rest of the country.

4.9.3 Nursery value of the Olifants estuary

About 19 of the fish species occurring in west coast estuaries are utilised in coastal fisheries. Of these, 8, 9 and 2 species fall into categories II, III and IV, respectively (none in I or V), in terms of their dependence on estuaries (Whitfield 1994, see previous section on fish). Of particular importance are the category II species, for which management of estuaries plays a crucial role in inshore fisheries.

The contribution of different categories of estuary-associated species to inshore marine fisheries on the west coast is summarised in Table 7. Category IIa species (e.g. White Steenbras), which are entirely dependent on estuaries, generally make up a relatively small percentage of catches, ranging from 0.5% of recreational boat and spear fishing catches to 1.05% of commercial net catches. Historically, prior to stock collapse, IIa species (white steenbras and dusky kob) made up a substantial part of catches. The proportion of category IIb species in catches is generally lower than of category IIa species, but category IIc species are highly important in the commercial net fisheries and recreational shore fishery (Table 7). The category IIc species are dominated by harders in the commercial net fisheries. The main species in these fisheries are shown in Table 8.

The inshore marine fisheries of the West Coast fisheries are estimated to be worth about R647 million per annum (based on Lamberth & Turpie 2003). Recreational fisheries make up approximately 53% of this value, the remainder being ascribed to commercial fisheries.

Estuarine fish make up about 25% of the value of the gill- and seine-net fisheries and 0.3% of the value of the commercial boat fisheries on the west coast, or about 8% of the overall value of West Coast inshore marine fisheries (Table 9). However, not all of these fish are equally dependent on estuaries. Category IIa species are 100% dependent on estuaries to complete their life cycles. Because the juveniles of Category IIb species are largely confined to estuaries, their level of dependence on estuaries was considered to be very high, and was estimated as 90%. The overall numbers of Category IIc species, whose juveniles mainly occur in marine environments, are augmented by the presence

of estuarine habitat areas. Estuarine area comprises about 30% of the juvenile habitat available to these species, and those juveniles using estuaries are frequently in better condition than those in marine habitats (De Decker & Bennett 1985). It is thus estimated that 30% of the marine catches of Category IIc species can be attributed to estuarine export. Thus in calculating the contribution of the different types of species to fishery values, estuaries are assumed to account for 100%, 90, and 30% of the value of Category IIa, IIb and IIc species, respectively. Category III species are not included in this value.

Table 7. Percentage contribution of different categories of estuarine associated fish to the inshore marine fisheries on the west coast. All percentages in terms of biomass except recreational shore angling, in terms of numbers. Source: Turpie *et al.* 2006a.

	Estuary dependence category*				Total
	IIa	IIb	IIc	III	
Recreational shore	0.51	0.17	41.26	13.81	55.75
Recreational boat	0.02	<0.01	0.80	0.10	0.92
Recreational spear	0.05		0.09	0.09	0.23
Commercial boat	0.09	<0.01	0.80	0.10	0.91
Seine & gill-net	1.05	0.04	80.86	1.10	83.06

*IIa Juveniles depend on estuaries; IIb juveniles occur mainly in estuaries; IIc juveniles occur in estuaries; III Marine species that occur in but not dependent on estuaries.

Table 8. Contribution of the main estuary associated species to West Coast fisheries (% catch). Source: Turpie *et al.* 2006a.

	Category	Commercial I Gill/seine	Commercial I boat	Recreational I shore	Recreational I boat
Harders	IIc	79	0.1	9.5	0.1
Elf	IIc	1	0.1	0.1	0.1
Strepie	IIc	0.1	0.1	0.3	0.1
Dassie	IIc	0.1	0.1	1	0.1
White Steenbras	IIa	0.1	0.1	0.5	0.1

Table 9. Percentage contribution of estuarine associated fishes to the total value of the inshore marine fishing sectors on the West Coast, the total annual values of the fisheries, the amount and % of total which is comprised of estuary-associated species, and the contribution of estuaries to total fishery values (2005 rands). Source: Turpie *et al.* 2006a.

	% Estuary-associated species				Total value R million	Estuary fish contribution		Value due to estuaries	
	IIa	IIb	IIc	III		R million	%	R million	%
Recreational shore	0.60	0.03	18.05	2.24	160.53	33.59	20.92	9.7	6
Recreational boat	0.00	0.00	0.39	0.01	170.18	0.68	0.41	0.2	0.1
Recreational spear	0.12		0.06	0.12	11	0.03	0.3	0.02	0.1
Commercial boat	0.04	0.00	0.78	0.05	286.87	2.52	0.88	0.8	0.3
Seine & gill-net	3.89	0.02	72.90	1.86	18.1	14.23	78.67	4.66	25.8
TOTAL					646.68	51.05	7.90%	15.38	2.40%

The estimated contribution from estuaries to inshore marine fisheries on the West Coast is 2.4% of the total value, or about R15.4 million per year (2005 rands, Table 9). This is the value that would be lost if estuaries were 'removed' from the coastline.

The portion of the West Coast inshore fishery value that is due to estuaries (R15.4 m) is the nursery value of estuaries on the West Coast. How much of this comes from the different estuaries is unknown, and depends on several factors such as estuary size and mouth status, as well as geographical location. The Olifants estuary makes up about 23% of the

estuary area on the West Coast (not including the upper Berg estuary floodplain which is largely a freshwater habitat). This is a conservative estimate because the Olifants and Berg estuaries probably contribute more than the Orange, due to the location of the fisheries. Thus a conservative estimate of the nursery value of the Olifants estuary is some R3.45 million per year (2005 rands; Table 10).

Table 10. Annual values of fisheries that benefit from the Olifants estuary, and the total value attributed to the estuary.

Fishery	Fishers	Total value (millions)	Value from Olifants estuary* (millions)
West coast gill & seine	321 gill + 84 seine (+ crew)	R18.1	R1.07
West coast commercial boat	9000	R286.87	R0.18
West coast recreational shore and boat	210	R341.71 million	R2.28 million
Total nursery value of Olifants estuary fish			R3.45 million

4.10 Genetic resources

Genetic resources are valuable in many systems, but probably least valuable in freshwater and estuarine systems, where most species are extremely widespread. There are also few species that have widespread commercial potential (e.g. for agriculture or horticulture). Nevertheless, there are endemic species, and there is a possibility that these may become useful. It is not possible to determine this value.

4.11 Tourism and recreational value

The Olifants/Doring Catchment has become an increasingly popular tourist destination for South Africans and overseas tourists. Much of the appeal lies in the natural features of the area, particularly the mountainous areas which provide opportunities for peaceful getaways or adventure holidays involving a variety of aquatic and non-aquatic outdoor activities. The Cedarberg Wilderness Area is well known for its rugged beauty, features rare species such as the elephant's foot plant and the snow protea, and the best examples of San rock art in the Western Cape. The Namaqualand flower displays are possibly one of the biggest attractions to the area during early spring and several tour operators offer tours to view flowers. Aquatic ecosystem-based activities in the area include river rafting, canoe trails (near Citrusdal), fly fishing and coarse fishing, as well as viewing the Nieuwoudtville Falls, a 100 metre high natural feature on the Doring River. However, comparatively little tourism occurs at the estuary. There are no figures available on the extent of use of the estuary for recreational purposes.

Unlike most large estuaries in South Africa, there is no major urban settlement around the mouth of the Olifants estuary, apart from the village of Papendorp. There is a guesthouse at Papendorp, and at Ebenhaesar, about 10km up the estuary, locals have established a guest house and camping area. The nearest resort town is Strandfontein, situated on the coast just south of the estuary. The main attractions of the estuary are for fishing and birdwatching.

Although recreational use of estuaries is significant in South Africa, with an estimated total of 67 000 recreational anglers and 5700 cast netters, it is limited on the west coast, mainly due to the lack of suitable angling fish, with only about 0.2% of effort taking place in this area (equivalent to 147 average anglers; based on Lamberth & Turpie 2003).

Recreational anglers on the Olifants estuary are mainly shore anglers and boat use is minimal. The boats used range from small dinghies to ski-boats of 6 m in length. Recreational anglers catch an estimated 14 – 20 t of marine line-fish in estuaries on the

west coast annually, with an estimated 1 - 2 t (8 %) from the Olifants estuary (Turpie *et al.* 2006a). The bulk of the Olifants estuary linefish catch is made within 500 m of the mouth and comprises silver kob, Angolan kob *Argyrosomus coronus*, white steenbras *Lithognathus lithognathus*, west coast steenbras *L. aureti* and elf. Of these, the stocks of silver kob and white steenbras are collapsed and those of elf and west coast steenbras are overexploited.

Estuarine fish stocks cannot be considered as discrete and in isolation from the marine environment. The current status of estuarine stocks is largely a reflection of the nationwide decline that has occurred for most line-fish species.

The economic value of the recreational fishery can be considered in terms of the expenditure on fishing by recreational fishers (= income to subsidiary industries such as accommodation and fuel). While the commercial and traditional fisheries are forms of generating cash or subsistence income, and are largely valued in terms of the market value of their catches, the value of recreational angling does not lie mainly in the market value of the fish caught. Recreational anglers value the sport and experience, and expend considerable sums on this activity, largely irrespective of their catch returns (McGrath *et al.* 1997). The value attributed to this fishery is mostly in terms of gains to subsidiary industries that benefit from angler expenditure (McGrath *et al.* 1997). Based on regional estimates of recreational value, the fishery is estimated to be worth between R561 600 and R1 259 200 (Turpie *et al.* 2006a).

5. LEGISLATION AND MANAGEMENT ISSUES

5.1 The main threats and opportunities to be considered

The Olifants estuary is relatively undisturbed, but there are a number of factors that threaten the future health of the system and hence its biodiversity and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict are as follows:

1. Water quantity and quality
 - a. reduction in freshwater inflows due to water abstraction in the catchment, and continuing increase in demand for abstraction
 - b. increasing nutrient enrichment due to agriculture in the catchment,
 - c. potential risk of pollution entering from the sea
2. Exploitation of living resources
 - a. overexploitation of fish stocks conflicting with nursery function
 - b. potential for future overexploitation by recreational fishers
3. Land-use (including mining) and associated disturbance
 - a. potential for residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat
 - b. potential damage to environment and sense of place due to future mining activities

In addition to meeting the existing legislation governing the above activities, opportunities to protect the health and value of the system over the medium to long term include:

1. The establishment of terrestrial and estuarine protected areas, and
2. Implementation of rehabilitation measures.

All of the above issues are discussed below in the context of the prevailing policies and legislation.

5.2 General policy and legislative background

This section provides an overview of legislation and policy applicable to management of estuaries in South Africa and specifically to the Olifants estuary. More details on the legislative framework for estuary management including international and regional treaties and obligations, national policies and laws, and provincial and local policies and legislation is provided in Taljaard (2007).

The South African Constitution is the supreme law of the land, and provides the legal framework for legislation regulating environmental management in general. Section 24 of the Constitution states that:

"Everyone has the right:

- *to an environment that is not harmful to their health or well-being; and*
- *to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that –*
- *prevent pollution and ecological degradation;*
- *promote conservation; and*
- *secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.*

This lays the basis for environmental law in South Africa (Breen & McKenzie 2001) and is a very important justification for the wise use of estuarine biodiversity.

Because they are not freshwater, terrestrial or marine, estuaries have tended to be neglected in past legislation. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are affected by a large number of policies and laws. The situation has improved with newer policies and legislation, but there is still no specific provision for Estuarine Protected Areas.

South African policy and law as pertinent to estuaries has been summarised in detail elsewhere (Smith & Cullinan 2000, McKenzie 2001, van Niekerk & Taljaard 2002, McGwynne & McKenzie 2006). A brief summary of the most relevant policies is given here (Table 11 and Table 12). Policy and legislation which affects estuaries directly can be roughly divided into that affecting (a) water quality and quantity, (b) land use and infrastructure development, and (c) living resources within estuaries (Van Niekerk & Taljaard 2002, Taljaard 2007).

Estuary management falls mainly under two national government departments: the Department of Water Affairs and Forestry, responsible for water resources, and the Department of Environmental Affairs and Tourism (DEAT), responsible for everything else, e.g. land use, living resources. Environmental management in most instances is devolved to provincial level through whichever provincial department is responsible for environmental matters. Management and conservation of marine living resources is an exception in this respect, in that this is retained as a national competency, responsibility residing with the Branch Marine & Coastal Management (MCM) of DEAT. In instances where provincial or local legislation are in conflict with national legislation, national legislation prevails. At a local (municipality) level, municipal councils pass municipal by-laws, which in turn, cannot conflict with provincial and national laws (McKenzie 2001).

Under the national legislation, Provincial as well as District and Local Government Agencies are also required to draw up appropriate planning documents for the integration of environmental management into their governance structures under the Municipal Systems Act (2000). These planning documents take the form of Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs).

The Olifants estuary lies wholly within the Western Cape Province, within the West Coast District Municipality and the Matzikama Local Municipality. These provincial and local government structures have also enacted certain legislation that has a bearing on the Olifants estuary. Pertinent aspects of this legislation are summarised in Table 12.

The Western Cape Government has also released a Coastal Management Policy which includes a suite of goals, objectives and strategies designed to achieve sustainable coastal development in the Western Cape. These are closely aligned with the National Coastal Management Policy and are organised within five themes:

- Theme A: Governance and Capacity Building
- Theme B: Our National Asset
- Theme C: Coastal Planning and Development
- Theme D: Natural Resource Management
- Theme E: Pollution Control and Waste Management

A number of goals within each of these themes are of relevance to the management of the Olifants estuary (Table 13).

Table 11. Summary of national policies which affect water quality and quantity in estuaries in general, landing use, development and resource use in the estuarine environment.

	White Paper (= Policy)	Bill or Act (= Law)	Lead Agent	Implications
Water quality & quantity	White Paper on National Water Policy for SA (1997)	National Water Act 36 of 1998	DWAF	Defines the environmental reserve in terms of quantity and quality of water; provides for national, catchment and local management of water
	White Paper on Integrated Pollution and Waste Management for South Africa (2000)	Marine Pollution (Control and Civil Liability) Act (1981)	DOT/ DEAT	Provides for the protection of the marine environment from pollution by oil and other harmful substances, the prevention and combating of such pollution, and the determination of liability in certain respects for loss or damage caused by the discharge of oil from ships, tankers and offshore installations.
		Dumping at Sea Control Act (1980) as amended	DEAT	Provides for the control of dumping of substances in the sea (including estuaries) (will be repealed by the Integrated Coastal Management Bill).
Land use & management		Seashore Act (1935) as amended	DEAT/ DEADP	Ownership of the seashore (includes the water and land between the low-water mark and the high-water mark in tidal rivers such as the Olifants Estuary) is vested in the State; currently used to control recreational boating activities in estuaries. (To be replaced by Integrated Coastal Management Bill)
		Environmental Conservation Act (1989)		Most of the provisions of this Act have been repealed by NEMA, apart from the regulation on Sensitive Coastal Areas.
		National Heritage Resources Act (1999)	DEAT	Provides for managements of national heritage resources (including landscapes and natural features of cultural significance, and for participation of communities in the identification, conservation and management of cultural resources
	White Paper for Sustainable Coastal Development in South Africa (2000)	National Environmental Management: Integrated Coastal Management Bill	DEAT	Provides for integrated coastal and estuarine management in South Africa, and sustainable development of the coastal zone, defines rights and duties in relation to coastal areas; includes a National Estuarine Management Protocol for South Africa, and requires that estuarine management plans be developed and implemented for all estuaries
	White Paper on Spatial Planning and Land-use Management (2001)	Local Government: Municipal Systems Act (2000)	DPLG	Requires each local authority to adopt a single, inclusive plan for the development of the municipality intended to encompass and harmonise planning over a range of sectors such as water, transport, land use and environmental management.

	White Paper (= Policy)	Bill or Act (= Law)	Lead Agent	Implications
	White Paper: Mineral and Mining Policy for South Africa (1998) White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998)	Mineral and Petroleum Resources Development Act (2002)	DME	Deals with environmental protection and management of mining impacts, including sand and coastal mining.
Protected areas		National Environmental Management: Protected Areas Act (2003)	DEAT	Provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; and for establishment of a national register of national, provincial and local protected areas, describes the different types of protected areas that can be declared which may also apply to estuaries.
		World Heritage Convention Act (1999)	DEAT	Provides for the incorporation of the World Heritage Convention into South African Law, and for the recognition and establishment of World Heritage Sites in South Africa
		National Environmental Management: Biodiversity Act (2004)	DEAT	Provide for the conservation of biological diversity, and regulates sustainable use of biological resources
Use of living resources & MPAs	Marine Fisheries Policy for South Africa (1997)	Marine Living Resources Act (1998)	MCM/DEAT	Regulates living resource use within marine and estuarine areas, mainly through licensing; provides for establishment of Marine Protected Areas

Table 12. Provincial and local government legislation applicable to the Olifants estuary

Act/Ordinance	Lead Agent	Implications
Municipal Ordinance (Cape) (1974)	DEADP	Grants local authorities in the province of the Western Cape the power 'to drain storm water into any natural water course'.
Land Use Planning Ordinance (1985) as amended	DEADP	Provides for the establishment of the Western Cape Nature Conservation Board. Most planning applications received by the provincial department are in terms of this Act including applications for departure, rezoning or subdivision and appeals against planning decisions taken by a municipality
Western Cape Planning and Development Act (1999)	DEADP	Provides guidelines for the future spatial development in province of Western Cape
Nature Conservation Ordinance (1974)	WCNCB	Provides for the establishment of provincial, local and private nature reserves and the protection of indigenous species of flora and fauna. Protected and endangered species of flora and fauna are listed in schedules to the ordinance. It is administered by the Western Cape Nature Conservation Board (WCNCB) and grants certain powers to the WCNCB.

Table 13. Goals and strategies in the Western Cape Coastal Management Policy of particular reference to management of the Olifants estuary.

Goals	Strategies
Goal B3: To preserve, promote or protect archaeological, historical and cultural resources and activities of the coast	B3.1.1: Implementation of section 38 of the National Heritage Resources Act B3.1.2: Encouragement of heritage conservation planning B3.1.6: Termination of inappropriate uses of places, illegal activities
Goal C1: To promote the diversity, vitality and long term viability of coastal economies and activities, giving preference to those that are distinctly coastal or dependent on a coastal location	C1.7.1: Diversify tourism opportunities C1.7.3: Build capacity of communities to initiate and effectively participate in sustainable tourism ventures C1.7.4: Identify and address the limits imposed by natural and manmade environments when planning tourism (and other) initiatives
Goal C3: To maintain an appropriate balance between built, rural and wilderness coastal areas in the Western Cape	C3.4.2: Ensure the protection and conservation of natural/wilderness areas
Goal C4: To design and manage coastal settlements to be in harmony with the aesthetic, environmental and cultural attributes of the Western Cape Coast	C4.1.1: Determine adequate setback and buffer zones along the coast C4.1.2: Control the siting of infrastructure in the coastal zone C4.1.3: Restrict non-coastal related land uses from being located in the coastal zone C4.1.4: Encourage appropriate forms of coastal settlement and building C4.1.5: Formulate design guidelines for all buildings and structures in the coastal zone C4.2.1: Develop regulations to restrict the alteration of landforms and vegetation cover in dynamic coastal zones C4.2.3: Manage pedestrian and vehicular access in coastal environments
Goal C5: To plan and manage coastal development so as to avoid increasing the incidence and severity of natural hazards and to avoid exposure of people, property and economic activities to significant risk from dynamic coastal processes	C5.1.1 Protect and maintain dynamic coastal features that act as a buffer against natural coastal processes and hazards C5.2.1: Incorporate appropriate preventative and adaptive measures into all planning and management policies, plans and decision-making processes to account for projected changes in climate, particularly increases in sea level
Goal D1 To maintain the diversity, health and productivity of coastal and marine processes and ecosystems	D1.2.1 Identify and protect unique sensitive environments and habitats in the coastal and marine zones
Goal D2: To establish and effectively manage a system of coastal protected areas	D2.1.3: Ensure proper management of protected areas that caters for ecological and human use requirements
Goal D3: To ensure that the use of renewable resources and associated user practices do not compromise the regenerative capacity of coastal ecosystems	D3.1.2: Adopt holistic rather than single species management approaches D3.1.3: Set harvest levels that correspond to the regenerative capacity of coastal resources D3.1.5: Develop adequate strategies for monitoring and compliance D3.1.6: Promote participation of all stakeholders in management

Goals	Strategies
Goal D5: To rehabilitate damaged or degraded coastal ecosystems and habitats	D5.1.1: Identification of significantly degraded coastal areas and ecosystems and development of rehabilitation management plans D5.2.1: Put in place procedures to enforce rehabilitation of degraded coastal areas by those responsible
Goal E1: To implement pollution control and waste-management measures in order to prevent, minimize and strictly control harmful discharges into coastal ecosystems	E1.2.3: Inclusion of pollution and waste management into land-use planning
Goal E2: To manage polluting activities to ensure that they have minimal adverse impact on the health of coastal communities, and on coastal ecosystems and their ability to support beneficial human uses	E2.1.7: Reduce pollution entering rivers and estuaries by promoting catchment management

5.3 Water quantity and quality requirements

5.3.1 Legislative context

Water quality and quantity are mainly controlled from the terrestrial side under the *National Water Act 36 of 1998*, under DWAF (Table 2). Legislation being developed under the *White Paper on Integrated Pollution and Waste Management for SA (2000)* will also have a bearing on river systems. The risk of marine pollution is addressed by the *Combating Pollution of the Sea by Oil Act 6 of 1981*, under DEAT. This discussion focuses on National Water Act as being the most pertinent to the development of the Olifants Estuary Management Plan.

The *White Paper on National Water Policy for SA (1997)* promotes efficiency, equity and sustainability in the use of water resources through its slogan "some, for all, for ever". The policy explicitly recognises the environment as a legitimate user of water and makes provision to protect the environment from overexploitation of water resources. The *National Water Act 36 of 1998* (NWA) provides the legal framework for this policy. The NWA makes provision for a water "Reserve" which provides the quantity and quality of water flow required in aquatic ecosystems required to meet basic human needs and to protect the natural functioning of a water resource. The latter portion of the reserve is known as the environmental Reserve.

5.3.2 The classification process

The extent to which an estuary's functioning is catered for is determined by the designated "class" (= future state of health) of that estuary, with some estuaries being assigned a low class to allow maximal water provision and others being assigned a high class in order to meet conservation needs. The decision as to the designated class of the estuary is thus a critical one. In future, this will take place using a classification process that has recently been devised by DWAF and is being gazetted. This process will entail consideration of the trade-offs in value generated by allocating water (or pollution rights) to off-stream users (e.g. irrigation agriculture), flow-reducing activities (e.g. plantation forestry) and polluters (e.g. municipalities, farmers) versus allocating water to the environment for the provision of ecosystem services (e.g. fishing, tourism). The Catchment Management Agencies will in future probably play the key role in this decision-making process, but until these agencies are operational, decisions are being made with the aid of water situation assessments known as Internal Strategic Perspectives (ISPs) that were developed as an interim aid.

5.3.3 The reserve determination process

In the absence of a gazetted classification process, the environmental Reserve is currently determined on the basis of recommendations emanating from a reserve determination study using the Resource Directed Measures methodology in conjunction with considerations of the demand for water in the catchment (the classification process described above will effectively standardise the way this is done).

A reserve determination study was conducted for the Olifants estuary in 2006 under the auspices of the Resource Directed Measures (RDM) Directorate of the Department of Water Affairs and Forestry (DWAF). The study determined the current health status of the estuary, and used existing understanding to predict the changes in health that would occur under a set of possible future scenarios. The outcome of this exercise, together with consideration of the conservation importance of the estuary, was used to make a recommendation as to the future health status, or "class", of the estuary. The results of each of these steps are outlined below.

5.3.4 Current water supply and health of the estuary

Estuary health is assessed in terms of the degree to which the current state resembles the natural condition. Once the natural hydrological conditions have been described, specialists assess the natural conditions in terms of a range of biophysical variables. The current state is then scored for each of these variables on a scale of 0 (no resemblance to original state) to 100 (same as natural state).

The health scores and overall score are summarised in Table 14. The estuary currently receives some 69% of its natural MAR (see section on hydrology). This does not affect mouth condition, since the Olifants is not sensitive to closure due to its rocky sill at the mouth. However, the reduction in flow has had a considerable impact on water quality, both due to reduced ability to dilute pollution and due to the increase in polluted return flows as a result of use of the water in irrigation. The reduced flows have also altered the physical habitat of the estuary in that the depth and profile has changed.

The reduction in flows has also resulted in considerable changes to the biota of the estuary. Primary productivity by microalgae is thought to have increased due to the nutrient input and reduction in flushing of the estuary. Plants have also been significantly affected. The stagnation and enrichment of water in the upper reaches of the estuary has led to an increase in the biomass and extent of *Potamogeton pectinatus* and macroalgae. The distribution of brackish reeds and sedges has probably diminished as a result of increased salinity. The biomass of zooplankton and bottom-living invertebrates such as amphipods and prawns is likely to have increased as a result of the increase in salinity. The fish community composition is thought to have changed radically as a result of changes in salinity. Numbers of estuarine round herring and flathead mullet as well as indigenous freshwater species have decreased, but harders have become slightly more abundant (if one removes the impact of fishing). Changes in the bird community have probably been only slight, with species associated with fresher conditions becoming less common on the estuary (Table 14).

Table 14. The Estuarine Health Index scores allocated to the Olifants Estuary (Present State)

VARIABLE	Score (% resemblance to natural condition)
Hydrology	69
Hydrodynamics and mouth condition	100
Water quality	50
Physical habitat alteration	78
Habitat health score	74
Microalgae	70
Plants (macrophytes)	58
Invertebrates	65
Fish	40
Birds	95
Biotic health score	66
OVERALL SCORE	70

The overall health score of 70 translates into a Present Ecological Status of C, which is classed as a moderately modified system (Table 15).

Although the Present State of the Olifants Estuary currently falls within an Ecological Category C, it is likely that the estuary is on a negative trajectory of change, because of the extremely low base flows under the Present State (< 1 m³/s), particularly during the summer months. Maintaining the status quo is therefore likely to result in continued modification of the Ecological Status of the estuary (Taljaard *et al.* 2006a).

Table 15. Relationship between Estuarine Health Score, Present Ecological Status (PES) classification, and how it is understood.

EHI Score	PES	General description
91 – 100	A	Unmodified, natural
76 – 90	B	Largely natural with few modifications
61 – 75	C	Moderately modified
41 – 60	D	Largely modified
21 – 40	E	Highly degraded
0 – 20	F	Extremely degraded

5.3.5 Implications of alternative future scenarios

A summary of the suite of future scenarios of inflow into the estuary evaluated in the RDM study (Taljaard *et al.* 2006a) is provided in Table 16. Each scenario is based on a development possibility for the catchment.

The health scores for each of the variables and the overall health scores for each of the scenarios are given in Table 17, as well as the corresponding Ecological Reserve Category. The first scenario which involved restoring flows would lead to an increase in health to a largely natural system. Scenarios 2 and 3 allow some further water use development without significant impact on estuary health, whereas the additional water required for scenarios 4 and 5 would plunge the estuary into a largely modified system or into an unacceptable state of health (E-class).

Table 16. Future runoff scenarios used in the RDM study. Source: Taljaard *et al.* (2006a)

Scenario	Description	MAR (M m ³ /year)
Reference	Representative of flows before agricultural developments and impoundments in the catchment	1070.1
Present	Reflects the present agricultural developments and dam developments in the Olifants main stream (Clanwilliam and Bulshoek Dam) - simulated data reflect inflow without Bulshoek leakage	715.0
Scenario 1	Present inflow plus the Ecological Water Requirement releases of the River	800.3
Scenario 2	Raising Clanwilliam wall (15 m) plus the Ecological Water Requirement releases of the River	741.5
Scenario 3	Raising Clanwilliam wall (15 m) with no River EWR releases	605.7
Scenario 4	Brandewyn weir/dam development on the Brandewyn river (a tributary to the Doring River) with a capacity of 5 x 106 m ³ , including an abstraction of 5 m ³ /s plus raising the Clanwilliam wall (15 m) with no River EWR releases	529.3
Scenario 5	Maximum development represents the Melkbosrug Dam in the Doring catchment. This development would regulate almost all of the inflows from the Doring River and maximise the yield from the Olifants / Doring River system. This scenario ignores the Ecological Water Requirement of the Doring river (includes 15 m raising of Clanwilliam wall) with no River EWR releases	423.5

Table 17. Estuary Health Score and corresponding Ecological Reserve Category for each scenario

Variable	Present	Future Scenario				
		1	2	3	4	5
Hydrology	69	77	74	64	61	38
Hydrodynamics/mouth condition	100	100	100	100	100	100
Water quality	50	61	56	46	41	34
Physical habitat alteration	78	78	75	75	70	50
Habitat health score	74	79	76	71	68	47
Microalgae	70	80	75	70	50	40
Macrophytes	58	70	55	49	47	40
Invertebrates	65	75	70	55	45	25
Fish	40	50	52	40	30	25
Birds	95	94	95	95	90	78
Biotic health score	66	74	69	62	52	33
Estuarine Health Score	70	76	73	67	60	40
Ecological Reserve Category (ERC)	C	B	C	C	D	E

5.3.6 Recommended future health class

Based on the size of the estuary relative to others in South Africa, the fact that it is one of few permanently-open estuaries within the cool temperate biogeographically zone (West Coast), its high diversity of habitats, biodiversity and functional importance, the estuary was assigned a very high importance score (99/100), which puts it into the Highly Important category in the RDM process.

Table 18. Estuary importance scores for the Olifants estuary.

Criterion	Score	Weight	Weighted score
Estuary Size	100	15	15
Zonal Rarity Type	90	10	9
Habitat Diversity	100	25	25
Biodiversity Importance	98	25	25
Functional Importance	100	25	25
Estuary importance score			99

The Ecological Reserve Category (ERC) which represents the level of protection assigned to an estuary, is determined based on a combination of the current health of the system and its importance and/or current or desired protected area status (Table 19). It cannot be lower than the present state of health, and cannot be an E or F.

As well as being categorised as a 'Highly important estuary', the Olifants Estuary has been targeted as a Desired Protected Area (Turpie *et al.* 2002, DWAF 2004a, Turpie & Clark 2007). Therefore, according to the guidelines for assigning a recommended ERC, the estuary needs to be in a Category A or the Best Attainable State (BAS).

However, the RDM study concluded that the existing large dam developments in the catchment (e.g. Clanwilliam Dam) would make it difficult to improve the Olifants Estuary to a Category A. Thus the recommendation was to improve the status of the estuary to a B class, i.e. the recommended ERC was a B (Taljaard *et al.* 2006a).

Table 19. Relationship between health, importance and minimum ecological reserve category (Source: Taljaard *et al.* 2006a).

Current/desired protection status and estuary importance	Recommended Ecological Reserve Category	Policy basis
Protected area		Protected and desired protected areas should be restored to and maintained in the best possible state of health
Desired Protected Area (based on conservation planning)	A or BAS*	
Highly important (score 81 – 100)	PES + 1, min B	Highly important estuaries should be in an A or B category
Important (score 61 – 80)	PES + 1, min C	Important estuaries should be in an A, B or C category
Low to average importance (up to 60)	PES, min D	The remaining estuaries can be allowed to remain in a D category

* BAS = Best Attainable State

5.3.7 Flows required to maintain the recommended health class

The recommended Ecological Flow Requirements is defined as the runoff scenario (or a slight modification thereof) that represents the highest reduction in river inflow that will still protect the aquatic ecosystem of the estuary and keep it in the recommended ERC (Taljaard *et al.* 2006a).

The recommended Ecological Reserve Category corresponds to the level of health that would be expected under Scenario 2. Scenario 2 was the Present inflow scenario plus the Ecological Water Requirement releases of the River (MAR = 800.3 x 10⁶ m³). This scenario requires that water is removed from other out-of-stream uses and reallocated to the environment to partly restore the natural flows.

However, part of the reason that the estuary is in a C-class is due to non-flow related anthropogenic activities, namely nutrient inputs from agricultural activities and over-exploitation of fish resources (gill net fisheries). If these problems are better controlled, it would be possible to achieve a B-class estuary under a higher development scenario. Thus the recommended flow requirement was taken from a scenario that would otherwise lead to no change in class, i.e. maintain a C-class.

Scenario 3, which involved allocating more water to out of stream use by raising the Clanwilliam dam but also providing Ecological Water Requirement releases, showed that by returning some of the base flows during summer, it is possible to maintain the estuary in a Category C, while still allowing further development in the catchment. Scenario 5 was thus selected as the basis for the recommended Environmental Flow Requirements. The required flows are described in detail in Taljaard *et al.* (2006a).

5.3.8 Implications for the estuary

The estuary is degrading under the current flows. The main consequences of maintaining the Olifants Estuary in an Ecological Category C through the flows associated with Scenario 5 are considered to be as follows:

1. Excessive (or nuisance) macrophyte growth during the late summer months in the upper reaches, particularly if nutrient inputs are not reduced, negatively impacting on water intake systems, recreational usage and aesthetics (i.e. 'loss of value').

2. Reduced cueing effect to estuarine dependent invertebrate and fish species and resulting reduction in nursery function.

5.3.9 Specifications for water quality

The RDM process includes identifying targets and thresholds of potential concern for abiotic and biotic aspects of the system. Water quality is dealt with in these targets (see Taljaard et al. 2006a) with specifications set in such a way as to maintain the estuary in the recommended class. The resource quality objectives define thresholds of potential concern (TPCs) for toxic substances, inorganic nutrient concentrations, system variables (Temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) and salinity intrusion (Taljaard et al. 2006a; Table 20).

Table 20. Thresholds of potential concern for the Olifants estuary in order to maintain a B-class (summarised from Taljaard et al. 2006a).

Concern for	Threshold of potential concern
Brackish saltmarsh, reeds and sedges & invertebrates	Salinity > 20 ppt for > 3 months at 7 km upstream from mouth
Flood plain salt marsh)	Salinity of groundwater > 50 ppt and depth to water table > 1 m
Phytoplankton	Total dissolved solids (measure of 'salinity') of river inflow > 3500 mg/l
Phytoplankton, prevent hyper-salinity	Salinity in estuary exceeds 35 ppt
Fish	Salinity > 10 ppt occurs above 16 km upstream of the mouth
General biota	Inflowing river water: <ul style="list-style-type: none"> • < 20°C in summer, • pH < 6.5 or > 8.5, • Dissolved oxygen < 4 mg/l, or • DIN concentrations exceed 100 µg/l during low flow or exceed 500 µg/l during high flow; • average DRP concentration exceeds 100 µg/l in river inflow • Secchi disc reading (measure of turbidity) > 8 km from the mouth >1 m
Human health	For pesticides/herbicides baseline studies still need to be undertaken before TPCs can be set (special concern in upper reaches with extensive agricultural activities along banks of estuary)

5.4 Exploitation of living marine resources

5.4.1 Legislative context

The exploitation of marine living resources in South Africa (which includes those in estuaries) is governed by the *Marine Fisheries Policy for South Africa (1997)* and the *Marine Living Resources Act (1998)*. Objectives of the policy are as follows:

- to achieve optimum utilisation and ecologically sustainable development of marine living resources,;
- to conserve marine living resources for present and future generations, to use marine living resources;
- to achieve economic growth, human resource development, capacity building within fisheries and mariculture branches, employment creation and a sound ecological balance consistent with the development objectives of national governments;

- to protect the ecosystem as a whole, including species which are not targeted for exploitation; and
- to preserve marine biodiversity.

The *Marine Living Resources Act (1998)* defines the species that can be exploited, and protection measures for those species, such as closed areas, closed seasons and size and bag limits. Various types of resource-use permit systems are also defined under this act.

5.4.2 Issues surrounding the Olifants estuary small-scale fishery

While the small-scale gill net fishery provides benefits to the Ebenhaeser community, there are serious concerns that the negative impacts of the fishery may outweigh these benefits. Commercial gill net fishing in estuaries is of serious concern because of the impact that this activity can have on the fish stocks, and because these estuarine fish stocks, in turn support far more valuable fisheries around the coast. As such, it would appear that this activity is not well aligned with the objectives of the Marine Fisheries Policy. The reasons that gill nets have such a major impact in estuaries are as follows:

- Gill nets are very size selective, but not species specific – all fish with a body circumference greater than the mesh size are either caught or cannot pass through the netted area.
- Fish entangled in a gill net are usually fatally injured and cannot be released.
- Estuaries are confined bodies of water between two banks, fish utilizing estuaries usually migrate/swim in narrow channels which are easily blocked by gill nets set perpendicular to the tidal or river flow.
- Nearly all overexploited linefish species that use estuaries as nursery areas are considerably deeper bodied than the target species (in this case harders) and are vulnerable to capture within several months of the post flexion larvae recruiting to the estuary. Nearly all by-catch in estuarine gill nets is well below the legal minimum size limits (for species where size limits exist) applicable to commercial and recreational fisheries (Hutchings et al in prep. Hutchings & Lamberth 2002a, b).
- Gill nets are an extremely efficient gear type, easily operated by one or two fishers, but have an average linefish catch rate of 27 line anglers (Hutchings & Lamberth 2002a, b).
- Gill net fishing in an estuary, even at very low effort levels, can therefore nullify the value of the estuary as a nursery area with severe detrimental consequences for the estuarine and coastal ichthyofauna, ecology and fisheries.

These concerns, as well as the scarcity of estuaries on the West Coast of South Africa and their known importance as nursery areas and refuges for fish during upwelling and low oxygen events, were considerations in the development of the gill net and beach-seine net fishing policy by MCM. In 2003, MCM rescinded all 120 gill net permits for the Berg River Estuary and stated their intention to phase out the Olifants Estuary gill net fishery over 10 years (S.J. Lamberth, MCM, pers. comm.).

In developing and implementing this policy, MCM took cognisance of the socio-economic importance of the Olifants Estuary gill net fishery to communities living in the Ebenhaeser/Olifantsdrif and Papendorp/Viswater area (Sowman *et al* 1997). Although long term fishing rights were not allocated to these fishers, 45 exemptions were given (under section 81 of the Marine Living Resources Act 1998).



Figure 26. Subsistence gill net fishing on the estuary is an issue of contention due to the threat this poses to estuarine biodiversity and the nursery value of the estuary.

The impending closure of the Olifants Estuary gill net fishery is a cause for concern amongst the affected fishing community and there remains a socio-economic crisis with respect to their future livelihoods. In an attempt to alleviate this, MCM funded a research project titled “Reviving the Olifants River Harder Fishery Co-management System”. This project was undertaken by the Environmental Evaluation Unit at the University of Cape Town and had five main objectives (Sowman *et al.* 2007):

- 1 To determine the dependence of the Olifants River fisher community on marine and coastal resources;
- 2 To identify and facilitate the development of alternative and/or additional livelihood options for the fisher community;
- 3 To establish and facilitate the implementation of a community-based catch monitoring system;
- 4 To determine whether fishing levels in the Olifants River estuary are sustainable; and
- 5 To revive the co-management arrangements for the Olifants River harder fishery

The findings of this research included evidence of a high degree of reliance on fishing for fisher households and limited alternative livelihood options for fishers (Sowman *et al.* 2007). A community-based catch-monitoring system was successfully introduced and an analysis was conducted of the data collected (Fielding *et al.* 2007). Some of the findings of this analysis are given in section 4.3 above. These reports argue that the fishery is sustainable, that by-catch levels are low and not sufficient to warrant concern and that MCM does not have sufficient scientific grounds for closure of the fishery. The authors do, however, concede that the fishery is operating well below maximum economic yield (characteristic of open access/lack of management). They also concluded that current low by-catch levels may be a result of the long history of the fishery and the general overexploited status of most of the by-catch species. Estimated catch rates of by-catch species and the regulations pertaining to these species are given in Table 21.

All scientific evidence does indicate that the stock sizes of most exploited fish species are at a fraction of the pristine levels, thus by-catch rates in the Olifants Estuary gill net fishery are expected to be low (Mann 2000). Furthermore the abundance of harders is known to be naturally far greater than that of by-catch species such as leervis, white steenbras,

elf, silver kob and these would always constitute a small proportion of the total catch in a fishery targeting harders.

The catch returns submitted by the fishers have nonetheless been very consistent and accurate over the last three years indicating a willingness to co-operate with the management authority (MCM). This is probably a result of the community-based monitors who were active over this period and thus encouraged or motivated fishers to submit accurate returns. Their willingness to participate in a co-management arrangement would make sense in view of the positive impact that this would have on the economic value of the fishery. However, MCM stands firm on their decision to phase out the Olifants Estuary gill net fishery by 2013 (S.J. Lamberth pers. com) out of concern for the recovery of collapsed stocks in South Africa. The fishers involved feel that they were not consulted on this decision and that co-management of the fishery has not been given a chance (Sowman *et al.* 2007).

Table 21. By-catch in the Olifants Estuary gill net fishery over the period 2004-2006. Data shown are the estimates based on community fishery monitors (Source: Fielding *et al.* 2007).

Fish Species	CPUE (No. trip)	Estimated total catch (kg)	Mean length (cm)	Mean weight (kg)	Size at maturity (cm)	Minimum legal size (cm)
Elf	1.18	540	19.90	0.11	31	30
Barbel			21.86	0.12	25	
Springer	0.14	262	28.81	0.42	75	
Steenbras	0.06	35	20.70	0.17	55	60
Stumpnose			16.78	0.16	20	25
Gurnard			22.87	0.22	35	
Sardine			21.31	0.26	3	
Silverfish			15.87	0.06	36	
Leervis	0.02	26	19.25	0.10	75	70
Maasbanker			15.50	0.50	30	
Klipvis			15.00	0.05	?	

5.4.3 Issues surrounding recreational fishing

The estuary is not heavily utilised by recreational fishers at present. This situation could change in the future depending on the fate of the gill net fishery and how development in the area proceeds. Recreation fishing effort on the Berg estuary has expanded considerably in recent years following the cessation of gill net fishing on this estuary (Dr B. Clark, pers. obs.), and appears to be related to improvements in catches.

Due to the large number of participants, and associated expenditure (tackle, bait, accommodation, food, travel costs), recreational fisheries have been shown to contribute significantly to regional economies (Mann *et al.* 2002, Lamberth & Turpie 2003, Pradervand *et al.* 2003). It has been shown that the demand for recreational angling is largely driven by a desire for relaxation and that the quantity of fish caught does not negatively affect the expenditure by recreational anglers (McGrath *et al.* 1997). As a result, although the linefishery on the Olifants estuary will always land substantially fewer fish than the gill net fishery ever did, the recreational and subsistence linefishery may be more valuable in terms of overall economic contribution, especially since estuarine gill net fisheries are fairly marginal (Hutchings *et al.* 2002). From a conservation perspective, the lower overall fishing mortality from line fishing compared with gill net fishing is certainly preferable for conserving fish stocks both within the estuary and in the adjacent marine environment. This is particularly pertinent for the conservation of juvenile fish that use the estuary as a nursery area and are vulnerable to capture in the mesh size gill nets (44-54mm stretched mesh) that were used in the commercial fishery (Hutchings and Lamberth 2002b). However, continued increases in development up the west coast could eventually lead to recreational overfishing in the estuary if the situation is not carefully managed.

5.5 Land use and management of estuary margins

5.5.1 Legislative context

Under the **Seashore Act** of 1935, the estuary up to the high-water mark belongs to the state. The **Coastal Management Bill** provides guidance on the sustainable development of the coastal zone and requires that a management plan be developed for each estuary. The Bill requires a development setback of 100m from the high tide mark (including in estuaries) in areas zoned for residential, industrial or commercial land use and a much larger development setback of 1km for public land and land zoned for agricultural use. In the case of the Olifants, all land surrounding the estuary falls into the latter categories, and thus in terms of this bill a setback of 1km will be required around the whole estuary (Figure 27). Within this setback, no new land transformation or development may take place without a permit issued by the minister. There is also provision to create a larger setback line under the Integrated Coastal Management Bill where necessary. Note though that an exemption has been afforded to landowners afforded in respect of land clearance activities on the land below the irrigation canal and certain other areas adjacent to the Olifants estuary in terms of the Conservation of Agricultural Resources Act of 1983 & National Environmental Management Act of 2006. It is likely that this exemption will be applicable in terms of the Coastal Management Bill as well when it is finally enacted, but is probably applicable to land clearance for agriculture only. This needs to be confirmed.

Development in the coastal zone will be strongly influenced by the planning that has to take place under the **Municipal Systems Act** (2000). Under this act, all municipalities have to undertake an Integrated Development Planning (IDP) process to produce **integrated Development Plans** (IDPs). These will supersede all other plans that guide development at local government level, and is the principal strategic planning instrument which guides and informs all planning, budgeting, management and decision-making in a municipality for a five year period. It is a very interactive and participatory process which requires involvement of a number of stakeholders. The process involves identifying a vision, objectives and strategies followed by the identification of projects to address the issues. Every municipality is required to produce an *indicative plan*, called a '**Spatial Development Framework** (SDF)', showing desired patterns of land use, directions of growth, urban edges, special development areas and conservation-worthy areas. It must also produce a *scheme*, called a '**Land Use Management System** (LUMS)' recording the land use and development rights and restrictions applicable to each erf in the municipality. The plan should be flexible enough to accommodate changing priorities, and the scheme has to conform to the plan. The plan (SDF) is a *guide* to development, and the scheme (LUMS) is *binding*.

Environmental issues are cross-cutting, which means that they have to be addressed in IDP. It is important to note that estuaries are particularly cross-cutting, given their linkages with entire catchment areas and the inshore marine environment. Municipalities must incorporate a strategic environmental assessment (SEA) into their spatial development frameworks, forming part of their IDPs, and that they now also take the responsibility for EIAs, in theory to help resolve environmental and planning conflicts (DLA 2001). IDPs are thus explicitly required to consider environmental issues and indicate how negative impacts will be resolved and/or avoided. The main opening for recognising the need for managing the Olifants estuary in the IDP process is in the State of Environment Reporting during the Analysis phase. It is during this process that issues relating to estuarine values would be identified and included in the issues prioritization. It will be necessary to sensitise IDP planners to estuary values.

Thus the key land-use planning decisions will be taken by the local municipalities, in this case the Matzikama Municipality. Their plans have to fit in with broader scale plans of the district and province.

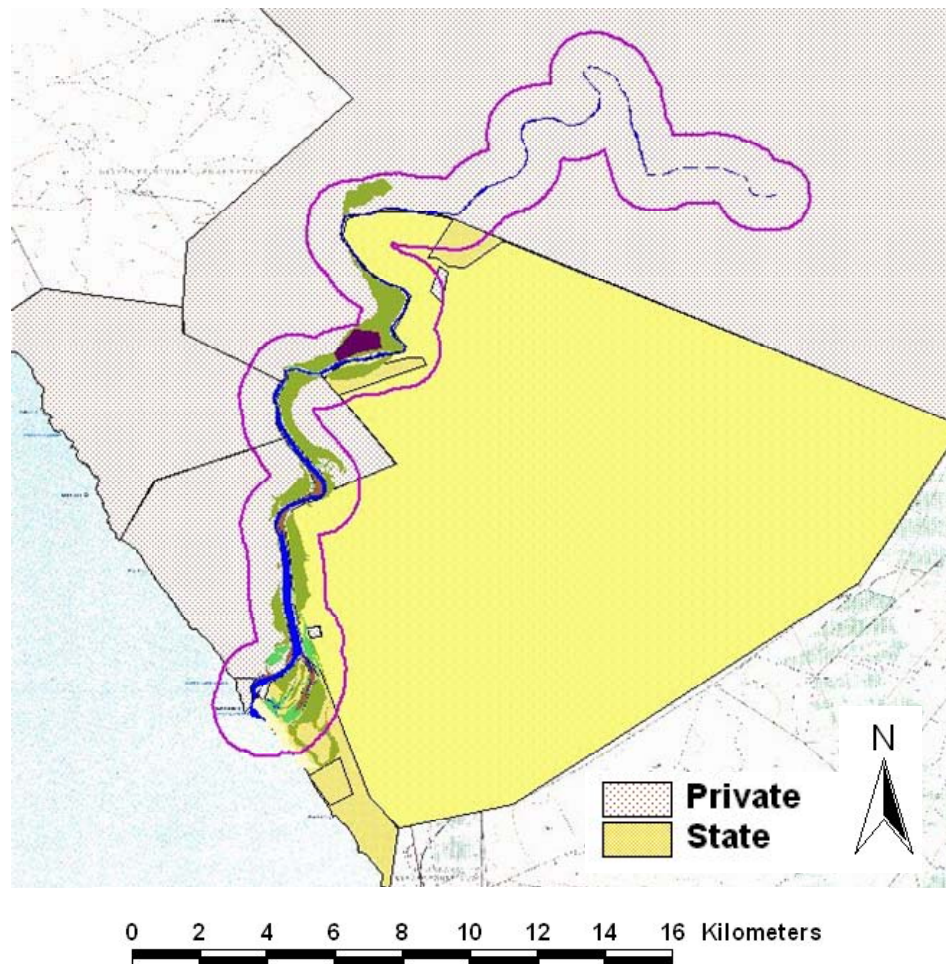


Figure 27. Land ownership around the Olifants estuary - private agricultural and Ebenhaeser Colony (currently held in trust by the state), - and the position of the 1km margin from the high tide mark of the estuary.

In addition, any major activities taking place on the banks of the Olifants estuary, and/or development and use of the margins of the estuary are likely to fall within the ambit of the **Environmental Impact Assessment (EIA)** regulations promulgated under the national Environmental Management Act (1998). The regulations stipulate that the execution, construction or upgrading of activities and developments in and around estuaries, e.g.:

- Marinas, (fishing) harbours and structures below high-water mark;
- Bridges, roads, railways and airfields;
- Dams, reservoirs, levees or weirs;
- Canals, channels and water-transfer schemes;
- Public and private amenities and resorts;
- Sewage treatment works and solid waste dump sites;
- Rezoning for residential or industrial development in and around estuaries;
- Altering the bed, banks, course or characteristics of a watercourse (e.g. mouth breaching, bank stabilisation, storm water outlet structures, dredging, dredge-spoil dumping, sedimentation or erosion issues, dune stabilisation);

- Reclamation of land below the high-water mark of the sea and in inland waters;
- Salt works (e.g. in flood plains and salt marsh areas); and
- Other (e.g. electricity generation, nuclear reactors, cableways, communication network structures and access roads, racing tracks, industrial and military facilities associated with explosives or ammunition and transport routes, structures and facilities involving hazardous substances), require that an environmental impact assessment be undertaken to assess potential impacts on the environment, socio-economic condition and cultural heritage, the results of which must be reported to the authority charged with authorizing, permitting or otherwise allowing the implementation of an activity (in this case DEA&DP).

Agricultural activities in and around the Olifants estuary, including livestock grazing, cultivation of crops and husbandry involving invasive alien species (plants or animals), are all subject to the Conservation of Agricultural Resources Act (1983) which gives the Minister of Agriculture the power to prescribe control measures to achieve the objectives of the Act (viz. the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources (including estuaries), and by the protection of the vegetation and the combating of weeds and invader plants).

5.5.2 Development planning pertaining to the Olifants estuary

The Spatial Development Framework for the Western Cape Province is pitched at a very broad level, encapsulated in the vision “a home for all in the Western Cape”. It offers very little material guidance of specific relevance to the management of the Olifants estuary, except to say that estuaries are unique ecosystems under serious threat both directly from human activities such as overexploitation, waste discharges, and through activities in the catchment. The Western Cape SDF also highlights the conservation importance of the Olifants estuary at a national level.

The IDP and SDF for the West Coast District Municipality and the Matzikama Local Municipality contain much more of direct relevance to management of the Olifants Estuary. The West Coast District Municipality SDF is currently being updated but excerpts from the existing (2002/2006) documents of direct relevance to this management plan have been collated in Table 22 (West Coast District Municipality IDP) and Table 23 (West Coast District Municipality SDF). Relevant material contained in the Matzikama Municipality IDP is included in Table 24 (Vision, goals and objectives) and Table 25 (specific strategic goals directly relevant to the estuary).

Table 22. The vision, mission and objectives of the West Coast District Municipality as outlined in the 2002/2006 IDP document

Vision	Mission	Objectives
A better quality of life for all	Through participating and co-operation in the district to develop the people to its optimum	<ul style="list-style-type: none"> ▪ The purposeful improvement of the quality of life for all the residents of the west coast region ▪ The establishment and preservation of a safe environment ▪ The pro-active and responsible stimulation of the regional economy ▪ The furtherance and conservation of the natural environment and the conservation of natural resources ▪ The advancement of pro-active co-operation between everyone that fulfils a role in development

Table 23. West Coast Region Spatial Development Framework (SDF)

Component	Strategy with spatial implications	Strategy without spatial implications
Wilderness areas	<ol style="list-style-type: none"> 1. Expand statutory wilderness status to more than 6% of West Coast Region; 2. Establish buffer zones around wilderness areas and core conservation areas 	<ol style="list-style-type: none"> 1. Maintain intrinsic value of wilderness areas 2. Promote insight into the significance of wilderness areas; 3. promotes users of wilderness areas with wilderness experiences; 4. establish wilderness conservation as economically viable, also as a form of land use
Conservation areas	<ol style="list-style-type: none"> 1. Expand statutory conservation status to at least 12% of the West Coast Region 	<ol style="list-style-type: none"> 1. Conserve the social and ecological integrity of natural areas and provide a wide spectrum of recreational opportunities ; 2. ensure effective public participation in environmental conservation
Natural resources <ul style="list-style-type: none"> ▪ Soil ▪ Water ▪ Plants ▪ animals 	<ol style="list-style-type: none"> 1. Regulate the exploitation and utilisation of all geological and mineral resources with a view to curbing environmental degradation; 2. Ensure the effective management of all catchment areas in the West Coast Region; 3. Conserve the diversity of indigenous plants at species, population and community levels; 4. Consolidate and enlarge the natural habitats of indigenous animal communities in the West Coast Region 	<ol style="list-style-type: none"> 1. Reduce the "loss" of agricultural lands to acceptable levels; 2. Establish viable and sustainable irrigation schemes to ensure sustainable agricultural development; 3. Ensure the conservation of all catchment areas in the West Coast Region; 4. Ensure reasonable rates for all water consumers; 5. Ensure reasonable access to water for all legitimate consumers; 6. Ensure sustainable exploitation of alternative water sources such as groundwater; 7. Reduce flood damage to infrastructure and developed land to acceptable levels 8. Maintain minimum acceptable population levels of rare and endangered plant species; 9. Promote the sustainable economic exploitation of indigenous flora; 10. Conserve natural habitats of indigenous animal species; 11. Conserve the diversity of indigenous plants at species, population and community levels; 12. Maintain minimum acceptable population levels of rare and endangered animal species; 13. Promote the sustainable economic exploitation of indigenous fauna.
Cultural environment		<ol style="list-style-type: none"> 1. Conserve representative historical buildings and structures; 2. Conserve all archaeological resources on government and private land; 3. Conserve all intangible cultural resources such as spoken history, languages, place names, social activities and human habits.
Rural development	<ol style="list-style-type: none"> 1. Provide the infrastructure and services needed to improve the quality of life of communities in rural areas. 	<ol style="list-style-type: none"> 1. Conserve the social and ecological integrity of natural areas by means of effective environmental planning; 2. Ensure effective environmental control in rural areas; 3. reduce negative impact on the ecological, social and natural environment to acceptable

Component	Strategy with spatial implications	Strategy without spatial implications
		levels; 4. Regulate the disposal of solid waste.
Urban development	1. Provide the necessary infrastructure and services needed to improve the quality of life of communities in urban areas.	1. Develop the necessary infrastructure and facilities to accommodate future development; 2. Implement location specific planning with reference to rural planning with a view to protecting the cultural, social and aesthetic al environment; 3. Ensure effective management of municipal functions; 4. Limit negative impact of urban development to acceptable levels; 5. Regulate the disposal of solid waste.
Economic sectors <ul style="list-style-type: none"> ▪ Tourism ▪ agriculture 	1. Advance the development of tourism infrastructure in keeping with location-specific architectural, environmental and aesthetic requirements; 2. create new irrigation schemes within the limitations of sustainable resource utilisation; 3. Provide sustainable opportunities for small and emerging farmers.	1. Ensure the conservation and preservation of the area's character and natural aesthetics by imparting information to tourists; 2. Ensure effective management of tourism at all levels; 3. Promote community-based and driven industry with inherent direct and indirect benefits for the communities; 4. Promote the development of sustainable agricultural enterprises; 5. Combine professional management skills with human, mechanical and financial resources in order to ensure sustainable agriculture; 6. Diversify agricultural enterprises; 7. Make the status of natural resources and the environment determinants for sustainable agriculture.
Human wellbeing		1. Ensure sustainable development 2. Create a safe, healthy and aesthetically acceptable social environment for all communities; 3. Create equal opportunities for professional education and training in order to ensure sustainable human resources and access to available job opportunities 4. Promote land reform in accordance with the Land Reform programme
Institutional and Legislative framework		1. Ensure effective cooperation and coordination between the various levels of government; 2. Ensure effective law enforcement

Table 24. The vision, mission and objectives of the Matzikama Municipality as outlined in the 2007-2011 IDP document

Vision	Mission	Objectives
A safe, peaceful and prosperous community	To provide the community with effective, affordable and quality service by means of sustainable development	<ol style="list-style-type: none"> 1. Municipal transformation and institutional development 2. Financial sustainability and financial management practices 3. Development of infrastructure and basic service delivery <ul style="list-style-type: none"> Primary infrastructure Operational basic service delivery and maintenance Housing 4. Good governance and public participation <ul style="list-style-type: none"> Facilities for the community and specific peer groups Health and safety Functional and aesthetically pleasing environment 5. Local economic development and poverty alleviation <ul style="list-style-type: none"> Economic development and tourism Poverty alleviation

Table 25. Strategic goals within the listed objectives of the Matzikama Municipality having direct bearing on the management for the Olifants River estuary (from Matzikama IDP 2007-2011).

4.2 Functional and aesthetically pleasing environment	<ul style="list-style-type: none"> ▪ Recognise and market unique natural environment (e.g. Knersvlakte) ▪ Law enforcement officers are needed to enforce regulations and improve quality of the environment namely the built environment and natural environment and coastal areas ▪ Functional environmental conservation strategy and coordination with institutions outside the municipality to realise goals
5.1 Economic development and tourism	<ul style="list-style-type: none"> ▪ Develop coastal area and river potential; developments and slipways

Another policy planning document that has considerable relevance for the development of this management plan is a Management Plan Guideline document (Urban Dynamics 1998) developed specifically for the lower Olifants River that was prepared for the West Coast District Municipality as part of the original IDP development process. This document was designed to provide the framework for the IDP, and includes a management framework, zonation plan and guidelines for conservation and development of the estuary and surrounds. The study area encompassed by the proposal extends well beyond the boundaries of the estuary as defined in this study, incorporating the whole of Farm 187/1 Ebenhaeser Colony on the southern bank, all land up to the top of the ridge on the north bank of the estuary, upstream as far as the Olifantsdrif settlement (Figure 28). It proposes a biosphere reserve-type approach for the area, incorporating a small core conservation area surrounding the mouth of the estuary, a transition zone surrounding the Olifantsdrif settlement, and the remainder of the study area being proposed as buffer zone (Figure 28). It was proposed that the entire area be gazetted as a Protected Natural Environment under the Environment Conservation Act (1989), with attendant regulations governing use of natural resources (e.g. landuse and activities in the core being restricted to those that further the conservation objectives of this zone, all development below the 10 m contour being banned in this zone). It also proposes that application be made for Ramsar Status for the area considering its conservation importance. While this proposal is now somewhat dated it does none the less provide a good starting point for the development of the current management plan.

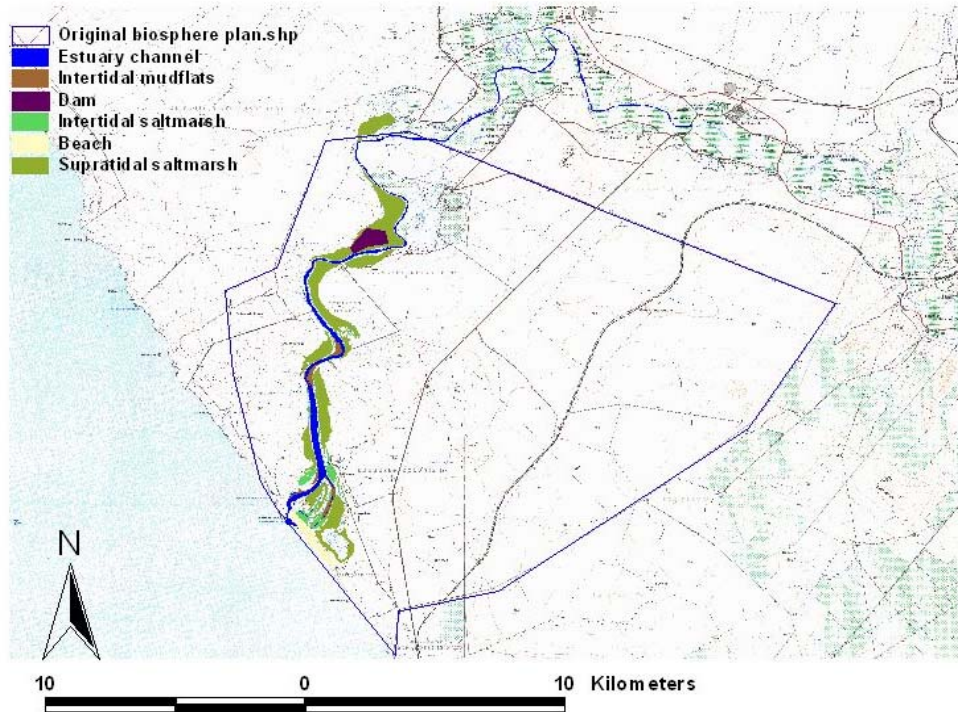


Figure 28. Map of the original proposed Biosphere reserve-type conservation area surrounding the Olifants estuary (after Urban Dynamics 1998).

5.5.3 Issues of surrounding land use and development

There is currently relatively little development and use of the margins of the Olifants estuary. However, at least one recent development (a large private reservoir) has led to the loss of a significant area of saltmarsh. Nevertheless, there is increasing demand for development up the west coast, and applications for development around the estuary margins have been made and are likely to increase in the future.

Increased development will lead to the degradation and loss of estuary habitats, and will bring about the increased use of the estuary for recreational purposes. This, in turn, could create problems of disturbance and pollution if inadequately managed. Recreational use of the estuary is discussed further below.

Not only does future development pose a threat to the estuary habitats and fauna, it also threatens the cultural heritage of the area in terms of changing the nature of the historically-interesting settlements along the estuary.

5.6 Non-consumptive recreational use

5.6.1 Legislation

There is no legislation at present that specifically controls non-consumptive recreational use of the estuary. There are indirect means by which this can and has been achieved.

Section 10 of the Seashore Act (1935) is the most common means used to control recreational boating activities in estuaries with powers delegated to Provincial Authorities (in this case the Western Cape Provincial Government). This Act is likely to be

repealed in the near future, however, to be replaced by the Integrated Coastal Management Act.

In addition to this, Section 24(4) of NEMA, through the Off Road Vehicle Regulations (2001, amended 2004) regulates the licensing and control of recreational boat launching sites as well as the use of recreational vehicles in the coastal zone.

Zonation of recreational uses of estuaries has only been applied within protected areas (national parks or nature reserves).

5.6.2 Management issues

The Olifants estuary is used recreationally for boating, fishing, birdwatching and photography, and is currently appreciated for its unspoilt, wilderness feel and the quaint settlements on its margins. Although these uses have not been quantified in any way, they pose little threat to the estuary at present.

Other recreational activities are of more concern. There is reportedly also some use of the estuary margins by quad bikers that may be causing environmental damage. Aircraft such as gyrocopters and microlights have been observed flying low over the estuary, and causing disturbance of flamingos and other birds. Speedboats also cause disturbance on the estuary, though this is not a major problem at present.

With increasing development in the area, disturbance of wildlife is likely to increase. Appropriate management measures such as protected areas and zonation could be developed to guard against impacts associated with increased use.

5.7 Exploitation of non-living resources

5.7.1 Legislation

The Minerals and Petroleum Resources Development Act (2002) makes provision for equitable access to and sustainable development of the nation's mineral and petroleum resources. The Act affirms the State's obligation to protect the environment for the benefit of present and future generations, to ensure ecologically sustainable development of mineral and petroleum resources and to promote economic and social development. Chapter 4 of the Act deals with Environmental Management principles as set out in section 2 of the National Environmental Management Act (1998). The holder of a prospecting or mining right or permit must abide by the general objectives of integrated environmental management as stipulated in Chapter 5 of NEMA and is required to conduct an environmental impact assessment and thereby manage all environmental impacts in accordance with the environmental management plan. The Act also stipulates that the holder of such a right or permit is responsible for any environmental damage, pollution or ecological degradation resulting within or outside the boundaries from the mining activity. On application for a mining right, an environmental management programme is required to be submitted to the Minister and on application for a prospecting right or mining permit, an environmental management plan (as prescribed) is required to be submitted. Only on approval of the environmental management programme or plan by the Minister, can such a mining or prospecting right or licence be granted.

5.7.2 Diamond mining

In South Africa offshore diamond mining concession areas stretch from the border with Namibia off the Orange River mouth, to an area just south of Saldanha Bay (Figure 29)). Each concession area is further split into four sub-areas in an offshore direction. The 'a' concession extends from the low water mark to 31.5 m offshore, while the 'b' concession extends from the western boundary of the 'a' concession to a co-ordinated boundary approximately 5 km offshore. The 'c' concession runs from the western boundary of 'b'

concession to the 200m isobath and the 'd' concession runs from the western boundary of 'c' concession to the 500m isobath.

Terrestrial diamond mining concessions, including beach mining concessions, extend along the coast from Orange River mouth to an area slightly south of the Olifants River. Two major companies, Alexkor and De Beers Namaqualand (Pty) Ltd dominate diamond production along the shores of Namaqualand and the Northern Cape. Alexkor operates from the Orange River mouth to just south of Port Nolloth, while De Beers operates from Alexkor's border to slightly north of the Olifants River (Figure 29). Around these major concessions are a number of smaller concessions operated by companies like Trans Hex Investments (Pty) Ltd.

Terrestrial diamond mining activities are currently confined to those concession areas to the north of the Olifants estuary and currently do not pose any threat to the estuary. Offshore mining operations are also currently confined to the concession areas north of the Olifants estuary but a number of diamond boats involved in mining activities in the "b" concession areas are moored from time to time in the mouth of the estuary and have been highlighted as a potential threat to fish stocks in the system (CSIR 1991). However, since mining concessions do straddle the estuary mouth, both on the terrestrial and seaward sides. These areas have been mined in the past, but concessionaires could exercise their rights to mine there in the future. Any such activity would require an EIA and an EMP.

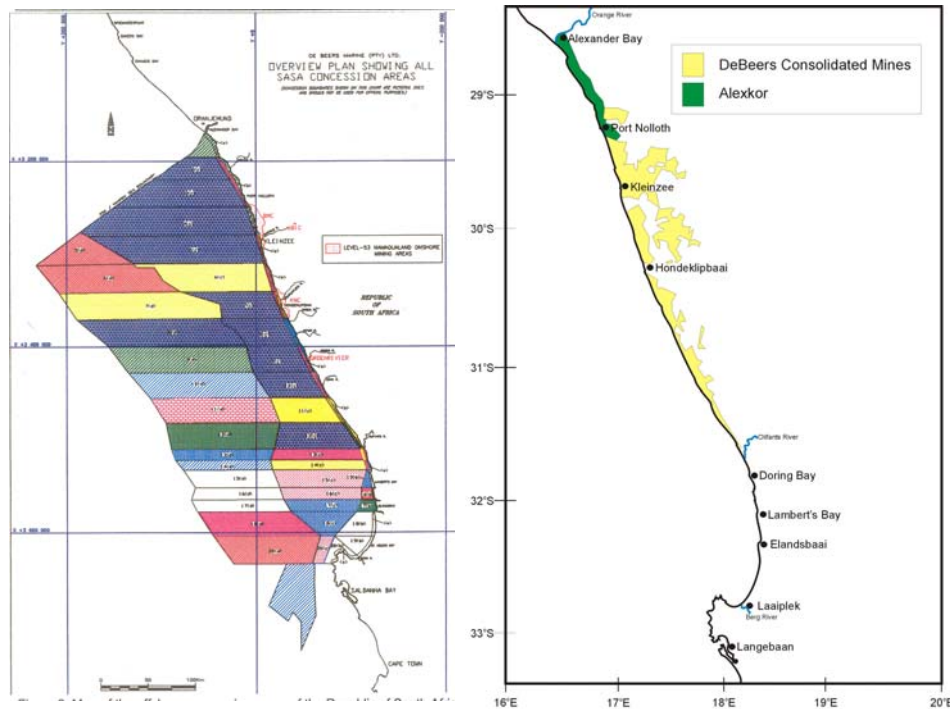


Figure 29. Offshore (left) and onshore (right) diamond mining concession areas in South Africa.

5.7.3 Salt mining

Salt mining is practiced on the south banks of the Olifants estuary, immediately adjacent to the mouth. This is a low key operation (Figure 30) and while construction of the salt pan itself has resulted in the loss of some salt marsh vegetation, overall impacts of this operation on the estuary is low.



Figure 30. Salt mining on the Olifants estuary

5.8 *Potential for protected area status*

5.8.1 *Legislative context*

The *White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998)* recognises the importance of estuaries and commits the government to a number of strategies to protect wetlands in general, such as facilitating the development of appropriate legislation to secure their conservation, promoting the establishment of a National System of Protected Wetlands, preventing inappropriate activities and development around wetlands, finding ways to recognise wetlands in planning and decision-making, determining the impact of fishers and developing guidelines for managing them.

Marine reserves were previously proclaimed under the *Sea Fishery Act 12 of 1988* or under the *National Parks Act 57 of 1976*. Now all marine reserves have been re-proclaimed under the *Marine Living Resources Act*. However, this only affords protection up to the high tide mark. Estuaries can also be protected within regular protected areas (see below), though the latter do not have jurisdiction over the use of estuarine living resources. Estuaries may also be protected within World Heritage Sites under the *World Heritage Convention Act 49 of 1999*.

The General Policy in terms of the *Environment Conservation Act – Terrestrial and Marine protected areas (1994)* categorises protected areas into 7 categories (based on IUCN and one additional category). It prescribes the management objectives and criteria for selecting and managing each category. The policy suggests that estuaries, fish, spawning areas and seascapes should generally be treated as Category IV – Habitat and wildlife management areas, regardless of who owns those resources. In reality, estuaries could fall into any category. Those such as Kosi could be classified as Category V – Protected land/seascapes, while others could be classified as Category VI – Sustainable Use Areas. Each estuary should be classified on the basis of the management objectives of the estuary (Smith 2000).

The Biodiversity Act (2004) provides for the conservation of biological diversity. It requires identification of important landscapes, ecosystems, ecological process and species for biodiversity conservation, and promotes monitoring of these. It also provides for the proclamation of protected areas, recognising South Africa's obligations to international conventions. The Protected Areas Act (2003) provides for the declaration and management of protected areas, and can also provide for co-operative governance, the sustainable utilisation of protected areas that preserves their ecological character, and the participation of local communities in the management of protected areas, where appropriate. A consultation and public participation process is outlined in the Act. It also contains the requirement that marine and terrestrial protected areas with

common boundaries must be managed as an integrated protected area by a single management authority. It is also important to note that under this Act, commercial prospecting or mining is prohibited in any nature reserve.

5.8.2 Potential for protection of the Olifants estuary

The Olifants estuary rates as the second most important estuary in South Africa from a conservation perspective, scoring in the top 10% for size, habitats, type rarity within its biogeographical zone, and biodiversity (Turpie et al. 2004a). It ranks among the top estuaries for birds and plants, and invertebrate and fish importance is within the top 30% of estuaries. Based on these criteria alone, there is extremely high justification for establishment of a protected area which encompasses at least part of the estuary.

Although it would be highly desirable, based on the above arguments, to provide no-take protection to the estuary in its entirety, it would probably not be feasible to achieve complete protection of the system.

Turpie & Clark (2007) conducted a conservation planning exercise in conjunction with the estuarine research and management community of the CAPE region under the C.A.P.E. Estuaries Management Programme. The study aimed to elicit the minimum set of estuaries that would be required to meet conservation targets (i.e. set percentages of habitats and populations of estuary-dependent species). Without worrying about costs, this can be done with the partial protection (50% of estuary as a sanctuary area) of some 50 of the 159 temperate estuaries. The Olifants estuary was included in this set of 50. When costs and benefits of conservation measures were incorporated into the analysis, the configuration changes, and it makes sense to afford partial protection to about 80% of estuaries. This creates a good argument for a general zonation system to be applied to most South African estuaries in which 50% of the estuary is declared a no-take zone. The Olifants estuary is still included in the latter selection, in spite having relatively high opportunity costs in terms of the additional water that would be required. In anticipation of protected area status, the RDM study for the Olifants has already recommended that some flows are restored to enable the health of the estuary to be improved (see section on water above).

5.8.3 Recommendations and procedure for establishing a protected area

With the lack of development around the estuary, the establishment of a protected area is highly feasible and would be strongly recommended. The protection should include a substantial no-take zone or zones and the protected area should extend to supratidal saltmarsh areas and possibly to some of the fringing terrestrial area. Under current regulations, this would require establishment of a nature reserve that contains a marine protected area, both of which would be managed by a single authority. Specific recommendations, to be further developed in consultation with stakeholders, are as follows:

1. Establish a nature reserve encompassing as much of the land around the estuary as possible including supratidal estuarine habitats;
2. Establish the entire estuary below the high tide mark as a Marine Protected Area;
3. Develop a zonation plan in which 50% of the MPA (not necessarily contiguous) is declared a no-take zone;
4. The whole protected area to be managed by the provincial authority (CapeNature);
5. Incorporate Papendorp as a heritage site, putting restrictions on the extent and type of development allowed in that area in order to retain its character

The details of the above will have to be established. Following feedback from stakeholders at the Stakeholder Workshop (24 January 2008), Anchor Environmental Consultants will draw up a detailed management plan including plans for the proposed protected area. This will be finalised after a final round of comments on the draft Olifants Estuary Management Plan.

Following this, a submission will need to be made to the Minister by the Matzikama Municipality or CapeNature. The Minister or the MEC is then obliged to inform the public of his/her intentions to engage in a government consultative process, providing sufficient details and inviting written representations on or objections.

The nature reserve area is likely to include private, community and state owned. (Note that much of the community owned land around the estuary is currently held in trust by the state). This may be declared as part of the nature reserve with the owner's consent. Alternatively, the minister or provincial MEC may acquire land to be included in the protected area by

- (a) purchasing the land or right;
- (b) exchanging the land or right for other land or rights; or
- (c) expropriating the land or right in accordance with the Expropriation Act, 1975 35 (Act No. 63 of 1975), and subject to section 25 of the Constitution, if no agreement is reached with the owner of the land or the holder of the right in or to the land.

Once assigned, the management authority will have 12 months in which to submit a management plan for the protected area.

5.9 Potential for restoration

There is no specific legislation pertaining to the restoration of ecosystems. Although it is in good condition, the Olifants estuary has been identified as one in which there is a need for rehabilitation. In the case of the Olifants estuary restoration of the estuary to a better state of health would be very straightforward, and would mainly entail (in order of priority):

- 5. Reduction in fishing catch;
- 6. Restoration of the quantity of freshwater inflows;
- 7. Restoration of water quality; and
- 8. Removing the barrier effect of the Lutzville causeway.

Apart from the last-mentioned, these are all addressed in the management issues described above. Alteration of the Lutzville causeway is the lowest of these priorities and it worthiness needs to be considered.

In general, the degree to which these factors should be managed to restore the health of the system depends largely on the vision that is developed for the estuary, and on its future protection status. Protection status will provide a strong case for the provision of restorative flows and their quality. The most contentious issue remains that of the fishery.

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APPENDIX 1: TERMS OF REFERENCE

The development of the Olifants Estuary Management Plan will be carried out in two phases, as follows:

Phase 1: Situation Assessment

- 1. Review of legislation pertaining to the management of environmental threats within estuaries**
The focus of this task will be explaining the specific relevance of legislative instruments highlighted in the generic legislative review compiled for the GEMP, on how interaction of the respective Governmental Departments will affect management of the Olifants estuary, and also the relevance of any local by-laws to management of the estuary. A summary of all relevant information will be included in the Phase 1 Situation Assessment Report.
- 2. Description and GIS map of the estuary**
A clear GIS map of the estuary will be prepared indicating important biophysical features (open channel area, macrophyte beds, invertebrate beds, etc.), protected/conservation areas, areas earmarked for rehabilitation, land-use and planning provisions of surrounding lands, infrastructure (e.g. roads, bridges), cultural & heritage sites, recreational activities (e.g. swimming, boating), living resource exploitation (e.g. bait collection, fishing areas, etc), mariculture activities, wastewater discharges (sewage, industrial), stormwater drains, and solid waste dump sites.
- 3. Description of goods and services provided by the estuary**
Information on goods and services provided by the Olifants estuary will be extracted from recent studies completed on the system, focusing on the recent RDM study, and the DWAF Rivers' Classification project in which the Olifants estuary was used as a case study.
- 4. Identification of issues relating to the exploitation of living resources**
A brief description of current levels and trends in exploitation of living resources in the Olifants estuary will be provided, and on the likely impacts of this harvested on goods and services provided by the system.
- 5. Synopsis of water quantity and quality requirements**
Details on water quantity and quality requirements of the system will be extracted from recent studies on the Olifants estuary, focusing on the recent RDM study and the DWAF Rivers' Classification project, and will be summarized in the Phase 1 Situation Assessment Report.
- 6. Determination of priority restoration actions.**
All issues affecting or impacting on the health of the estuary will be identified, prioritized and specific rehabilitation measures proposed.
- 7. Determination of protected area potential**
Protected area potential of the Olifants estuary will be assessed using information provided in the recently completed C.A.P.E. Estuaries Programme: Classification, prioritization, protection and rehabilitation document as well as other relevant documents. Specific recommendations will be provided as to the type of protection that should be applied and associated application procedure that must be completed in order to achieve this status.
- 8. Plan for awareness-raising and public participation/stakeholder involvement**
A generic awareness programme for the Olifants estuary will be prepared that will include details on processes for involving relevant stakeholders and user groups in estuary management and decision-making processes. Much of the necessary material will be drawn from relevant reports produced by the East Cape Estuaries Management Programme.
- 9. Work plan and budget for Phase 2**
A detailed workplan and budget for Phase 2 of the project will be prepared and submitted to the C.A.P.E. Estuaries Task Team for approval along with the Task 1 Situation Assessment Report before work on Objective 2 is initiated.

Phase 2: Stakeholder consultation and compilation of Estuary Management Plan

- 1. Vision & Strategic Objectives**
The primary activity for this task will be to convene a stakeholder workshop aimed at

developing a local vision and associated objectives for the Olifants estuary. This vision will underpin the entire EMP and will need to be consistent with the vision and Strategic Objectives for the Estuaries of the CFR and with the findings of the C.A.P.E. Estuaries Conservation Planning report (Turpie & Clark 2007).

2. **Management Strategies**

Clear management strategies will be formulated that will ensure that the Vision and Strategic Objectives developed for the Olifants estuary are achieved that makes optimal use of available financial and human resources.

3. **Estuarine Zonation Plan & Operational Objectives**

Management strategies developed as part of task 2 above will be spatially explicit and linked with the GIS map prepared during Phase 1 of the project. This will become the Estuary Zonation plan (EZP). Appropriate annotations will be added to the map to ensure that management objectives and visions for all sections of the estuary are clearly laid out and easy to follow.

4. **Management Action Plans**

Detailed Management Action Plans (MAPs) will be developed to ensure that all defined operational objective can be achieved in an efficient and effective manner. MAPs to be developed for this purpose will include those dealing with conservation, social issues, land-use and infrastructure development, water quality and quantity, and exploitation of living resources. Each MAP will include a prioritized list of management actions, related legal, policy and/or best practice requirements, monitoring plans, work and resource plans.

5. **Implementation**

A detailed 5-year implementation plan for the EMP will be developed in which agencies and individuals responsible for implementation of all aspects of the EMP are identified. Qualifications required by key individuals responsible for implementation of the plan will be clearly articulated as will opportunities for capacity building and empowerment of Historically Disadvantaged Individuals (HDIs). The implementation plan will take cognisance of available human and financial resources.

6. **Monitoring and evaluation**

An appropriate monitoring programme will be designed for the Olifants estuary with the primary objective being the ongoing evaluation of the health of the system and success of the EMP. The following key components of the monitoring programme will be defined within the monitoring plan: monitoring objectives, parameters (indicators) to be monitored, staff and budgetary requirements, spatial and temporal resolution of monitoring activities, sampling and analytical techniques to be employed, and protocols for evaluation and reporting, and for incorporation of results into the MAPs.

7. **Research**

Focal areas for further research effort that will contribute to improved management of the estuary.