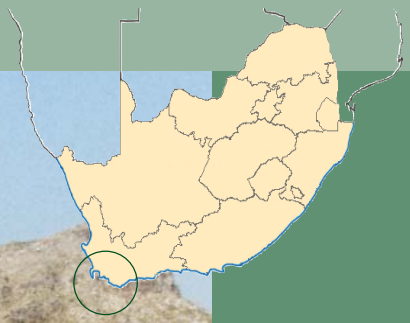
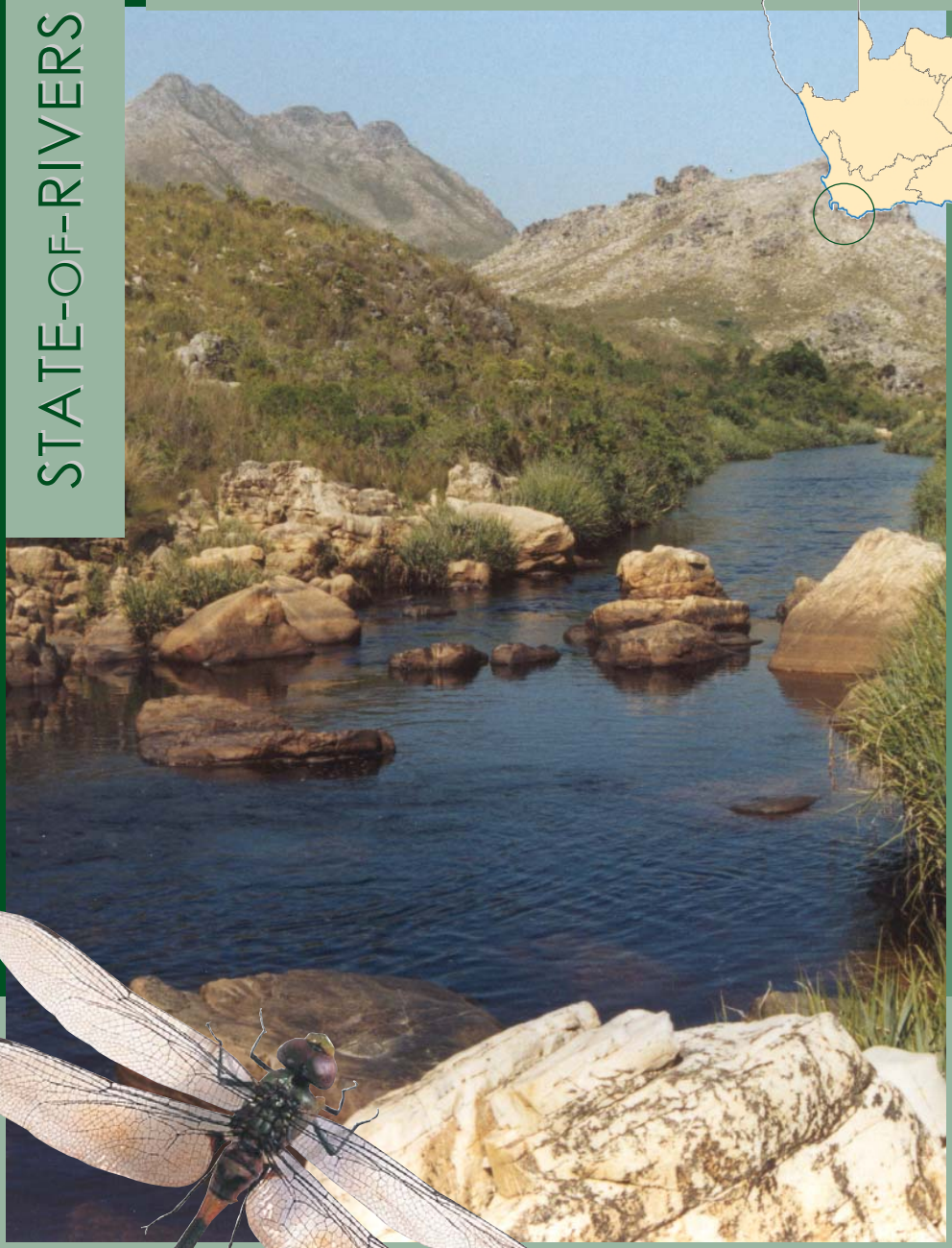
STATE-OF-RIVERS REPORT

DIEP, HOUT BAY, LOURENS AND PALMIET RIVER SYSTEMS - 2003





RIVER HEALTH PROGRAMME

Contributing Organisations

Department of Water Affairs and Forestry

Department of Environmental Affairs and Tourism

Water Research Commission

Western Cape Nature Conservation Board

City of Cape Town

University of Stellenbosch

CSIR Environmentek

National Research Foundation

Norwegian Agency for Development Coorporation

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Foreword

Water plays an important role in our lives and we must ensure that we manage our water resources in a manner that ensures the sustainability of these resources. Rivers are an important water source and are also ecosystems that help maintain our environment's natural balance. The City of Cape Town is committed to the cause of the Department of Water Affairs and Forestry to manage our rivers as a water resource in a sustainable manner. We have come together as National Government, Provincial Government, Local Government, Quasi Government and Scientific Organizations to give voice to our rivers and the life giving force flowing in them, through the publication of this report.

Our water resources need to be monitored, assessed, and reported on to achieve sustainable development. The information presented in this State of Rivers Report has been gathered from a variety of organizations, researchers and scientists to enable the identification of trends and emergent patterns and to assess management responses to change. The value of the report is that it informs decision makers, interested parties and the public on fundamental issues impacting on our rivers in an easy to understand format. It aims to raise awareness and understanding on the current state of our rivers, the impacts on them and what management actions can be taken by all to improve them. We are not managing rivers for the rivers sake but to ensure that present and future generations can enjoy them for the benefits that they offer.

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State-of-Rivers Report: Diep, Hout Bay, Lourens and Palmiet River Systems

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Context

This report is based on the findings of river surveys that were conducted in the Diep, Hout Bay, Lourens and Palmiet River Systems as part of the implementation of the River Health Programme in the Western Cape. These surveys took place during 2002 and 2003.

Introduction

What is the River Health Programme?

The Department of Water Affairs and Forestry, custodian of South Africa's water resources, **protects** the health of aquatic ecosystems and ensures their **sustainable use**. The River Health Programme, operational since 1994, is a key part of this responsibility.

The River Health Programme assesses the biological and habitat integrity of rivers (through evaluation of, for example, fish, aquatic invertebrates and riparian vegetation). This assessment enables us to report on the ecological state of our river systems in an objective and scientifically sound manner. Information from the River Health Programme allows for the identification of those areas where unacceptable ecological deterioration is taking place. This programme reflects the effectiveness of existing river management policies, strategies and actions.

The monitoring of river health is a legal requirement under the National Water Act of 1998, and the results are important for the application of the National Environmental Management Act (1998).

A Collaborative Venture

The River Health Programme is a collaborative venture. **Partnerships** are vital for its success.

The national organisations leading the River Health Programme are the Department of Water Affairs and Forestry, the Department of Environmental Affairs and Tourism and the Water Research Commission. Each province is responsible for the River Health Programme within its borders, and a provincial champion coordinates the efforts of a network of implementers. The protocols and procedures that make up the River Health Programme are available to any institution that would like to become involved in river health monitoring.

Why Do We Monitor and Report on River Health?

'River health' is the overall condition of a river. The term can be compared to the health of a person or an economy. Rivers are central to our **welfare and economic development**. Their health is essential for our well-being.

Rivers contribute to our welfare and economic growth by providing goods and services. A healthy river provides water for drinking, washing, crops, livestock and industry. It also supports freshwater and estuarine fish, encourages the growth of plants, is essential for tourism and recreation and enhances the value of surrounding land.

Knowledge of the impacts on a river provides insight into why the river is in its present health. Examples of human activities that can impact on rivers include:

- water abstraction,
- disturbance to river-bank and -bed (e.g. dam and bridge construction in rivers; presence of invasive alien fauna and flora),
- development below the 1 in 50 year floodline (e.g. housing, sand mining, vineyards, forestry), and
- discharge of waste water or effluent of poor quality.

South Africa has limited water resources, so we need to make every drop count if we are to develop the country in a sustainable way. Even under the most cautious projections of population growth, South Africa will enter a period of water scarcity within twenty years. The average amount of water available per person in 2025 will be only half that available in 1990, yet the pressures for development will be far greater. We need to find ways to monitor and manage our water resources so that we obtain the maximum benefit without destroying them, and ourselves, in the process.

What are State-of-Rivers Reports?

State-of-Rivers reporting is an offshoot of the State of the Environment reporting process, which has become popular during the past decade. The aim is to provide better information for environmental decision-making. The South African State of the Environment report uses the 'Driving-Force-Pressure-State-Impact-Response' framework to explain what causes environmental change, how serious the problems are and what we can do to solve them. State-of-Rivers reporting disseminates information on river health to:

- assist in the ecologically sound management of rivers, and
- inform and educate people regarding the condition of our rivers.

River Health reports appear in an accessible report format (such as the one you are reading) or in a more simplified poster form. Eventually, the River Health Programme will cover all South Africa's major river systems. Regular updates will also form part of the River Health Programme.

How To Read This Report

This introductory section deals with the overall aims of the River Health Programme. The next eight pages provide general information on methods and the study area, followed by four sections dealing with each river system in detail. Each section consists of two double-page spreads outlining the catchment area, historical background, present and desired health, pressures on the health of the river and key management actions needed.

River Health Indices

What are River Health Indices?

Many physical, chemical and biological factors influence river ecosystem health. Examples are geomorphology, hydrological and hydraulic regimes, water quality, in-stream and riparian habitats and a host of biological processes. For practical purposes, the River Health Programme focuses on selected ecological indicator groups that are representative of the larger ecosystem and are feasible to measure. This report uses river health indices to present data in an easy-to-understand format.

Index of Habitat Integrity (IHI)

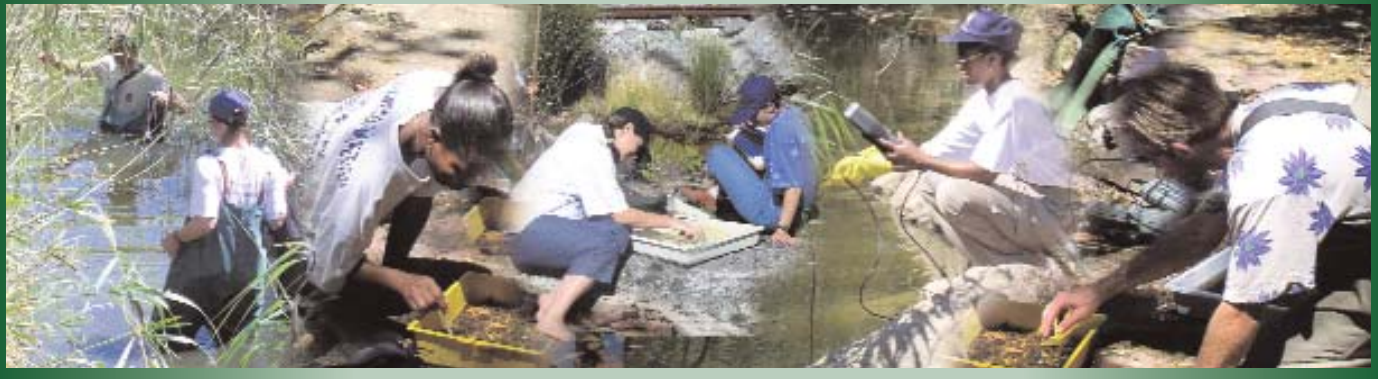
The availability and diversity of habitats dictate the kinds of biota that will be found in a specific ecosystem. Knowledge of habitat quality is important in an overall assessment of ecosystem health. The IHI assesses the impact of disturbances such as water abstraction, flow regulation and river channel modification on the riparian zone and in-stream habitats. The IHI icon shows the river and river bank, colour-coded according to the state of the in-stream and riparian habitat.

Geomorphological Index (GI)

Geomorphological processes determine the size and shape of river channels, which in turn define the types of habitat available for aquatic invertebrates. The geomorphological index reflects the condition and stability of the channel. Channel condition is based on the channel impacts (e.g. weirs, bridges, dams) evident in a river reach and the type of channel (e.g. bedrock or alluvial). Channel stability is based on the potential for erosion of the river banks and bed.

Riparian Vegetation Index (RVI)

Healthy riparian zones help to maintain the form of the river channel and serve as filters for sediment, nutrients and light. Plant material from the riparian zone is an important source of food for aquatic fauna. The structure and function of riparian vegetation is altered when vegetation removal, cultivation, construction, inundation, erosion, sedimentation and alien vegetation occur within or close to the riparian zone. RVI is a measure of the degree of modification of the riparian zone from its natural state.



South African Scoring System (SASS)

Aquatic invertebrates (e.g. insects, mussels, snails, crabs, worms) require specific habitats and water quality conditions for at least part of their life cycle. Changes in invertebrate community composition and structure reflect changes in river conditions. Invertebrates are good indicators of recent localised conditions in a river. SASS is a relatively simple index, based on invertebrate families found at a site.

Fish Assemblage Integrity Index (FAII)

Fish are good indicators of long-term influences on a river reach and the general habitat conditions within that reach. The number of fish species (indigenous or alien), the different size classes and the health of fish are all indicators of river health. The FAII is an expression of the degree to which a fish assemblage deviates from its undisturbed condition. The FAII was adapted to make it applicable to Western Cape rivers which have low fish diversities.

Water Quality

Water quality indicates the suitability of the water for aquatic ecosystems. This assessment is based on the phosphate, nitrate, nitrite, ammonia, suspended solids, dissolved oxygen, pH and conductivity measured in water samples from each sampling site.

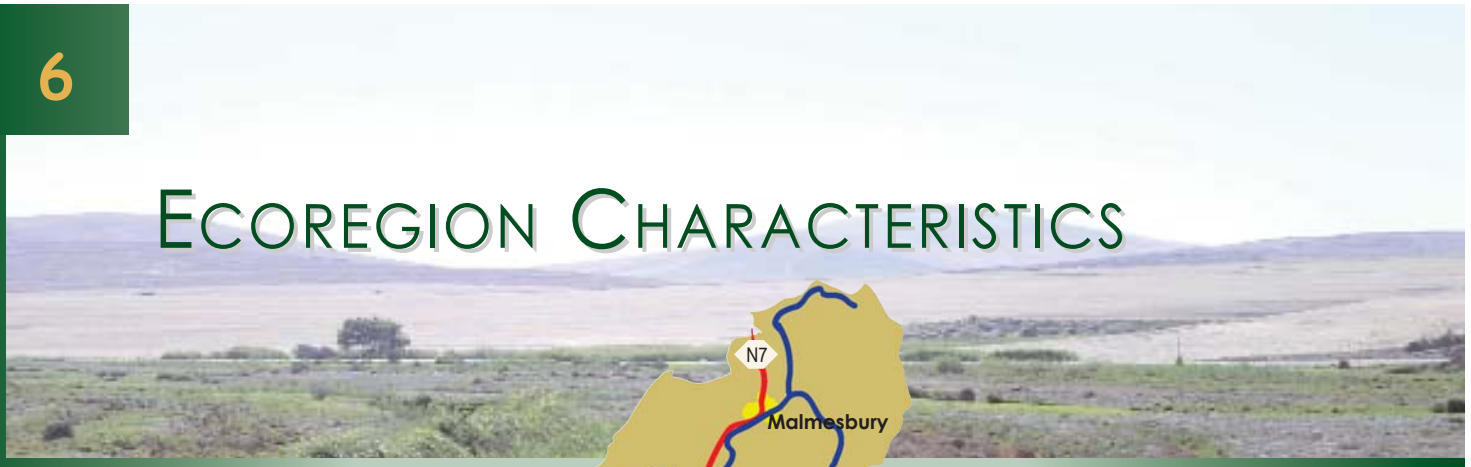
River Health Categories

The **present health** of a river is a measure of the present ecological state of the river during the time of the survey and is presented in terms of the river health categories given below.
The **desired health** of a river is the envisioned future ecological state of the river. It is based on ecological considerations, the need for sustainable development and management actions concerning the river environment.

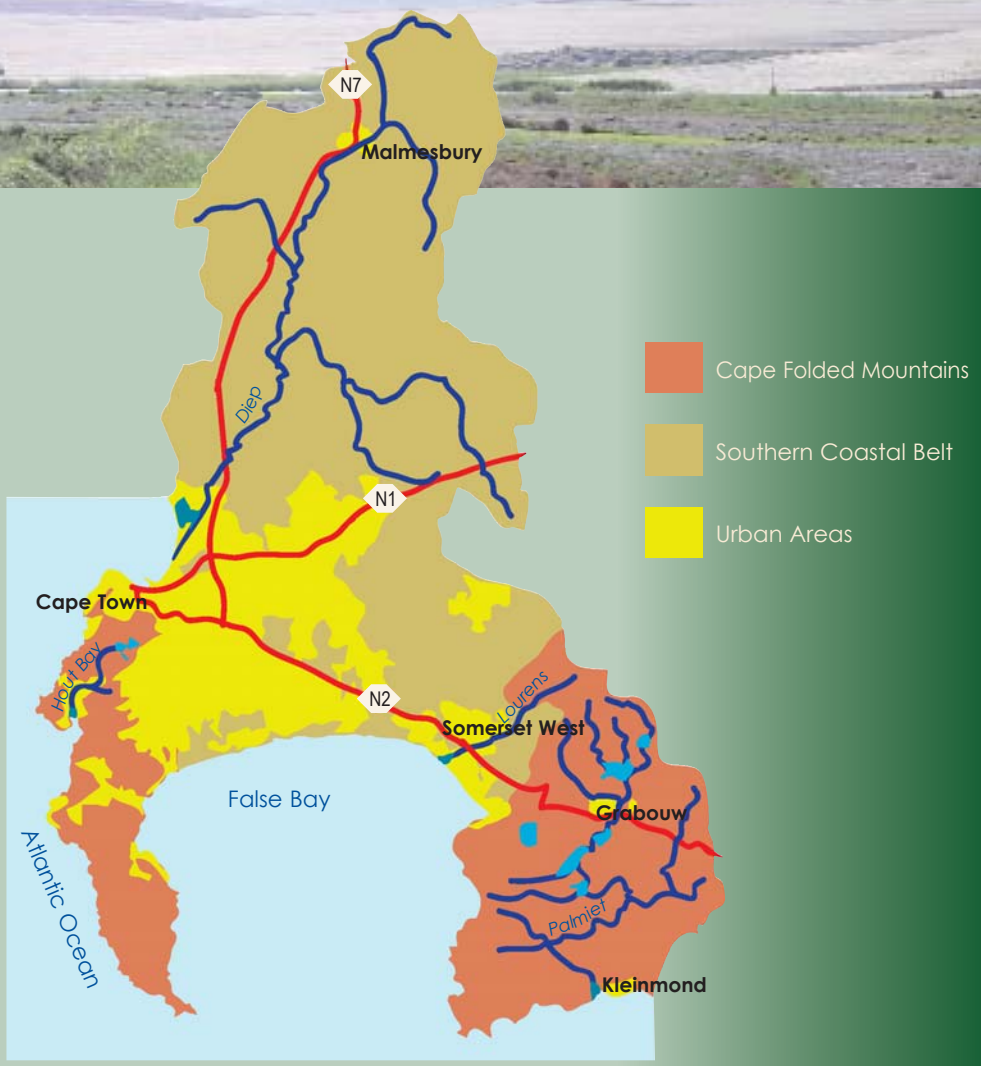
Desired health: Good

River Health Category	Ecological Perspective	Management Perspective
Natural N	No or negligible modification	Relatively little human impact
Good G	Biodiversity and integrity largely intact	Some human-related disturbance but ecosystems essentially in good state
Fair F	Sensitive species may be lost, with tolerant or opportunistic species dominating	Multiple disturbances associated with the need for socio-economic development
Poor P	Mostly only tolerant species present; alien species invasion; disrupted population dynamics; species are often diseased	High human densities or extensive resource exploitation

Ecoregion Characteristics



Ecoregions are a fairly new way of grouping areas of similar ecological characteristics. Ecoregions are defined according to factors such as climate, geology and terrain. The two main ecoregions in the study area are the Cape Folded Mountains and the Southern Coastal Belt. These names and boundaries may change with improvements in the classification techniques.



The Cape Folded Mountains

The Hout Bay and Palmiet rivers, as well as the headwaters of the Lourens River fall within this ecoregion. The topography of the ecoregion consists mainly of high relief plains, mountains and hills (right), with an altitude ranging from 200 – 1 750m above sea level. The vegetation is dominated by mountain fynbos with pockets of afromontane forest in the river ravines and renosterveld along the coastal strip. The geology is mostly Table Mountain Sandstone with some shale which results in a high surface runoff of low-salinity, acidic water.

The Southern Coastal Belt

The Diep River and the lower reaches of the Lourens River fall within this ecoregion. This ecoregion terrain is typified by plains, hills and mountains (right) with an altitude ranging from 0 - 600m above mean sea level. Rock types include quartzitic sandstone, shale, sand and biotite granite. The vegetation is mainly dune thicket, coastal renosterveld and sand plain fynbos. This region is mostly underlain by shale and sand, resulting in a lower surface runoff of more saline, alkaline water.

Geomorphological Zones of Rivers

Geomorphological river zones are groups of rivers or reaches of rivers within an ecoregion, that share similar geomorphological features, such as channel morphology, bed material and gradient. These features are an important factor influencing the distribution of biota, and different types of fauna and flora are associated with the different zones. Several river zones were identified in the Diep, Hout Bay, Lourens, and Palmiet rivers.

Mountain Stream Zone

This zone is characterised by a steep gradient, dominated by bedrock and boulders, with cobble and coarse gravels in pools. Water flows in cascades, waterfalls and pools.

Upper Foothill Zone

River reaches in this zone are moderately steep with cobble or mixed bedrock-cobble bed. This river zone is characterised by similar pool and rapid / riffle lengths.

Lower Foothill Zone

This zone has a lower gradient with an alluvial bed of sand and gravel which may be bedrock dominated. The zone is characterised by more pools than rapids or riffles, with sandbars common in the pools. A floodplain is often present.

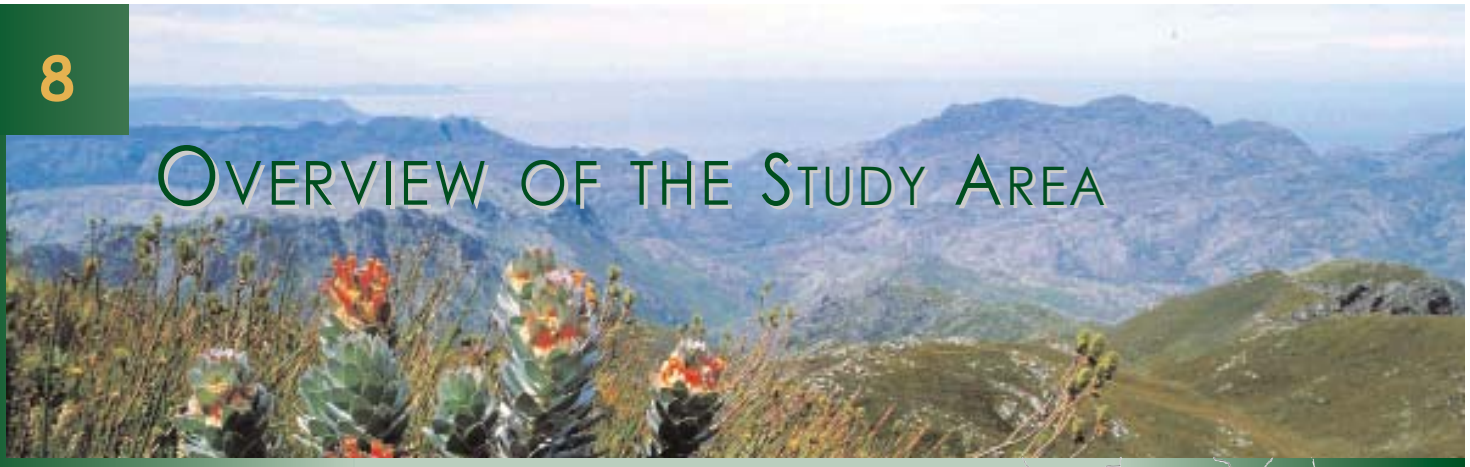
Lowland River Zone

A low gradient alluvial channel, which meanders within a floodplain characterises the river in this zone. There is an increased silt content on the bed or banks and water flow is uniform.

Rejuvenated Foothill Zone

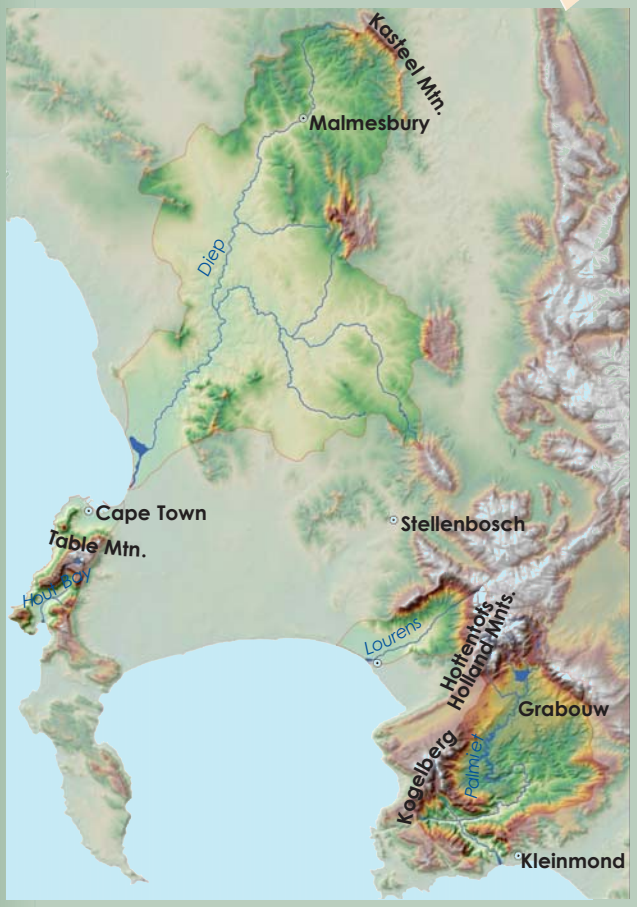
This is a steepened section within the middle reaches of a river caused by geological uplift. Gravel or cobbles dominate the bed, with pool-riffle and pool-rapid sequences. The river is often multi-channelled with a limited floodplain.

Overview of the Study Area



The study area is characterised by high mountain ranges separated by the Cape Flats. Several conservation areas protect the indigenous biodiversity within this winter rainfall area.

On the seaward escarpments, precipitation exceeds 1 000mm per year, while the rain-shadows in the mountains receive less than half of that. Fog precipitation from the Table Mountain "table-cloth" exceeds 3 000mm per year and provides vital moisture to plants on the summit during summer. This moisture contributes to the unique vegetation on Table Mountain.



The Diep, Hout Bay, Lourens and Palmiet rivers represent the wide range of river types in the Cape Town area.

- the Lourens River, although degraded in areas, is the only South African river that is a declared Protected Natural Environment;
- the Hout Bay River has its entire upper catchment in the Cape Peninsula National Park, while the lower reaches flow through residential areas;
- the Diep River differs ecologically from the other rivers as a result of differing morphology, vegetation and climate characteristics, and flows partially through the Rietvlei Wetland Reserve, which is also a Protected Natural Environment; and
- the Palmiet River has intensive agricultural development in its upper catchment, but is protected downstream, where it flows through the Kogelberg Biosphere Reserve.

	Diep	Hout Bay	Lourens	Palmiet
Catchment Size (km^2)	1 495	33.8	128	500
Main tributaries	Mosselbank, Klapmuts, Riebeek, Swart, Sout, Platklip	Disa, Original Disa	No major tributaries	Kromme, Wesselsgat, Klipdrif, Klein Palmiet, Louws, Berg, Dwars, Keerom
Geology	Malmesbury Group (shale), Cape Granite, Klipheuwel Group (conglomerates) and sandy sediments	Table Mountain Group (quartzitic sandstone), Cape Granite and sandy sediments	Table Mountain Group (quartzitic sandstone), Cape Granite, Malmesbury Group (shale) and sandy sediments	Table Mountain Group (quartzitic sandstone) and Bokkeveld Group (shale)
Vegetation *	West Coast Renosterveld, Dune Thicket, Sand Plain Fynbos	Mountain Fynbos, Afromontane Forest, Dune Fynbos, Dune Thicket	Mountain Fynbos, Coastal Renosterveld	Mountain Fynbos, South and South-West Coast Renosterveld
Mean annual precipitation (mm)	505	923	1 002	1176
Mean annual evaporation (mm)	1 491	1 400	1 410	1 414
Natural mean annual runoff (m^3)	87 x 10^6	10.4 x 10^6	59 x 10^6	253 x 10^6

** Note: These names are currently being revised (see Mucina and Rutherford, in press).*

Population

The Hout Bay catchment has the highest population density in the study area (nearly a thousand people per square kilometre) and the Diep and Palmiet catchments the lowest (about one to two hundred per square kilometre). Population growth varies between 2 and 3% per year, while economic growth averages 3% per year. Despite the increase in unemployment levels in the Cape Town area from 13% in 1997 to 20% in 2002, employment figures in the study area are relatively high compared to national statistics.

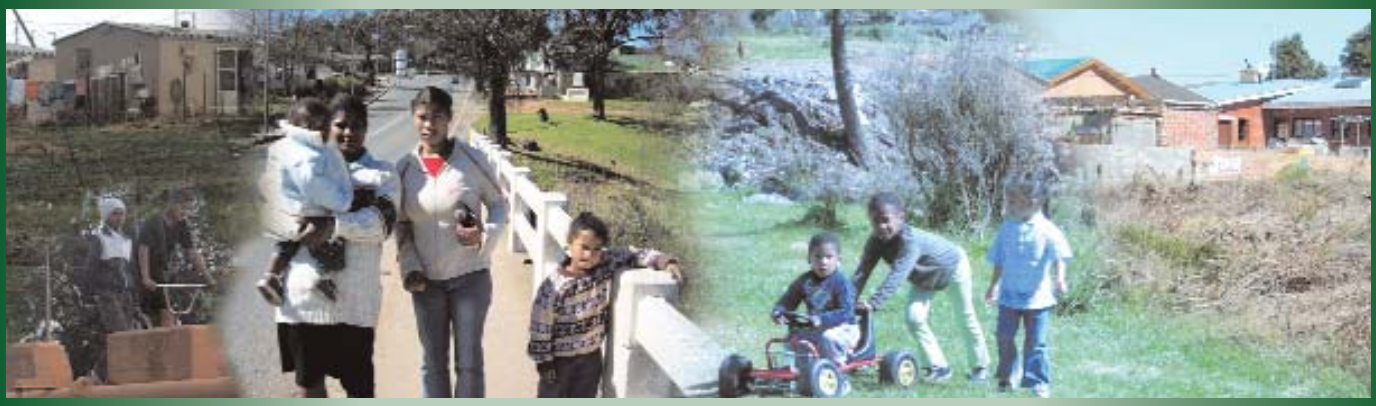
Economic Profile

Exports and tourism are major drivers of economic growth and therefore job creation in the study area. Agriculture (wheat, grain, fruit and mixed farming), forestry, fishing, manufacturing and real estate are major contributers to the total Gross Geographic Product (GGP). The Diep, Hout Bay and Lourens catchments all contribute towards the GGP of the City of Cape Town. In 2001, the Cape Town's economy (R94 billion in goods and services) comprised almost 11% of the national economy and 75% of the Western Cape's economy. The GGP for the Palmiet catchment was R9 billion, comprising more than 1% of the national economy. The GGP per capita falls within the middle to higher brackets, compared to the rest of South Africa.

Cape Town is one of the top ten international tourist attractions, and tourism is the most important economic activity for the development of the Western Cape. It provides more than 75 000 jobs, with over a million foreign tourists visiting the Western Cape every year.

Sources of income in the Hout Bay area are mainly tourism and fishing. Commercial development in the valley is limited and most residents commute to work in Cape Town. The central Palmiet catchment is extensively cultivated and is the largest exporter of fruit in southern Africa. Apple, pear and peach orchards dominate the landscape. The Diep River region currently accounts for about one-sixth of South Africa's grain production. The Lourens River region comprises vineyards, orchards and commercial development.

Various local government departments have strategies to promote economic growth, create jobs and reduce poverty.



Land-Use

Main land-use within the catchments consists of nature conservation, agriculture, livestock farming, plantation forestry, commercial industries, fruit farming and residential areas.

fynbos

grassland

dryland crops

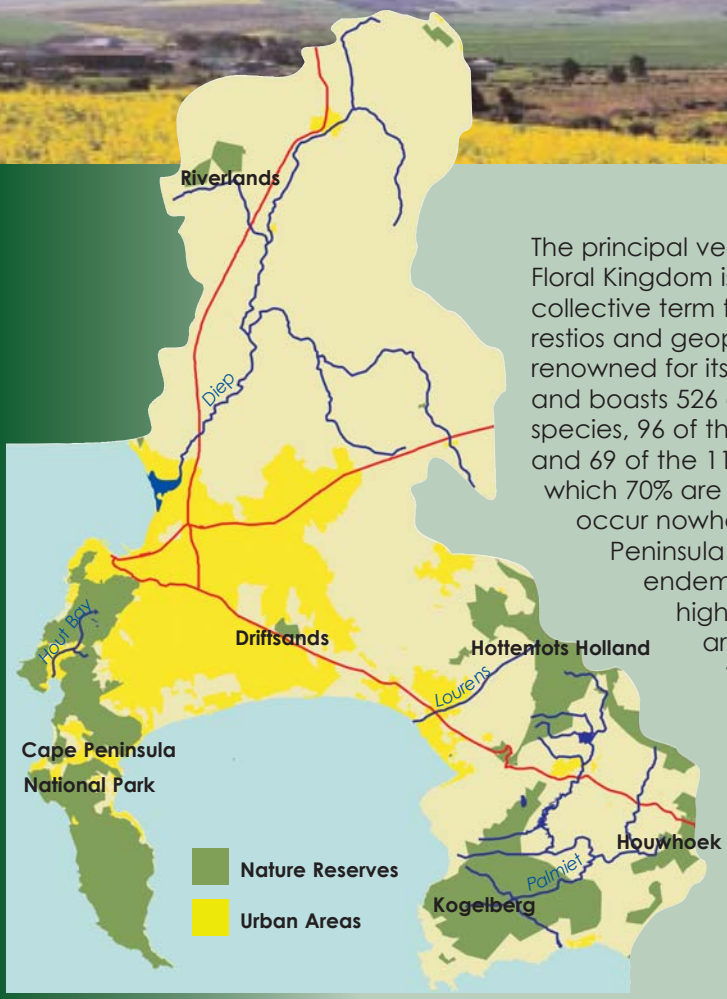
forest plantations

urban areas

irrigated crops

	Diep	Hout Bay	Lourens	Palmiet
Main land-use per catchment (%)	Agriculture (wheat & grain) (66%) Natural areas (18%) Urban areas (7%) Vineyards & orchards (6%) Other (3%)	Natural areas (64%) Urban areas (19%) Forestry (15%) Other (2%)	Forestry (33%) Natural areas (28%) Vineyards & orchards (20%) Urban areas (18%) Other (1%)	Natural areas (56%) Vineyards & orchards (29%) Forestry (12%) Urban areas (1%) Other (2%)
Dams	Many farm dams	5 in-stream dams: Woodhead, Hely-Hutchinson, Victoria, Alexandra, De Villiers	No major in-stream dams farm dams in tributaries	5 major in-stream dams: Nuweberg,Eikenhof, Applethwaite, Kogelberg, Arieskraal and many small farm dams
Total dam capacity (Mm^3)	17 (34% of *n*MAR)	2.5 (24% of *n*MAR)	9 (17% of *n*MAR)	101 (40% of *n*MAR)
Main dam water usage	Bulk water supply from outside of catchment	Domestic water supply	Irrigation Domestic water supply	Irrigation Domestic water supply Electricity generation Water transfer scheme
Total population	106 200	32 000	32 300	27 000
Population with water services (%)	90	95	99	80

Cape Floral Kingdom



The principal vegetation in the Cape Floral Kingdom is fynbos, which is the collective term for its ericas, proteas, restios and geophytes. Fynbos is renowned for its beauty and diversity and boasts 526 of the world's 740 erica species, 96 of the 160 gladiolus species and 69 of the 112 protea species, of which 70% are endemic (species that occur nowhere else). The Cape Peninsula itself has about 150 endemic plant species – the highest endemism for any area of similar size in the world. The Cape Peninsula National Park (see p 16) and Kogelberg Nature Reserve (see p 24) are hotspots within the fynbos as they have an unusually large variety of plant species.

The unique Cape Floral Kingdom is one of the richest of the world's six plant Kingdoms. It covers an area of slightly less than 90 000km^2 from the Cedarberg in the west to Port Elizabeth in the east and hosts about 9 000 plant species. Freshwater and marine environments in the Kingdom are similarly unique with plants and animals adapted to highly specialised environments.

Endangered Plants

Many plant species in the Kingdom are highly threatened, with more than 1 400 of the 9 000 plant species listed as critically rare, endangered or vulnerable. Examples are (clockwise starting top right) *Serruria aemula, Sparaxis tricolor, Morea neopavonia, M. insolens*). Already 29 species are known to have become extinct. Much of the area originally covered by fynbos has been lost to agriculture, urban development and invasion by alien plants.

Cape Action for People and the Environment (C.A.P.E.)

C.A.P.E. is a partnership programme between government organisations, landowners, parastatals and the public. Its vision is to secure the conservation of the biodiversity of the Cape Floral Kingdom and through this to deliver sustainable economic benefits to the people of the region. The initiative was made possible by funding from the Global Environment Facility in 1998. Currently, the initiative is in its implementation phase.

Diep River Catchment

The Diep River rises in the Kasteel Mountain near Malmesbury at an altitude of 420m above mean sea level (amsl). The river flows for about 65km in a south-westerly direction, passing through Rietvlei Wetland Reserve before entering the Atlantic Ocean. The only major tributary, the Mosselbank River, drains the south-eastern portion of the catchment near the towns of Kraaifontein and Durbanville.

The catchment comprises the Swartland and Sandveld regions in the western lowland area of the Western Cape. The Swartland is named after the renosterbos (vegetation which is seasonally black-coloured) that was abundant in the area, while the Sandveld is named after its sandy soils. The flat topography of the catchment makes it attractive for agricultural and urban development.

More than 90% of the catchment is under cultivation, predominantly wheat and other grain crops. Recent years have seen an increase in vineyards and orchards in the area. While livestock include pigs, cattle and sheep, poultry farming predominates. Stone, gravel and sand are mined at several quarries and informal sand works in the catchment.

Major urban areas are Malmesbury, Milnerton, Table View, Klapmuts, Kraaifontein and Durbanville. More than 90% of the bulk water supply comes from Voëlvlei Dam in the neighbouring Berg River catchment. Other water sources are the Cape Flats Aquifer (about 2%) and Paardeberg Dam. The catchment includes a large number of small to moderate sized farm dams.

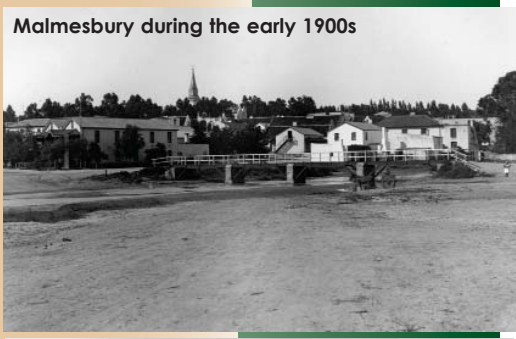
About 95% of the area has waterborne sewage systems with the remainder being served by septic tanks and soak-aways. Three wastewater treatment works discharge into the Diep River at Milnerton, Kraaifontein and Malmesbury. Vissershok Landfill Site receives hazardous waste, while there are also a number of general waste sites in the catchment.

Historical Background

1888 (Archives, Cape Town)

Development of the lower Diep River can be traced back to 1608. Maps from more than 200 years ago show that the lower section of the estuary joined the adjacent Liesbeek and Black rivers. As the name implies, the Diep River was deep enough for sailing and fishing boats to make their way upstream to the Dutch East India Company's (DEIC) post at Vissershok. Vissershok was established in 1683 by the DEIC as its furthermost outpost from Cape Town. It served as a cattle station and wheat growing area for the town. Paarden Eiland got its name from the wild horses ("paarden" being the Dutch word for horses) on one of the islands near the river mouth.

From 1699, the DEIC permitted livestock grazing in the catchment. This led to the establishment of cattle posts and farming communities. As the demand for grain increased, wheat farmers joined the livestock farmers. Kalbaskraal was named after the calabashes that were grown for making tobacco pipes. Oat hay was also harvested on smallholdings and farms around the estuary until the 1940s.


Malmesbury during the early 1900s

The area around Malmesbury was originally inhabited by Khoisan. Colonialists settled around a warm mineral spring which was developed as a spa and visited for the treatment of ailments such as rheumatism. This area became known as Swartlandskerk when the first congregation of the Dutch Reformed Church was established in 1745. The town was officially proclaimed in 1829 and renamed Malmesbury.

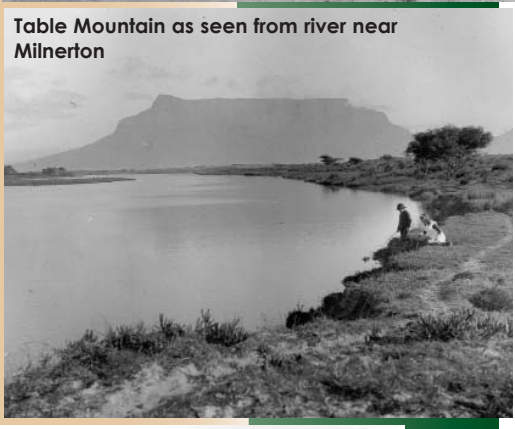


Table Mountain as seen from river near Milnerton

Mid-nineteenth century survey maps of Rietvlei Wetland and the lagoon show that the area was silting up and the mouth had separated from the Salt River. Steam dredgers employed in 1905 deepened parts of the Milnerton Lagoon for rowing regattas, but by the late 1920s siltation had seriously curtailed boating activities. In 1928, a weir was constructed across the river mouth to control water levels. Two substantial floods in 1941 and 1942 demolished this structure.

During the early 1960s and mid-1970s large road embankments and a bridge were built in Rietvlei as part of the West Coast freeway development. During this time dredging of Flamingo Vlei was undertaken to provide fill for the Cape Town harbour. A canal was constructed in 1991 -1992 to prevent treated sewage effluent from the Potsdam Wastewater Treatment Works from polluting Rietvlei Wetland. This canal permanently disconnected the wetland from the Diep River. Rietvlei is now replenished only when the riverbanks overflow during heavy winter rains.


Milnerton during 1904 - 1905

DIEP RIVER PRESENT STATE

RIEBEEK

P-F | F | P | F | G | G

Desired health: Good

KALBASKRAAL

P-F | F | P | F | F | F

Desired health: Fair

KLIPHEUWEL

P-F | F | P | P | P | P

Desired health: Fair

GOEDEONTMOETING

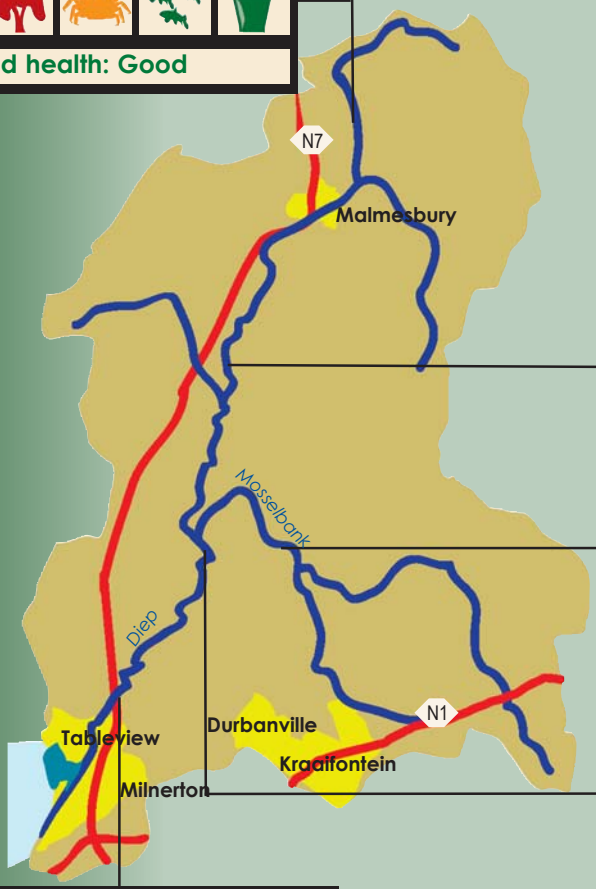
P-F | P | P | P | F | F

Desired health: Fair

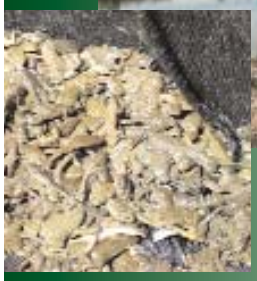
N7 BRIDGE

P-F | F | F | P | F | F

Desired health: Fair



Major Impacts and Management Actions



Dams

The cumulative effect of water storage and water abstraction have modified river flow. During summer, flows are reduced, water temperatures rise and dissolved oxygen levels decrease. Poor water quality causes diseases in fish and loss of sensitive invertebrate species. Common platannas (see p 29) adapt to these conditions and thrive in the river pools.

Removal of Indigenous Vegetation

Farming practices along the river bank disturb natural vegetation and result in alien vegetation infestation. Alien trees (e.g. river gum) use large amounts of water throughout the catchment.

Riverbed Modification

In the lower reaches, sand mining and other disturbances of the river channel and river bed cause erosion and increased sedimentation.
Alien trees confine the river bed, resulting in incised channels, especially at Kalbaskraal. Natural pools, refuge areas for fish, have been lost due to river channelling.

Urban and Agricultural Development

Treated wastewater from urban areas and agricultural runoff (e.g. dairy industry) cause nutrient enrichment and reduce water quality in the Diep River.

Alien Fish

Alien fish (e.g. carp, banded tilapia and mosquitofish) thrive in the stagnant eutrophic pools of the Diep River, preying on and competing with indigenous fish.

Management Actions

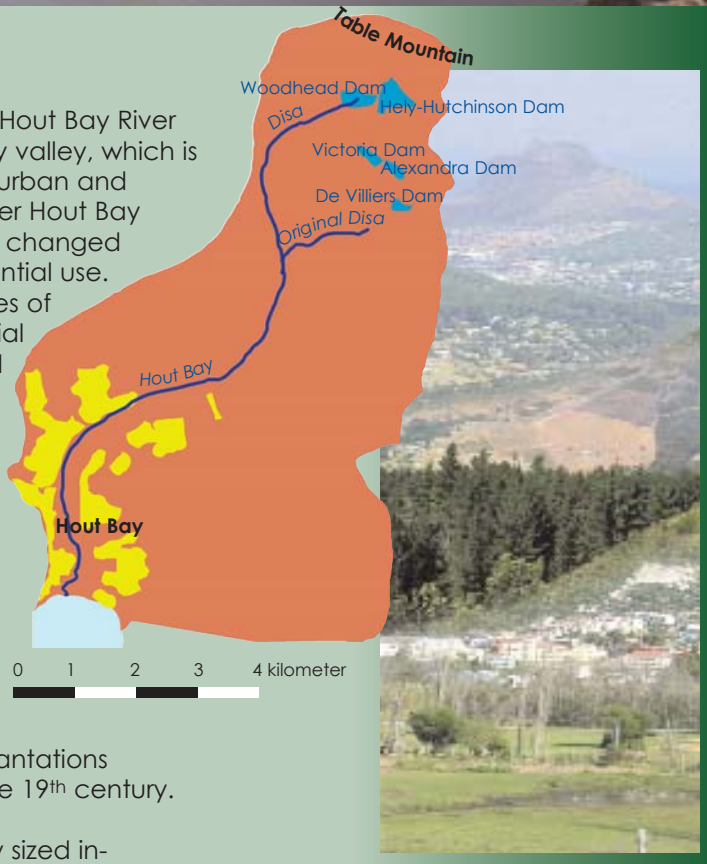
- **Improve land-use practices (e.g. farming) to reduce sedimentation and water quality problems**
- **Restore riparian zone by reintroducing indigenous riparian vegetation**
- **Clear invasive alien plants, particularly river gum trees, along the river channel**
- **Improve monitoring and management of runoff from urban and agricultural areas**
- **Ensure that newly built dams make environmental flow releases**

Hout Bay River Catchment

The Disa and the Original Disa originate on Table Mountain at an altitude of 720m amsl. These streams join in the Orange Kloof area within the Cape Peninsula National Park to form the Hout Bay River. This river is about 12km long and is typical of many rivers of the fynbos biome in that it is short, steep and fast flowing, with naturally acidic, tea-coloured waters.

Extensive reed beds flank the lower river as it meanders through farmlands and residential areas before it widens into a small lagoon which discharges into Hout Bay.

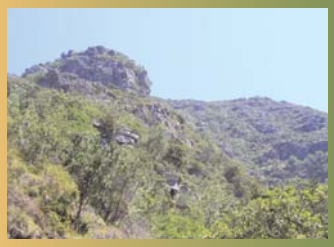
The lower reaches of the Hout Bay River flow through the Hout Bay valley, which is dominated by large peri-urban and urban properties. The lower Hout Bay catchment has gradually changed from agricultural to residential use. Hout Bay Village comprises of residential and commercial development, the informal settlement Imizamo Yetho, and gardens and horse paddocks that extend to the river's edge.



Indigenous trees were once abundant in the moist river valleys. SANParks and UKUVUKA, the Operation Firestop Campaign, are busy clearing the alien pine plantations established during the late 19th century.

There are five moderately sized in-stream dams (right)and a number of small dams in the catchment. Primary treated wastewater from the area is released into Hout Bay via a deep-sea outfall.

Cape Peninsula National Park



Cape Peninsula National Park, proclaimed a protected area in 1998, covers about 29 000ha of the Cape Peninsula mountain chain, including the renowned Table Mountain World Heritage Site. The Park is globally renowned for its extraordinarily rich, diverse and unique flora and fauna (described on p 11 and p 28 - 31) and its spectacular beauty. After many years of fragmented conservation management, the Park is now managed by SANParks.

The Orange Kloof area (285ha) forms part of the Park. Access to this sensitive catchment area is strictly controlled. The indigenous fynbos vegetation and some of the most impressive afromontane forests in the Cape Peninsula are protected here.

Historical Background

The name Hout Bay refers to the abundance of indigenous trees that once occurred in the river valley. Before development, the Hout Bay River was deep and wide enough for rowing boats to be taken about a kilometer upstream from the mouth and the catchment's forests that were said to be "the finest in the world". The lower reaches of the river were braided and flowed through an extensive palmiet (*Prionium serratum*) and reed marshland.

Agricultural development began in the catchment in 1677 when Governor Simon van der Stel leased the first land for such purposes. By 1681, Kronendal and Ruiteplaats were granted as freehold farms and by the mid-19th century, wine, vegetables, meat and milk were sold locally and to passing ships. An outbreak of phylloxera, a vine disease, caused a shift in agriculture from vineyards to market gardening. Vegetables produced for Cape Town became a profitable concern and an increasing amount of land was used for agriculture.

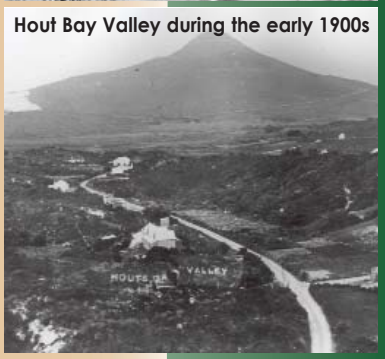
The Hout Bay River was an important water resource for Cape Town over 100 years ago. Firstly, the 640m long Woodhead Tunnel was built between 1888 and 1891 to divert the Disa stream to the western slopes of Table Mountain. The Woodhead Dam was then built on the Disa stream in 1897, followed by the Hely-Hutchinson Dam further upstream in 1904. The Woodhead Dam was the first stonemasonry dam built to store water for Cape Town. Alexandra and Victoria dams were built on the Original Disa stream in 1903, followed by the De Villiers Dam built further downstream in 1907. These dams served as an additional water storage and supply facility for Wynberg. These five dams now supply less than 15% of Cape Town's water requirements.

Large-scale harvesting of indigenous forest for homes, industry or firewood in the upper catchment and removal of palmiet and reed beds in the naturally wide floodplain has lead to severe erosion and flooding problems along the middle and lower reaches of the river. The Longkloof weir was constructed in the early 1960s and reconstructed in 1994 to alleviate these problems.

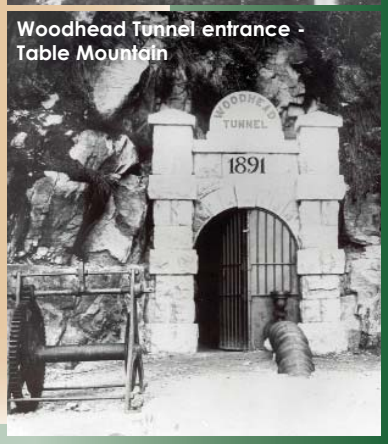
When farming activities were reduced in the 1960s, the disturbed land rapidly became infested with alien vegetation. Numerous pine plantations were also grown in the Orange Kloof area until the end of the 1950s when indigenous vegetation was allowed to re-establish itself.

1785 (Archives, Cape Town)

Cyclists crossing Hout Bay River - ~1900

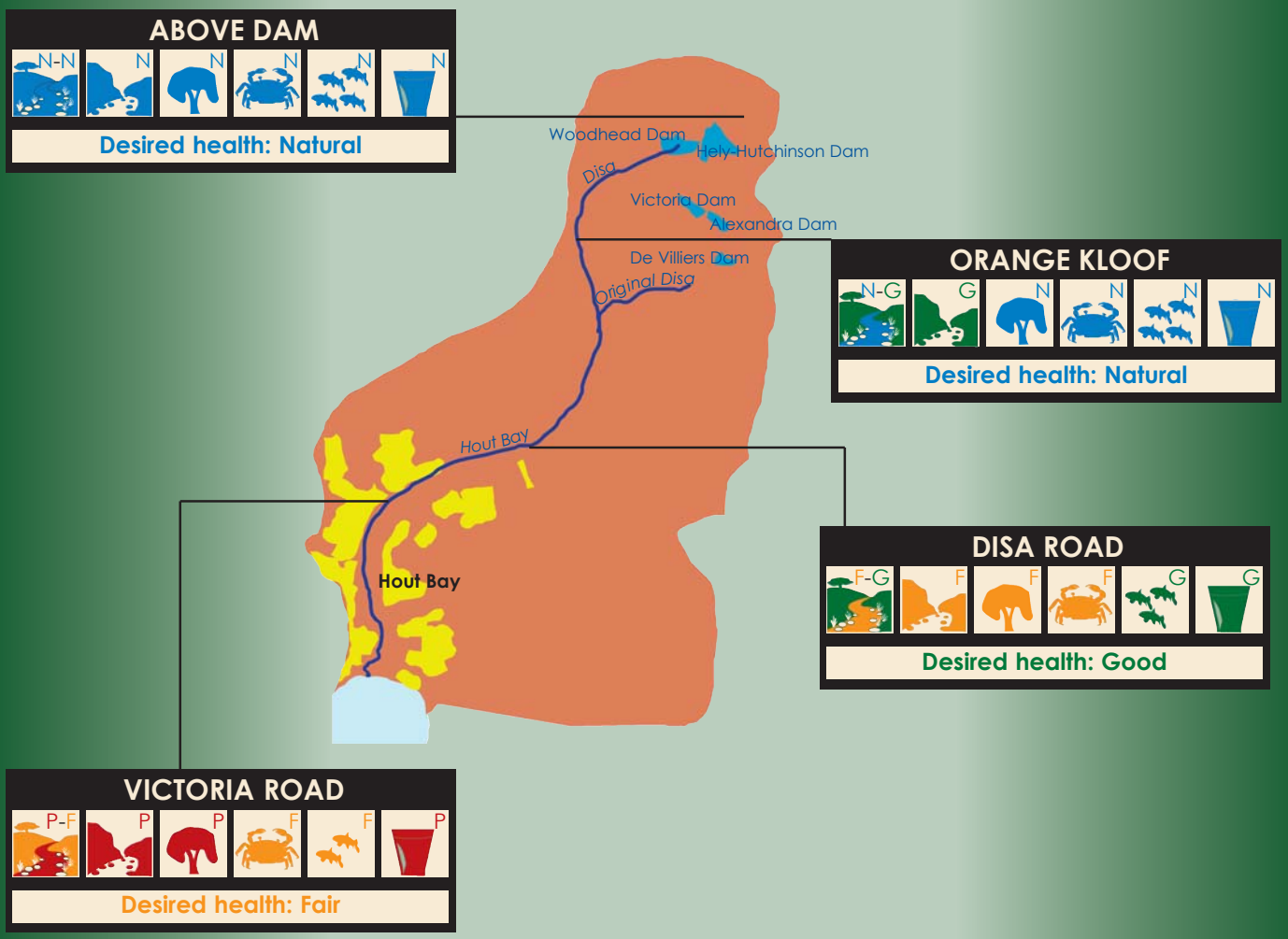


Hout Bay Valley during the early 1900s



Woodhead Tunnel entrance - Table Mountain

Hout Bay River Present State



Major Impacts and Management Actions

Dams and Weirs

Dams reduce the natural river flows in the upper reaches. Tributaries below the dams restore the natural flow regime. The Longkloof weir, a concrete structure, canalises the river for a limited stretch and restricts the natural function of the river.

Alien Vegetation

Alien vegetation is a growing problem in the middle and lower reaches, contributing to the instability of the river banks. Reeds have proliferated in the lower reaches due to elevated nutrient loads and reduction in flow. They clog the channel and hold back flood waters, requiring continual maintenance.

Peri-urban and Urban Development

Small dams and abstractions for livestock watering and garden irrigation have drastically reduced summer flow in the lower reaches. Runoff, storm water discharges and seepage from septic tanks reduce the water quality in the lower reaches. Low flow and poor water quality closer to the estuary result in the disappearance of pollution-sensitive invertebrates and Cape galaxias (see p 29). High faecal coliform counts have been recorded sporadically, indicating faecal contamination from sewage.

Erosion and Levees (Floodbanks)

Palmiet shrubs were once abundant in the lower reaches. Cultivation resulted in the removal of palmiet along the river banks, increasing erosion and causing deposition of large amounts of sediment in the river and estuary. Removal of this sediment by dredging has straightened the course of the lower river.

Levees have been constructed on either side of the river channel from Victoria Road bridge to the estuary to prevent flooding of adjacent lands. These levees canalise the river, intensify flood flows, disrupt the natural ability of the floodplain to absorb flood water, extend flood damage when river banks are overtopped and result in increased levels of siltation.

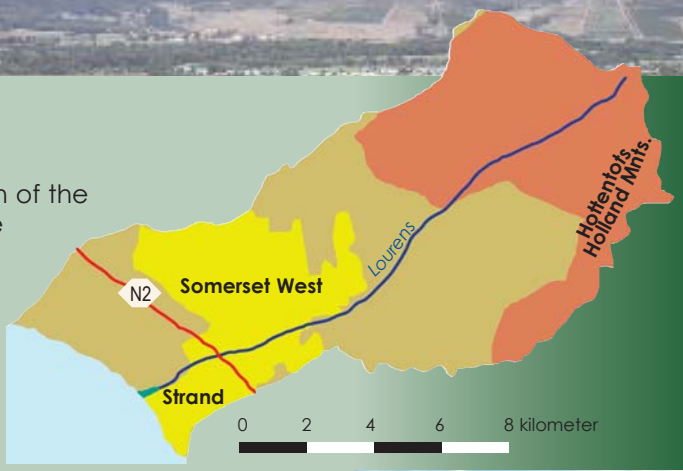
Management Actions

- **Ensure that instream dams release environmental flows**
- **Restore wetland function of the floodplain by re-introducing palmiet and other indigenous wetland species**
- **Develop walkways and horse trails that do not destabilise river banks**
- **Clear alien vegetation in the riparian zone and re-introduce indigenous riparian species**
- **Identify and manage the major sources of water pollution**

Lourens River Catchment

The Lourens River and several minor tributaries rise in the Hottentots Holland Mountains at an altitude of more than 1 110m amsl. The river flows in a south-westerly direction for almost 20km before passing through Somerset West and entering False Bay at Strand beach where it forms a small estuary.

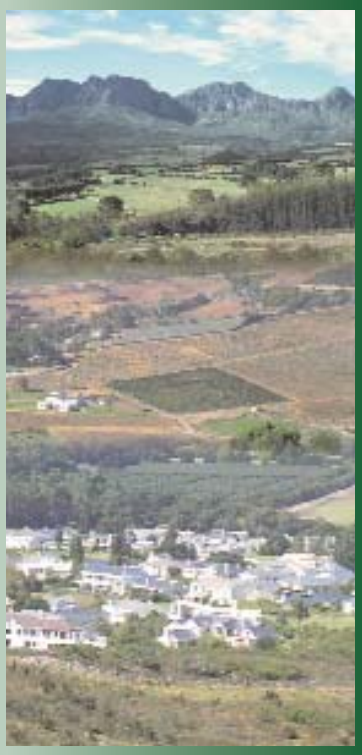
The upper reaches of the catchment are situated within the Helderberg and Hottentots Holland Nature Reserves.



Natural fynbos vegetation of the upper catchment outside the reserves has largely been replaced by forestry and agriculture (predominantly orchards and vineyards). In the lowland area, including the coastal plain down-stream of Somerset West, the natural coastal renosterveld vegetation has been replaced by urban development.

More than 90% of the bulk water supply to Somerset West and Strand is from the Steenbras Dam, with the remainder being abstracted from the Lourens River and boreholes. Wastewater from Somerset West and Strand is treated at the Macassar wastewater treatment works near the mouth of the Eerste River. The Dick Dent Bird Sanctuary, incorporating the old maturation ponds of Strand Sewage Works, is situated on the banks of the lower river.

There are no major in-channel dams along the Lourens River, only a number of farm dams in the tributaries. Surplus winter flows are stored in the dams for use in summer when flow in the river is low.



Lourens River Flood Alleviation Measures

Severe flooding in the Lourens River area prompted the City of Cape Town to implement the Lourens River flood alleviation measures in three phases.

Phase 1 entails reconstruction of riverbanks, removal of alien vegetation, litter and fencing, replanting of indigenous vegetation, with the aim of accommodating a one-in-five-year flood (120 cubic metres per second).

Phase 2 entails building a diversion canal to accommodate a one-in-twenty-year flood (240 cubic metres per second).

A flood attenuation dam at Radloff Park is planned for **Phase 3**.

The first phase is already nearing completion. Plans are currently underway to implement Phases 2 and 3.

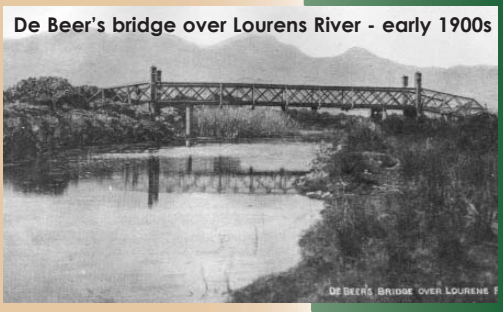
Historical Background

The Hottentots Holland area was named after its original inhabitants, the Khoikhoi people. The Khoikhoi grazed their livestock in this area and were so full of praise for the land that the Dutch nostalgically called it Hottentots-Holland. The Europeans 'bought' the land from the Khoikhoi and established farms in the area. Vergelegen, meaning "far away", one of the first farms in the area, was established by then Governor Willem Adriaan van der Stel in 1700. After he was called back to Holland during 1709, Vergelegen was subdivided into three farms, one of which is today known as Lourensford. The main land-use on these farms is vineyards. Early maps suggest that the river had a delta (see right), with a second flood channel starting just downstream of Radloff Park and entering the sea near Gordon's Bay. This second flood channel has long since been hidden by agriculture and urban activities.

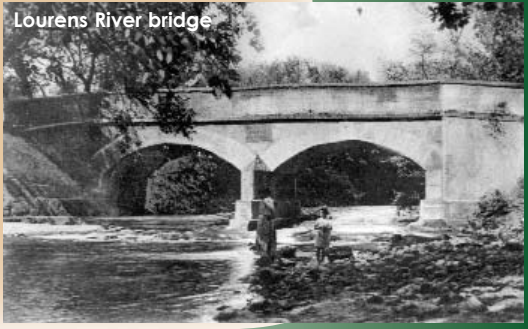
~1790 (Archives, Cape Town)

During the late 17th century the Lourens River was known as the "Tweederivier", as it was the second river crossed by the early European colonists during their travels eastward. In the early 18th century, the river became known as the Laurens River after a person of that name drowned in it. The spelling of the name has since changed to Lourens. Farmers have been using the Lourens River for irrigation since the early 18th century. The Melcksloot canal was also dug in the late 18th century by Martin Melck to supply Paardevlei, a shallow vlei, with water where he farmed springers (the flathead mullet, *Mugil cephalus*).

In 1817, a church was built in the lower reaches of the Lourens River and led to the eventual establishment of the town, Somerset West, in 1820. With the resultant increasing development in the area, the Lourens River became a source of irrigation water for crop farming (mainly fruit) in the catchment. Piped water systems (with associated off-take weirs along the river) were introduced with the formation of municipalities in the towns of Strand (1897) and Somerset West (1903). The extensive system of irrigation furrows is still in use today. In 1903, Paardevlei became part of the water supply system to Cape Explosives Works Limited (now known as AECI) and was enlarged to its present area of 50ha, with a capacity of 1.4 million cubic metres.

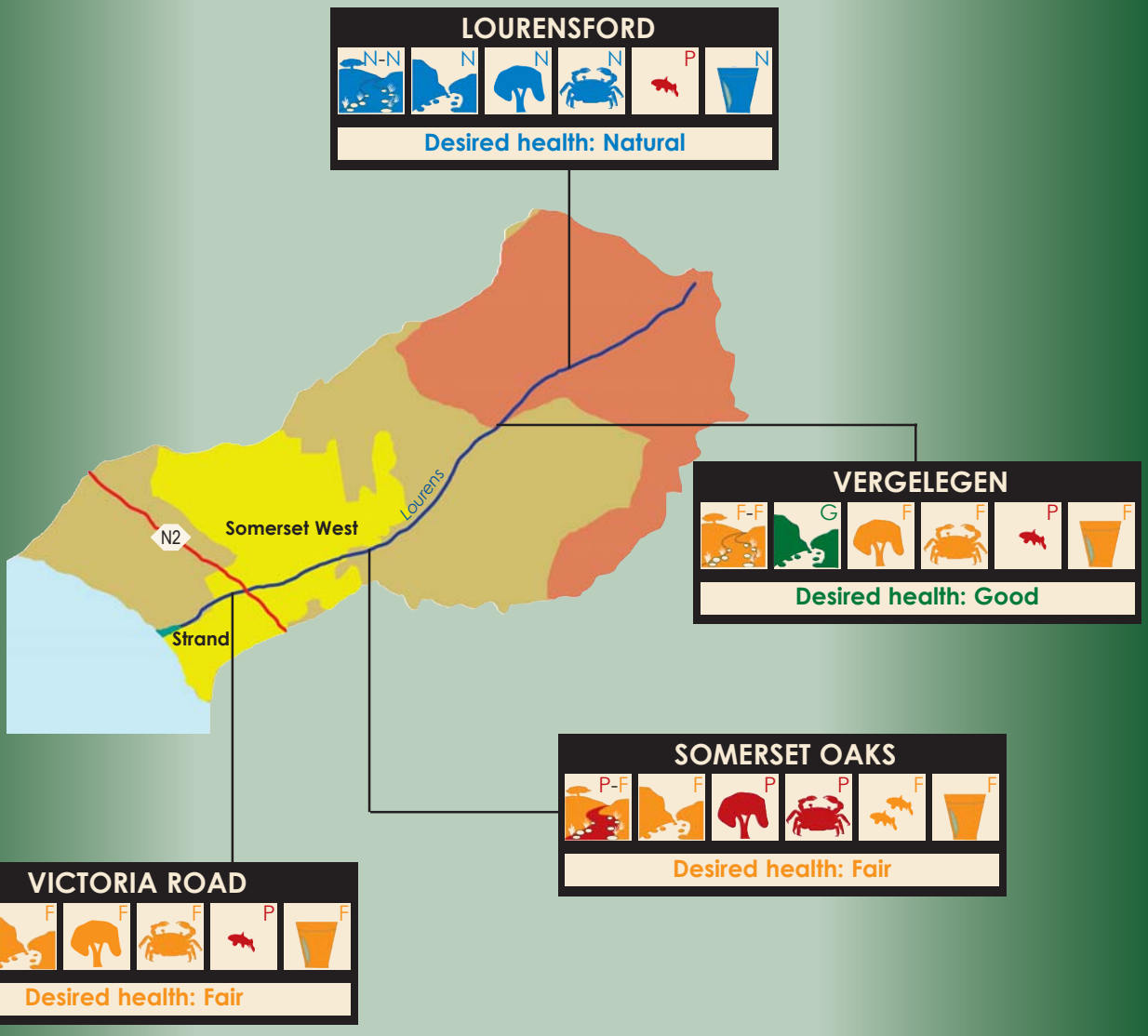


De Beer's bridge over Lourens River - early 1900s


Lourens River bridge

The use and management of the Lourens River has been influenced by various forms of legislation. A Water Court order of 1936 ruled how the water of the river should be apportioned amongst riparian owners, including farmers, municipalities and Cape Explosives Works Limited. In 1974, the Lourens River (and the farm dams along its course) became a "trout area" in terms of the Western Cape's Nature Conservation Ordinance No. 19. In 1997, through the efforts of the Lourens River Conservation Society, the Lourens River, from its headwaters to the sea, became the only complete river in South Africa to be declared a Protected Natural Environment. The protected area extends 45m on either side of the centre line of the river. Trout stocking has since ceased in the Lourens River (p 32).

LOURENS RIVER PRESENT STATE



Major Impacts and Management Actions

Alien Flora and Forestry

The upper reaches of the river are relatively unspoilt, with some impact from commercial plantations.

Removal of natural riparian vegetation along the river banks has resulted in the invasion of alien plants and their ongoing recruitment through seeds dispersed downstream.

Alien vegetation and forestry reduce runoff and hence river flows, especially during summer.

Alien Fish

Alien fish have had a major impact on the indigenous fish communities of the river. In the upper reaches, Cape galaxias is almost absent due to predation by rainbow trout.

Agricultural, Commercial and Urban Development

The middle reaches are exposed to chemical residues from fertilisers and pesticides in the runoff from surrounding farmlands. Potentially toxic levels of pesticides have been recorded in the river which has likely resulted in changes in the aquatic invertebrate community. The water quality in the lower reaches has been reduced largely as a result of storm water runoff from urban, industrial and commercial areas. Poor water quality has led to loss of pollution sensitive aquatic invertebrates (e.g. stoneflies and mayflies).

Dams and Water Abstraction

Farm dams and high levels of water abstraction have reduced the flow of the Lourens River, particularly during summer. The decrease in flow reduces dilution of pollutants and prevents fish from using some of the tributaries as refugia.

River Modification

Alien willow trees growing on the river banks, gabions and infilling have modified and confined the lower reaches. This reduces habitat diversity, resulting in a decline in the number of invertebrate and fish species.

Management Actions

- **Clear alien vegetation along and in the river and maintain cleared areas**
- **Reintroduce indigenous riparian vegetation to act as a buffer between the river and the surrounding agricultural areas**
- **Improve farming practices to reduce polluted run-off into the river**
- **Improve monitoring and management of storm water quality in urban areas**
- **Restore the natural channel shape in the lower reaches**

Palmiet River Catchment

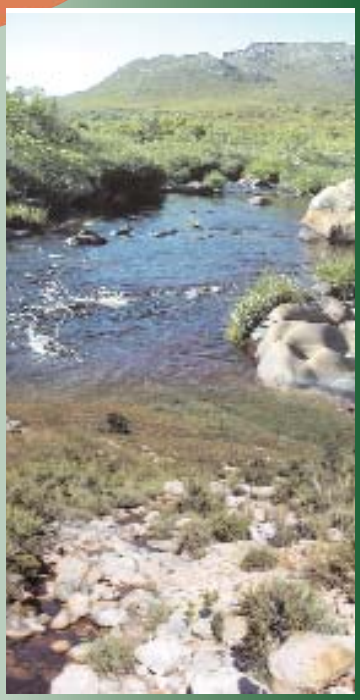
The Palmiet River rises in the Hottentots Holland Mountains at an altitude of 1 010m amsl. The river is about 70km long and fed by 11 perennial tributaries and numerous seasonal streams.

The river meanders south from Nuweberg, through the Elgin Basin where it is joined by the Klein Palmiet and Kromme rivers. It enters the Kogelberg Nature Reserve (see box below) and flows in a south-westerly direction to be joined by the Dwars and Louws tributaries, which feed water of very good quality into the system. The river then flows in a south-easterly direction to discharge into the Atlantic Ocean via a small estuary, near Kleinmond.

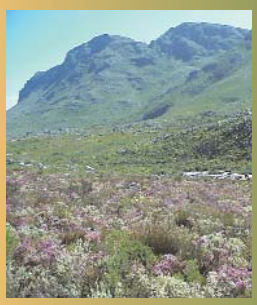
Natural fynbos comprises approximately 45% of the Palmiet catchment. The upper catchment has been largely altered by pine plantations and agriculture (predominantly deciduous fruit), with only a small portion of fynbos remaining in the Nuweberg and Hottentots Holland Nature Reserves.

The waste water treatment works near Grabouw, the only town of significant size in the catchment, discharges treated wastewater into the Palmiet River.

The Palmiet River has five major in-stream dams and a large number of smaller farm dams. Large in-stream dams are the Nuweberg (3.8 million cubic metres), Eikenhof (22 million cubic metres), Applethwaite (3.3 million cubic metres), Arieskraal (5.9 million cubic metres) and Kogelberg (19 million cubic metres) (see p27).



Kogelberg Nature and Biosphere Reserve



The Kogelberg Nature Reserve, in the heart of the Cape Floral Kingdom and the Fynbos Biome (see p 11), is managed by the Western Cape Nature Conservation Board. The habitat and plant diversity of this 240km^2 reserve is spectacular, with more than 1 600 recorded plant species. At least 150 of these species are endemic, including the endangered marsh rose (*Orothamnus zeyheri*) and the highest concentration of mimetes (*Mimetes hirtus*) in the Cape. The endemic freshwater crab (*Potamonautes brincki*) and the endangered micro-frog (*Microbatrachella capensis*) are also found in the area.

The nature reserve forms the sensitive core area of the Kogelberg Biosphere Reserve, the first of its kind in South Africa. The biosphere concept in this area accommodates conservation and development (e.g. agriculture and forestry). This is to ensure that the sensitive areas within the Kogelberg Nature Reserve are adequately protected by a system of buffer areas which are privately owned and managed according to biosphere principles (see p 38).

Historical Background

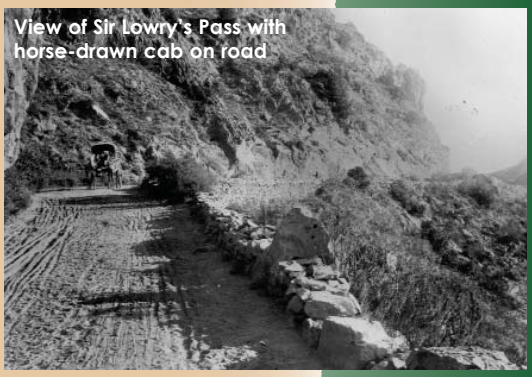
The Khoisan inhabitants knew the Palmiet River as the 'Houtema' or Snake River, either due to its meandering nature or because it was dangerous to cross. The Dutch renamed it the Palmiet after the abundant growth of palmiet shrubs along the river.

During Jan van Riebeeck's time (1652 - 1662), development from the Cape to the interior by-passed the lower Palmiet River. As a result, the area became a refuge for those who wished to escape the notice of the authorities: remnants of Khoisan tribes, escaped slaves, outlaws and even criminals. Early travel reports indicate that the area had a rich variety of wildlife such as buffalo, Cape mountain zebra, eland, Cape lion and hippopotamus. Mountain rhebuck, klipspringer, baboon and leopard still occur here.

Further inland, strong winter flows and extensive palmiet beds made river crossings treacherous. The first rural bridge in South Africa was built in 1811 on the Palmiet River near the town of Grabouw. Completion of Sir Lowry's Pass in 1830 and the road in 1852 provided the impetus for further development in the area. Grabouw itself was established in 1856 as a trading station at the ford across the Palmiet River.

The flourishing deciduous fruit industry in the Palmiet River valley led to the extension of the Sir Lowry's Pass railway line as far as the river in 1902. An access route along the coast was established after 1914 when a footbridge was built across the upper reaches of the estuary and a ferry service established to cross the river. The foot-bridge and ferry were replaced in 1952 when a road bridge was constructed across the head of the estuary.

Elgin Bridge in more recent times



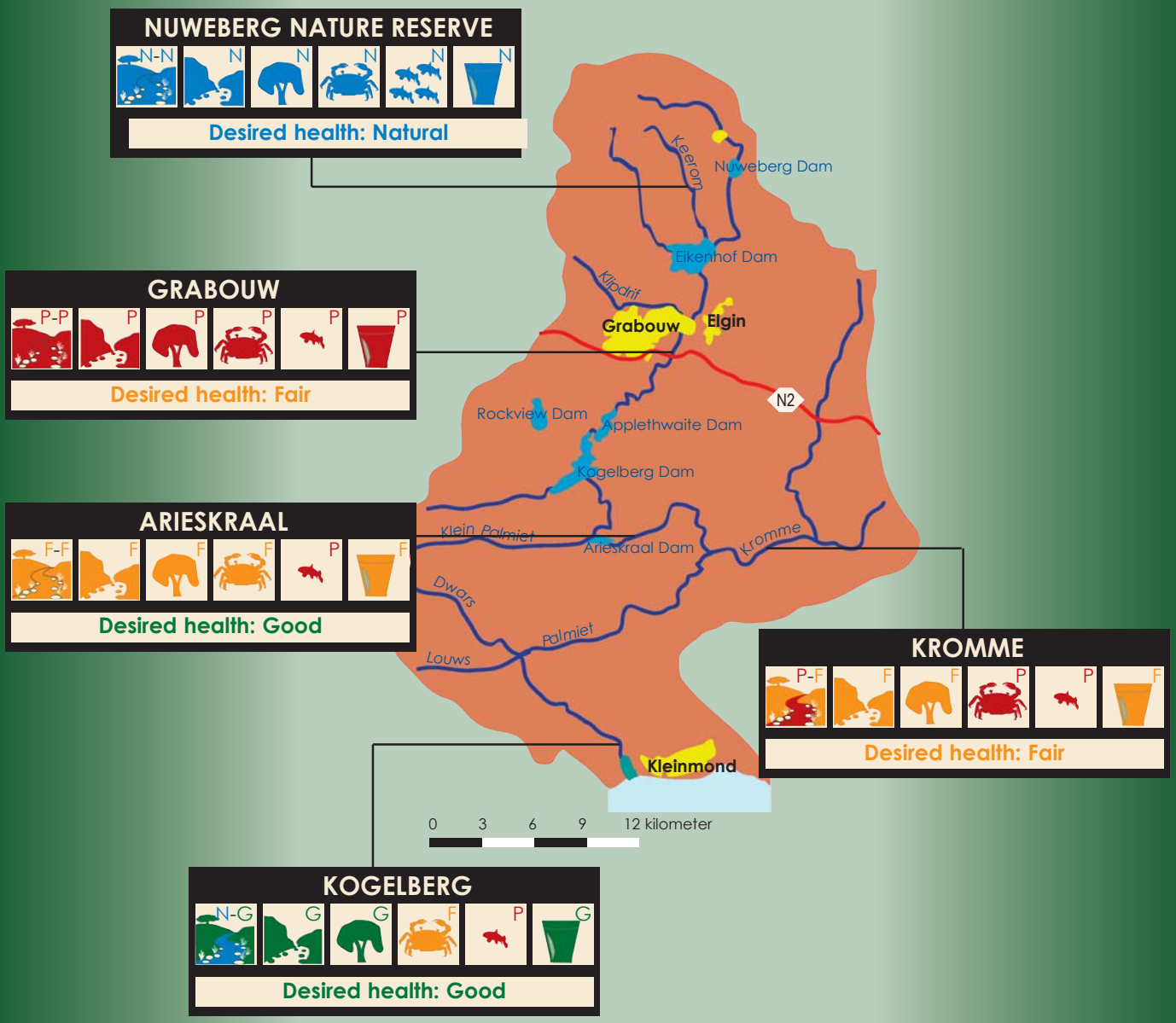
View of Sir Lowry's Pass with horse-drawn cab on road

Elgin Bridge, 1928

Date unknown (Archives, Cape Town)

Elgin Bridge, 1947

PALMIET RIVER PRESENT STATE



Major Impacts and Management Actions

Dams

Dams exert a major control on flow in the upper and middle reaches. Impoundments have severely modified the flow patterns in the river by eliminating most floods and altering the low flow conditions.

Alien Fish

Alien fish (e.g. smallmouth bass) are widespread and common in the middle and lower reaches. They have contributed to the disappearance of Cape kurper and Cape galaxias, two indigenous fish species previously common in the Palmiet River.

Urban and Agricultural Development

Industrial, agricultural and domestic wastewater and runoff near Grabouw result in elevated organic loads in the river, causing eutrophication and low dissolved oxygen levels. Litter in this area is also a problem. No fish and only a few pollution tolerant aquatic invertebrate species (e.g. leeches) were recorded.

Management Actions

- **Ensure that releases from instream dams simulate natural flow patterns**
- **Clear alien vegetation from the riparian zone and restore indigenous riparian vegetation**
- **Control litter and dumping of rubble near Grabouw**
- **Investigate and remediate sources of pollution**
- **Improve farming practices to reduce sedimentation and water quality problems**
- **Encourage removal of alien fish from the lower Palmiet River by anglers**

Impoundments in the Palmiet River

Dams in the Palmiet River are the Nuweberg Dam (mainly used for domestic water supply), the Eikenhof, Applethwaite and Arieskraal dams (used for irrigation), and the Kogelberg Dam which forms part of the Palmiet Pumped Storage Scheme. On weekends this scheme pumps about 16.5 million cubic metres of water from the Kogelberg Dam to be stored in the Rockview Dam. This water is released back to Kogelberg Dam during the week for generation of up to 400 megawatt of power into the National electricity grid. Additional water is also released from Kogelberg Dam via Rockview Dam to the upper Steenbras Dam for use in Cape Town.

Flow releases from four of the dams vary from no releases to constant releases (e.g. Arieskraal Dam which has a bottom outlet pipe which constantly releases water), none of which mimic natural environmental conditions. The Kogelberg Dam, however, is operated according to recommended instream flow requirements.

Fauna of the Diep, Hout Bay, Lourens and Palmiet Catchments

Migrating Mammals and Birds

Rivers and riparian vegetation provide habitat for many plants and animals and allow for their migration. Examples of animals that migrate along the rivers include the Cape clawless otter and the water mongoose. River corridors also facilitate the migration of many water-dependent bird species (e.g. giant kingfisher, ducks, herons and waders).

The red bishop (*Euplectes orix*) is a common and gregarious bird species. The striking colours of the male (left) during the breeding season makes it a recognisable bird in southern Africa. Red bishops form dense colonies in reedbeds near permanent waterbodies. They feed mainly on insects (dragonflies and damselflies) and seeds.

Aquatic Insects of the Fynbos

Most insects have a wide natural distribution, while some have relatively restricted ranges and are associated only with a particular habitat or vegetation type. The fynbos region of the Western Cape supports a unique collection of aquatic insects, many of which do not occur elsewhere in Africa, and have their closest relatives in New Zealand, Australia, South America or Madagascar.

The rivers of the fynbos region are characterised by clear, nutrient-poor, acidic waters, which are often stained brown by humic compounds leached from the surrounding vegetation. This water is the preferred habitat of spiny crawlers (Teloganodidae) (bottom right) and net-winged midges (Blephariceridae) (top right), and in the fast flowing mountain reaches unusual families of caddisflies, such as Barbarochthonidae (top left), Petrothrincidae (left) and Glossosomatidae (bottom left), abound.

Dragonflies

Dragonflies are one of the oldest flying creatures known, with recently discovered fossils dating back 300 million years. The dragonfly nymphs (right) live in water and are highly predatory, sometimes eating prey as large as tadpoles and small fish. They generally live under rocks or in sand and may last for more than one year during this stage of their life cycle. Once adults, they feed on other insects. Mature males are brightly coloured and territorial. The dark dropwing (blue dragonfly), *Trithemis furva*, and the red-veined dropwing (red dragonfly), *T. arteriosa,* are both common in southern Africa. They are found at pools, streams, large rivers and low salinity pans.


Cape kurper


flathead mullet


Cape moony

Fish

The Cape Floral Kingdom is the centre for a distinct 'Cape' component of Africa's freshwater fish fauna. Of its 19 fish species, 16 are found nowhere else. Of these species, only Cape galaxias (*Galaxias zebratus*) and Cape kurper (*Sandelia capensis*) are found in the study area.

Cape galaxias and Cape kurper occur in large numbers in ecologically healthy rivers, i.e. river areas that have diverse habitat, good flow and water quality and that are free of alien fish and plants. These ecologically healthy habitats must be present in all river zones, from source to sea. Habitat degradation and predatory alien fish species, such as smallmouth bass, bluegill and rainbow trout (see Alien fish p 32), threaten the continued existence of both fish species.

Estuary fish species (e.g. flathead mullet, Cape moony and estuarine roundherring) often enter the freshwater reaches of these rivers for feeding and shelter. So do eels (e.g. longfin eel, *Anguila mossambica*), which is common in deep pools of the Palmiet River.

Genetic Diversity of Indigenous Fish

The Diep River is home to a genetically distinct population of Cape galaxias which may be a completely new species. Taxonomic studies are currently being undertaken by scientists at the University of Pretoria's Department of Genetics to determine the status of this species.


Cape galaxias

Frogs and Toads

About 28% of southern African frogs and toads are found in the Fynbos Biome. These include Table Mountain ghost frog, Cape chirping frog, Villier's chirping frog, Cape Mountain rain frog, Cape river frog, Arum lily frog, raucous toad, Cape sand toad and Cape platanna.

The Cape river frog (top left) occurs virtually throughout the Western Cape, especially near permanent rivers, streams and dams. Its diet includes insects, snails, small rodents, snakes and frogs. This species adapts well to man-made habitats such as farm dams.

Two species of platanna are found in fynbos – the Cape platanna (middle left) and the widely distributed common platanna (bottom left). The Cape platanna is confined to seepages and ponds on the south-western Cape coast. This frog is endangered and is threatened by predators, including alien fish, interbreeding with the common platanna and alien vegetation which alters the acidity of its wetland habitat. The common platanna occurs in abundance in the pools of the Diep River, while the stronghold of the Cape platanna is in the naturally acidic pools of the Cape Peninsula National Park.

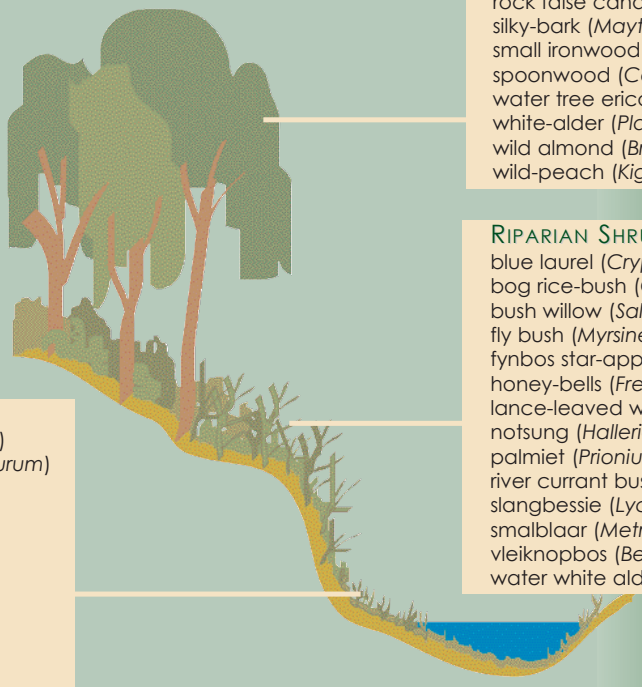
Flora of the Diep, Hout Bay, Lourens and Palmiet Catchments

A healthy riparian vegetation zone contributes to river functioning in many ways. It stabilises river banks; attenuates floods; maintains water quality; recycle nutrients and provides habitat, refuge and migration corridors for fauna. Other services provided by riparian vegetation are wood fuels, building materials and medicines for local communities. The general aesthetic appearance associated with riparian zones increases the environmental quality of the landscape for the well-being of humans.

Indigenous Flora

The vegetation of the study area mainly consists of fynbos (see p 11), interspersed with afromontane forests in the upper catchments. Renosterveld and dune thicket occur along the coast.

The diagram below shows indigenous riparian species commonly found within the Diep, Hout Bay, Lourens and Palmiet catchments:



Riparian Trees

bladder-nut (*Diospyros whyteana*)
Breede river yellowwood (*Podocarpus elongatus*)
Cape holly (*Ilex mitis*)
Mountain cypress (*Widdringtonia nodiflora*)
red-alder (*Cunonia capensis*)
rock false candlewood (*Maytenus oleoides*)
silky-bark (*Maytenus acuminata*)
small ironwood (*Olea capensis*)
spoonwood (*Cassine schinoides*)
water tree erica (*Erica caffra*)
white-alder (*Platylophus trifoliatus*)
wild almond (*Brabejum stellatifolium*)
wild-peach (*Kiggelaria africana*)

Riparian Shrubs

blue laurel (*Cryptocarya angustifolia*)
bog rice-bush (*Cliffortia strobilifera*)
bush willow (*Salix mucronata*)
fly bush (*Myrsine africana*)
fynbos star-apple (*Diospyros glabra*)
honey-bells (*Freylinia lanceolata*)
lance-leaved waxberry (*Morella serrata*)
notsung (*Halleria elliptica*)
palmiet (*Prionium serratum*)
river currant bush (*Rhus angustifolia*)
slangbessie (*Lycium ferrocissimum*)
smalblaar (*Metrosideros angustifolia*)
vleiknopbos (*Berzelia lanuginosa*)
water white alder (*Brachylaena neriifolia*)

Herbaceous Flora

arum lily (*Zantedeschia aethiopica*)
bedding grass (*Pennisetum macrourum*)
bracken fern (*Pteridium aquilinum*)
bulrush (*Typha latifolius*)
fluitjiesriet (*Phragmites australis*)
matjiesgoed (*Cyperus textilis*)
restios (*Ischyrolepis subverticillata*)
rush (*Juncus lomatophyllus*)
sedge (*Isolepis prolifer*)
sundew (*Drosera trinervia*)
wire grass (*Aristida junciformis*)

Palmiet *(Prionium serratum)*

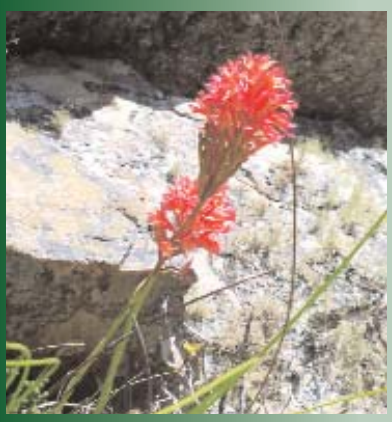
Palmiet (middle top), formerly classified as a species of the rush family, has recently been placed in its own family, the Prioniaceae. This semi-aquatic, woody shrub is endemic to Kwazula Natal and the Western and Eastern Cape. Palmiet plays an important role in fynbos rivers by stabilising the river banks, slowing down flood waters and is a source of shelter and food for river fauna. The leaves of palmiet contain strong fibres and were once used in the plaiting of straw hats.

Wild almond *(Brabejum stellatifolium)*

The wild almond (bottom) is the only African member of the sub-family Grevillioideae of the Proteaceae common to Australia and South America. This tree occurs in sheltered valleys along fynbos streams. In 1660, Governor van Riebeeck planted a wild almond hedge around the Dutch settlement near Kirstenbosch National Botanical Gardens. Remnants of this hedge can still be seen near the gardens.

Other Flora of Interest in the Catchments

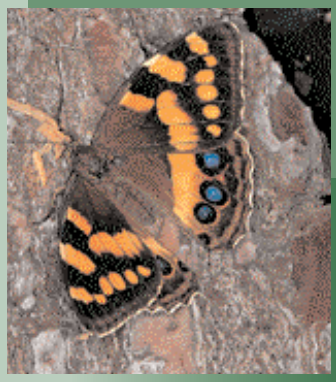
RED DISA *(Disa uniflora)*
This magnificent red orchid is the 'Pride of Table Mountain' and the floral emblem of the Western Cape Province. The plant is distributed widely in damp kloofs and mountain streams of the Western Cape. In earlier times, the disas resembled 'a scarlet blanket' near the Woodhead Dam. Flowers appear in February-March.



CLUSTER DISA *(Disa ferruginea)*
The cluster disa (left) closely resembles the iris *Tritoniopsis triticea*, but unlike the iris does not produce nectar. The plants grow alongside each other in rocky places on Table Mountain, where they grow to about 50cm. The Mountain Pride Butterfly pollinates both species, but gets no reward for its work from the cluster disa. Flowers bloom from February to April.

Delicate Partnerships between Flora and Fauna

The Mountain Pride Butterfly, *Meneris tulbaghia* (below), plays a key role in the ecology of the fynbos by pollinating at least five plant species with large red flowers, namely *Disa uniflora*, *Disa ferruginea*, the nerine or Guernsey lily *Nerine sarniensis*, the iris *Tritoniopsis triticea* and the red crassula *Crassula coccinea*. These plants would face extinction if the butterfly were to disappear.



Restios of the Fynbos

Restios, which belongs to the family Restionaceae, are colloquially known as Cape reeds ("biesies") or thatch ("dakriet"). They form one of the most important structural components of the fynbos. There are some 480 species of Restionaceae globally, occurring mainly in southern hemisphere countries. Of these, about 330 species are found in the Cape Floral Kingdom. The greatest richness of its species is in the Kogelberg Nature Reserve (see p 24). A few of its members are restricted to riparian habitats (e.g. *Calopsis paniculata, Elegia capensis* (left), *Ischyrolepis subverticellata* and *Rhodocoma capensis*).

Restios were probably used as brooms and as building material by the indigenous people of the Cape, long before the first European settlers arrived. Their stems are still bundled together and used as roofing material, as well as for the walls of huts. Recently, a thriving export business has developed with Germany being a lucrative export market.

Alien Fauna in the Catchments

Alien Fish

Fish from other countries (e.g. smallmouth bass from the USA) and provinces (e.g. Mozambique tilapia from Mpumalanga) were produced at the Jonkershoek hatchery outside Stellenbosch in the early to mid-1900s to satisfy the demand of anglers. The large alien fish species provided good recreational and subsistence fishing opportunities. Smaller alien fish species served as forage fish for alien bass (banded tilapia) and helped to control mosquito larvae (mosquitofish).

Alien fish were then stocked in large numbers in the rivers and dams of the Western Cape and many found the conditions very favourable. The local small freshwater fish had evolved in rivers without predatory fish such as smallmouth bass and without large competitors such as carp. Following the introductions, densities of Cape kurper and Cape galaxias declined sharply and they have disappeared completely in several areas, such as the Palmiet River in the Kogelberg Biosphere Reserve. Alien fish that are pollution tolerant (e.g. carp) thrive when rivers become polluted. The loss or reduction of indigenous fish in the Diep, Hout Bay, Lourens and Palmiet rivers reduces the overall biodiversity of these rivers and also impairs their ecosystem functioning.

Alien Fish Species	Diep	Hout Bay	Lourens	Palmiet
Bluegill (*Lepomis macrochirus*)				x
Carp (*Cyprinus carpio*)	x		x	
Mosquitofish (*Gambusia affinis*)	x	x	x	
Banded tilapia (*Tilapia sparrmanii*)	x		x	
Mozambique tilapia (*Oreochromis mossambicus*)	x			
Rainbow trout (*Oncorhynchus mykiss*)			x	
Smallmouth bass (*Micropterus dolomieu*)				x

x denotes species recorded in catchment


Mozambique tilapia


mosquitofish


bluegill


carp


banded tilapia


smallmouth bass

Trout in the Lourens River

Historical records indicate that at least three indigenous fish species were present, namely Cape kurper, Cape galaxias and Berg River redfin. The kurper and galaxias still occur in the middle and lower reaches, while the Berg River redfin is locally extinct. Noted fish biologist Arthur Harrison recorded its occurrence in the Lourens River but did not collect a museum specimen, causing some to doubt the identification. In the nearby Eerste River, the species fell victim to the predations of introduced rainbow trout in the late 1800s, and became extinct in that river during the mid-20th century. Rainbow trout were introduced from the Jonkershoek hatchery to the Lourens River at the same time, very likely with the same devastating effect on the Berg River redfin.


rainbow trout

While rainbow trout still flourish in the clear, unpolluted upper reaches of the river, providing an important source of recreation for anglers, trout stocking ceased when the river became a Protected Natural Environment.

Alien Flora in the Catchments

Alien Vegetation Control

Biological control of invasive alien vegetation using insects and fungi is a long-term, self-sustainable and environmental-friendly mechanism to slow the spread of invasive weeds and reduce re-invasion into cleared areas. Biocontrol programmes exist against a number of the alien plants occurring on our river systems. In many cases the use of biocontrol has overcome conflicts of interest between those utilising these plants (i.e. furniture production, firewood, paper pulp and tannin) and those who want to eradicate them. In these cases the selection of biocontrol agents has been restricted to seed-reducing agents only. Thus, adult plants remain, but the build up and spread of new populations by seedlings is reduced. Biocontrol plays an important role in long-term management of alien weeds, but does not eliminate the need for continuing manual eradication to control alien densities of the species.

Alien Plant Species	Diep	Hout Bay	Lourens	Palmiet
Australian cheesewood (*Pittosporum undulatum*)			x	
Barnyard millet (*Echinochloa crus-galli*)		x		
Black wattle (*Acacia mearnsii*)	x	x	x	x
Blackwood (*Acacia melanoxylon*)		x	x	x
Camphor (*Cinnamomum camphora*)			x	
Castor-oil plant (*Ricinus communis*)	x	x	x	
Cluster pine (*Pinus pinaster*)		x	x	x
Cocklebur (*Xanthium strumarium*)	x	x	x	x
Elephant's ear (*Colocasia esculenta*)			x	
Golden wattle (*Acacia pycnantha*)				x
Grey poplar (*Populus canescens* hybrid)		x	x	x
Hyacinth (*Eichhornia crassipes*)	x	x		
Kikuyu grass (*Pennisetum clandestinum*)	x	x	x	x
Knotgrass (*Persicaria lapathifolium*)		x	x	x
Lantana (*Lantana camara*)		x		
Longleaf wattle (*Acacia longifolia*)		x	x	x
Oak (*Quercus robur*)	x	x	x	
River gum (*Eucalyptus camaldulensis*)	x	x	x	x
Pampas grass (*Cortaderia selloana*)				x
Port jackson (*Acacia saligna*)	x	x	x	x
Sesbania (*Sesbania punicea*)	x	x	x	x
Spanish reed (*Arundo donax*)		x	x	
Stink bean (*Paraserianthes lophantha*)		x		x
Weeping willow (*Salix babylonica*)		x	x	x

x denotes species recorded in catchment

Some examples of insects and pathogens that have been successfully introduced into South Africa to control the spread of alien vegetation are given below:

- Seed-feeding weevils (*Melanterius* sp.) (right) can reduce seed production by as much as 95% in seven of the eight most invasive Australian *Acacia* species namely black wattle, port jackson, longleaf wattle, rooikrans, blackwood, silver wattle and green wattle.

- Wasps (*Trichilogaster* sp.) (right) help control longleaf wattle and golden wattle by reducing seed production and weakening the plant. This form of biological control can lead to the eventual death of the plant.

- The rust fungus (*Uromycladium tepperianum*)(right) reduces reproductive and vegetative growth of port jackson. The resulting large knobbly galls drain nutrients and lead to the death of the plants.

Brazilian Glory Pea

(Sesbania punicea)

Sesbania is thought to have arrived in South Africa more than 50 years ago. This legume from Argentina and Uruguay was widely planted as an ornamental, but spread at a phenomenal rate along streams in fynbos. A survey of the Western Cape lowland rivers in the early 1980s showed this species to be present along nearly two thirds of the rivers sampled.

ESTUARIES

Estuaries are not only directly influenced by human activities such as over-exploitation of fish and waste discharges, but also indirectly through activities taking place in the catchment. Storage and abstraction of water within the catchment reduce the amount of fresh-water reaching the estuary, and the estuary becomes more saline. Waste discharge affects estuarine water quality and erosion in the catchment leads to deposition of silt in the estuary.

ESTUARIES are unique habitats where rivers interact with the sea to varying degrees. The opening and closing of estuaries are seasonal events, and most estuary mouths on the South African coast close for a period of time during the year.

Estuaries provide many goods and services. Examples include food and bait collection; nurseries and refugia for fauna; tourism and recre-ation; cultural and spiritual activities; and materials for craftwork.

The **Diep Estuary**, also known as Milnerton Lagoon, follows a narrow winding channel that links the Diep River / Rietvlei system to the sea at Milnerton.

Length: 1 250m
Width: 150m
Depth: ~1.5m below mean sea level

The DIEP RIVER ESTUARY was once a nursery area for many estuarine and marine fishes, such as flathead mullet, leervis and elf. Now, it is in decline and gobies, white steenbras and stumpnose have all but disappeared.

Impacts affecting Diep River / Rietvlei system include: bank stabilisation; reduced runoff; dredging; sewage and storm water discharge; sedimentation from catchment; road bridges; industrial wastewater and litter.

RIETVLEI

Rietvlei, a 660ha freshwater wetland, is important on a regional, national and interna-tional scale. The wetland has a diversity of habitats, including an artificial freshwater lake (Flamingo vlei), shallow seasonally inundated pans, reedbeds and riverine habitats. These provide feeding, roosting and breeding habitat for migrant birds.

The wetland is the largest of all temporary vleis in the southwestern Cape and is seen as the most important area for waterbirds in the region. Over 105 bird species have been recorded, including the rare yellowbilled stork, damara tern, white pelican, caspian tern and little bittern. The wetland also provides an excellent nursery for southern and flathead mullet, as well as refugia for Cape galaxias and Cape kurper. Human disturbance has led to a decline in bird and fish numbers recorded.

The wetland was declared a Protected Natural Environment in 1989. The World Wildlife Fund, with financial assistance from Caltex, has purchased much of the wetland. Rietvlei Wetland Reserve was established in 1993, is planned to become a Provincial Nature Reserve, and is currently awaiting recognition as a Ramsar wetland site.

The HOUT BAY ESTUARY supports 14 species of birds including pied, giant and malachite kingfishers, terns, gulls and cormorants. The estuary also supports a small number of fish species such as southern mullet and gobies.

Impacts affecting Hout Bay Estuary include: bank stabilisation and flood levees; urban development; reduced runoff; sedimentation; stormwater discharge and litter.

The **Hout Bay Estuary** varies seasonally from a closed, brackish system with little inflowing water in summer to an open, more saline system due to an increase in tidal penetration through an open mouth caused by higher river flows in winter.

Length: 500m
Width: 20-40m
Depth: <0.5m below mean sea level

The biodiversity in the LOURENS ESTUARY is high, with 29 bird species and 18 fish species recorded. Biodiversity highlights are roosting sites for terns and the African black oystercatcher, a Red Data species. The majority of the fish species present rely completely or partially on the estuary for their survival. They include white steenbras, estuarine roundherring, and freshwater mullet.

Impacts affecting the Lourens Estuary include: bank stabilisation; agricultural and stormwater runoff; sewage pump station failures; storm water runoff; changes in runoff and alien fish (e.g. carp).

Plans are to include the estuary in a Marine Protected Area that would extend towards the Eerste River Estuary.

The **Lourens Estuary** is saline during summer and becomes less saline during winter as the freshwater input from the river increases. The estuary periodically closes in summer due to low river flow, with a sand bar forming across its mouth.

Length: 300m
Width: 30-40m
Depth: 1.5m below mean sea level

The PALMIET ESTUARY serves as an attractive gateway to the unique and species rich Kogelberg Biosphere Reserve (see p 24). Twenty-four waterbird and 21 fish species occur in the estuary. Nearly all of the fish species are partially or completely dependent on estuaries (e.g. white steenbras, estuarine roundherring and leervis). Three eel species (longfin eel, African and Madagascar mottled eels) use the estuary as a migration corridor for spawning and recruitment.

Impacts affecting the Palmiet Estuary include: runoff reduction and sedimentation.

The **Palmiet Estuary** is almost permanently open. In summer, the sea has a greater influence on flow patterns in the estuary, while in winter river flow is more important.

Length: 1 600m
Width: 280m (widest point)
Depth: 2-7m below mean sea level

ESTUARY HEALTH

The qualitative assessment of estuary health on these pages highlights the characteristics, benefits and environmental pressures relating to the estuaries of the four rivers in this report. Ideally, estuaries need to become the subject of a formal process along the lines of the River Health Programme, to encourage effective planning and operational management.

Management Issues

Management Actions

The needs and priorities for management intervention can be determined once we know what the present and the desired health of a river is. **Management action** refers to what is being done, whether current actions are effective and what should be done further to improve river health. Management actions may include policies, national and local management strategies or specific initiatives regarding the management of natural resources in general, and aquatic ecosystems in particular.

New legislation provides for formal structures and processes for integrated water resource management at a catchment and local level, through the establishment of catchment management agencies and strong user representation.

How to Get Involved

Catchment management agencies provide a forum for government authorities and stakeholders to work towards a consensus on the management and development objectives for a catchment. The active co-operation of water users is of the utmost importance in maintaining a healthy environment.

The City of Cape Town officially arranges catchment management forum meetings to serve as an interface between the public as well as non-governmental organisations and the city's officials. This focussed and dedicated contact has, in the recent past, influenced decision-making with regard to urban rivers. "Friend" groups and other interested and affected parties are encouraged, through acknowledged organisations, to actively participate in catchment management forums.

Land-owners and local interest groups can also work closely with their local nature conservation office.

MiniSASS

MiniSASS can be used by the public to measure the basic water quality and health of a river. It is a minitiature version of the more sophisticated SASS method that has been used for this report (see p 5). The results of MiniSASS have been tested against SASS to ensure that they are sufficiently close to the real value to be accepted as a real contribution to river management, especially in identifying rivers with deteriorating conditions. Anyone wishing to contribute to the national River Health Programme by undertaking MiniSASS in nearby rivers should visit the following website: www.riverhealth.co.za.

How Can We Protect and Conserve Our Indigenous Fauna and Flora?

- Remove alien plants and trees along the river banks in co-operation with the local authorities and major land owners
- Join a volunteer clearing or hack group and encourage others to become involved (e.g. local authorities, agricultural unions, schools, communities)
- Buy alien plant products (firewood, charcoal, crafts, furniture, toys, building material, mulch)
- Inform the authorities about the location of invasive alien plants and fish
- Protect natural species by not buying and introducing alien fauna and flora into rivers and dams
- Plant indigenous vegetation to control erosion of river banks and improve biodiversity
- Protect the best areas for river and fish conservation on your land
- Obtain permission before stocking rivers and dams with fish

What Can We Do to Protect our Rivers?

- Water is precious – use it sparingly and wisely!
- Improve agricultural practices, prevent erosion and reduce fertiliser and pesticide usage.
- Avoid straightening river channels and smoothing riverbeds since this promotes erosion. River meanders help to reduce water flow speed, and increase habitat diversity and quality.
- Remove chopped down alien plants and trees from river beds and river banks as this material could clog up the river downstream.
- Avoid dumping litter, garbage, pesticides or building rubble on river banks and in rivers.
- Plan activities within the river so that they cause minimal disturbance to the river. Request permission to modify river banks, sink boreholes in riparian zones and build dams on rivers.
- Consult local offices at the Western Cape Nature Conservation Board (Tel: 021-866 8000), Department of Water Affairs and Forestry (Tel: 021-950 7100, Regional Office: Bellville), SA National Parks Board (Tel: 021-689 4441) and where applicable the City of Cape Town (Tel: 021-487 2205) for guidance regarding river and catchment issues. They are there to help you.

GLOSSARY

Alien species Fauna and flora introduced intentionally or by accident from other countries. Not all alien species are invasive.

Biodiversity The structure, composition, functions of living organisms and the ecological complexes of habitats in which they occur.

Biosphere reserve is an internationally declared protected area, subject to approval by UNESCO and management according to a set of prescribed principles. The biosphere concept accommodates conservation and development, and ensures that the sensitive areas and biological diversity are adequately protected, remaining pristine and essentially wild.

Biota refers to the community of plants and animals which live in the river and wetland.

Desired health An indication of the envisioned ecological state of the river and is determined by considering the ecological importance and sensitivity of the specific river ecosystems.

Ecological importance refers to the diversity, rarity or uniqueness of the habitats and biota and the importance of protecting these ecological attributes.

Ecological sensitivity refers to the ability of a specific ecosystem to tolerate disturbances and to recover from certain impacts.

Ecological Reserve The quality and quantity of water that is required to protect the aquatic ecosystems of a water resource.

Environmental Impact Assessment Investigates the actual and potential impacts of the proposed action or development on an area.

Fauna The collective term for animals living in a particular area.

Flora The collective term for plants growing in a particular area.

Hotspot refers to an area where high levels of species richness, endemism as well as threat coincide.

Indigenous species Fauna and flora occurring naturally in an area.

In-stream refers to "within the river channel".

MAP (Mean Annual Precipitation) Average rainfall (including snow, hail and fog condensation) over a year.

MAR (Mean Annual Runoff) Average yearly available stream flow at a point in the river which has been calculated over a long period of time (usually 50 years or more), assuming a constant level of development.

***n*MAR** (natural Mean Annual Runoff) Average yearly available stream flow at a point in the river which has been calculated over a long period of time (usually 50 years or more), in undeveloped conditions.

Marginal vegetation refers to plants growing at the edge of the river.

Present health A measure of the present ecological state of the river during the time of the survey. This is expressed as a river health category that reflects how much the river has changed from its natural state.

Red data species Species of plants and animals that are under threat. The red data categorisation of species indicates their conservation status (extinct, endangered, vulnerable and rare).

Riparian habitat refers to the habitat on the river bank.

Riparian zone The area adjacent to a river or water body that forms part of the river ecosystem. The riparian zone plays an essential role in the functioning of the river ecosystem. It is characterised by frequent inundation or sufficient flooding to support vegetation distinct from the surrounding area.

Runoff Water which is not absorbed by the soil and flows to lower ground, eventually draining into a stream, river or other waterbody.

spp. Abbreviation for a grouping of species (plural). Species (sp.) (singular) refers to the unit of biological classification and diversity.

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Web pages to explore are:
Biosphere Reserve: http://www.unesco.org/mab/wnbr.htm
C.A.P.E.: www.capeaction.org.za
CCT: www.capetown.gov.za
CPNP: www.cpnp.co.za
DWAF: www.dwaf.gov.za
UKUVUKA: www.ukuvuka.org.za
WCNCB: www.capenature.org.za

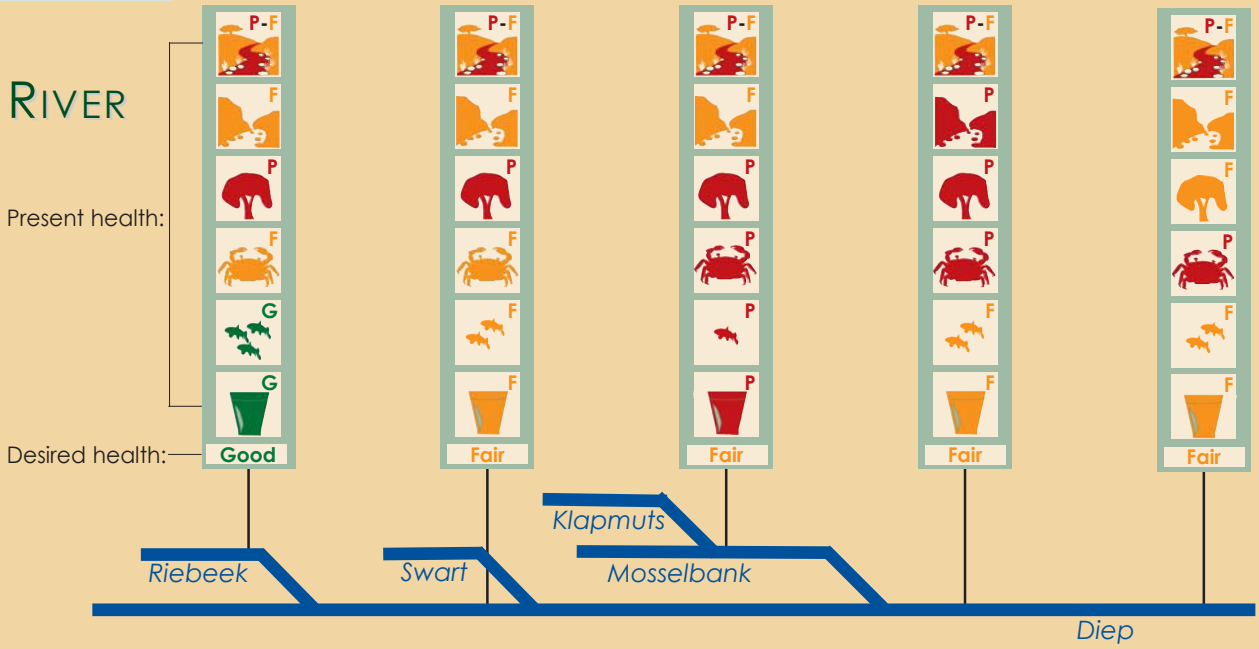
Summary

Diep, Hout Bay, Lourens and Palmiet

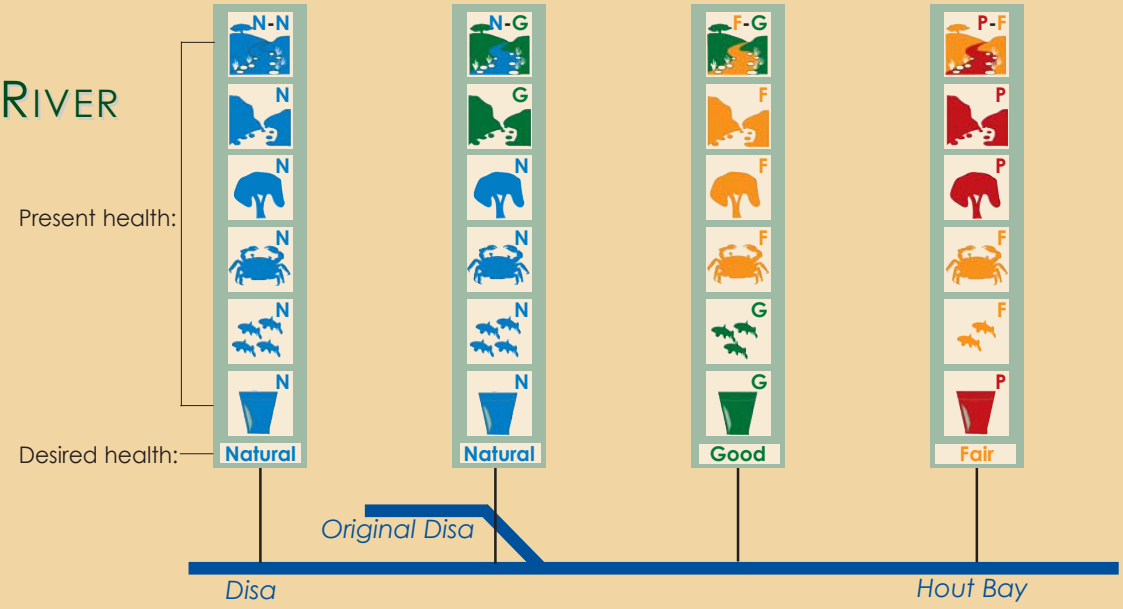
River Systems - 2003

The Diep, Hout Bay, Lourens and Palmiet rivers are some of the many rivers in the Cape Town area. The Hout Bay and Palmiet rivers, as well as the headwaters of the Lourens River fall within the Cape Folded Mountains. The Diep River and the lower reaches of the Lourens River fall within the Southern Coastal Belt.

Diep River



Hout Bay River



Dryland agriculture is the main land-use in the Diep River. The upper Hout Bay catchment lies within the Cape Peninsula National Park. The Lourens River starts within the Hottentots Holland Nature Reserve, and is mainly used for irrigated agriculture (orchards, vineyards). The Palmiet River has intensive agricultural development and forestry in its upper reaches and is rejuvenated in the Kogelberg Biosphere Reserve. Urban areas in these catchments are Malmesbury, Milnerton, Hout Bay, Somerset West, Strand and Grabouw.

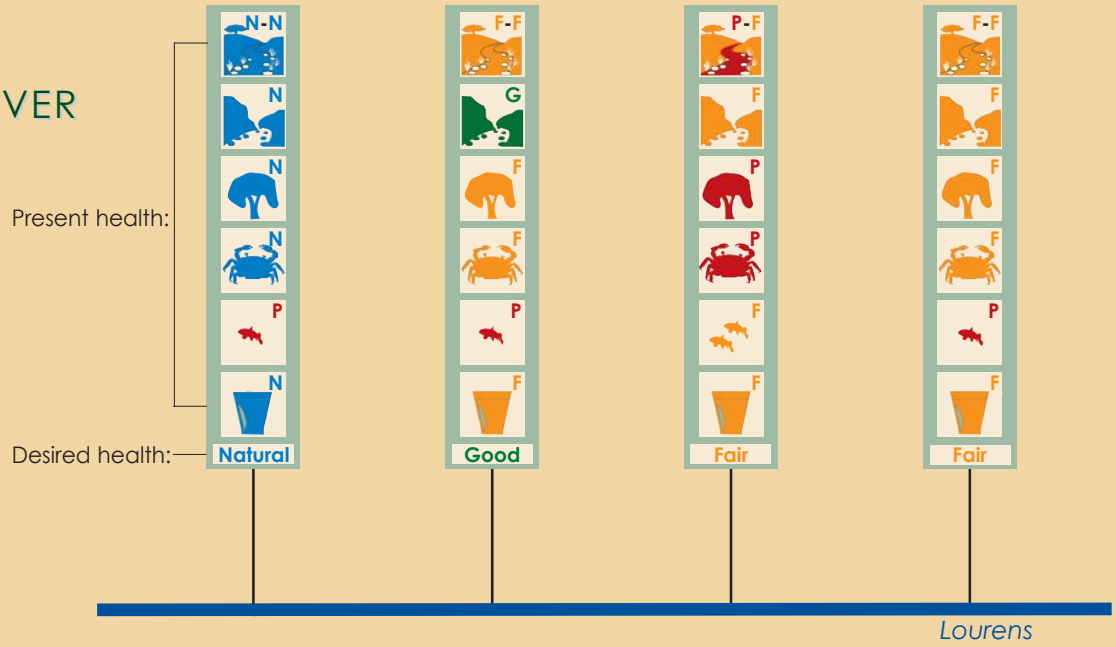
Diep River Water quality, habitat integrity and flow are severely altered in this system. This is due to the cumulative effect of farm dams and abstraction, removal of natural riparian vegetation, riverbed modification, treated wastewater discharges and agricultural runoff, as well as the introduction of alien fauna (banded tilapia) and flora (river gum).

Hout Bay River Flow in the upper reaches has been altered by large instream dams. Downstream, water quality and habitat integrity is reduced by peri-urban and urban development (stormwater discharges, abstraction, alien vegetation, sedimentation and floodbanks).

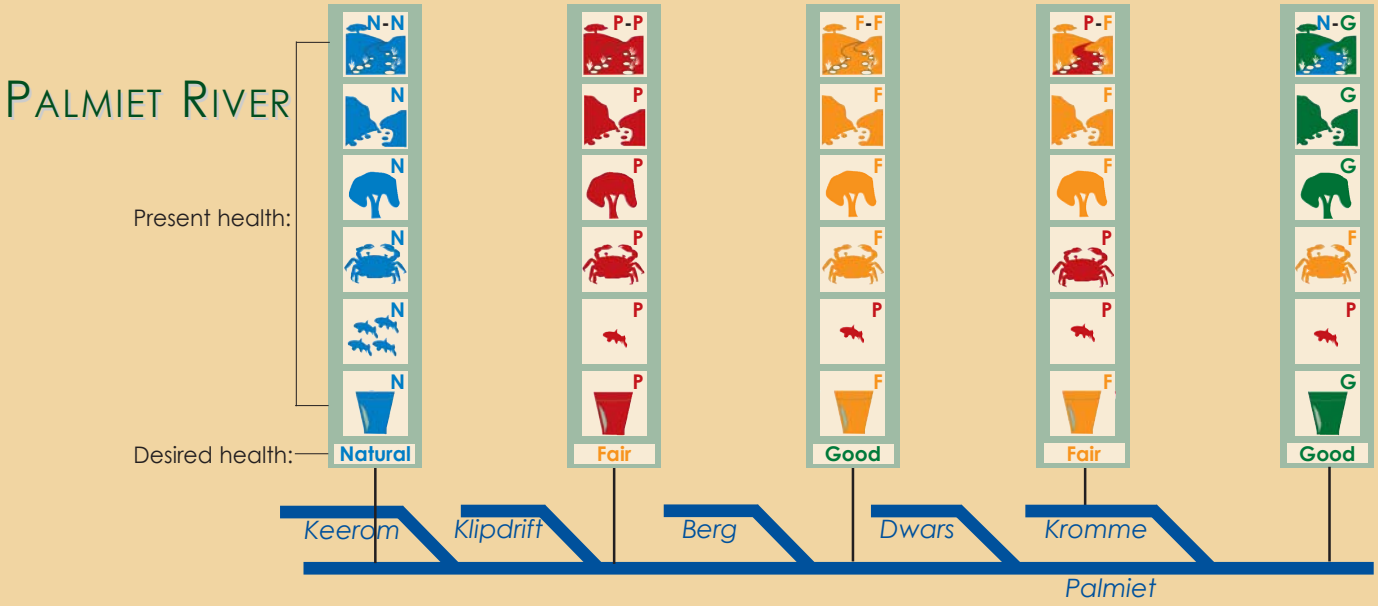
Lourens River Water quality and habitat integrity deteriorates downstream as a result of forestry, agriculture (water abstraction, runoff) and urban development (stormwater discharges). Rainbow trout throughout the river has resulted in the disappearance of indigenous fish (Cape galaxias) at many sites.

Palmiet River River health is reduced within the urban and agricultural areas near Grabouw as a result of large instream dams, and recovers in the Kogelberg Biosphere Reserve. Alien fish (smallmouth bass and bluegill) are widespread in the lower reaches and have led to the disappearance of Cape kurper and Cape galaxias.

Lourens River



Palmiet River



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