State of the Rivers Report

Crocodile, Sabie-Sand & Olifants River Systems

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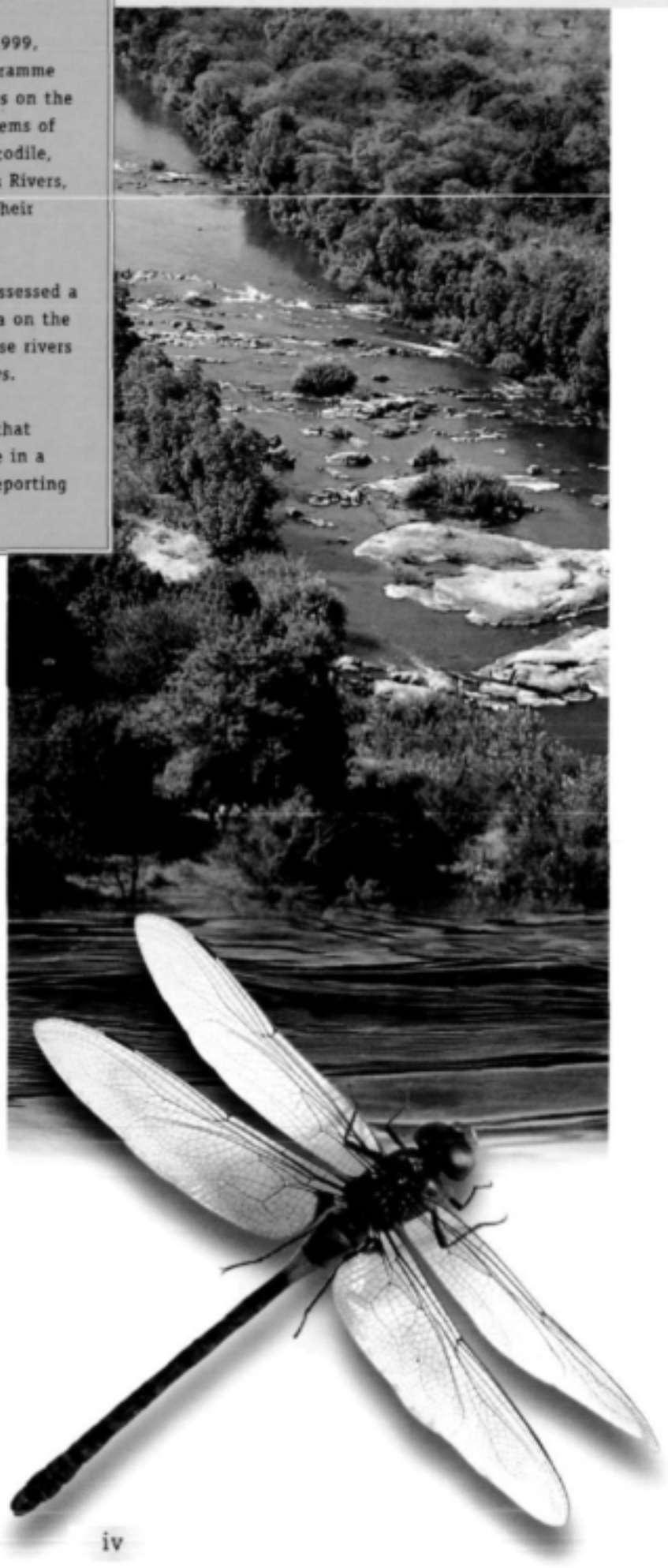
Contents

Context of this Report

Between 1996 and 1999, the River Health Programme (RHP) conducted surveys on the three major river systems of Mpumalanga, the Crocodile, Sabie-Sand and Olifants Rivers, including some of their tributaries.

The RHP collected and assessed a substantial body of data on the ecological health of these rivers during the surveys.

This report makes that information available in a state-of-environment reporting framework.



The River Health Programme

The national Department of Water Affairs & Forestry (DWAF) initiated the South African River Health Programme (RHP) in 1994. The purpose of this initiative was to gather information regarding the ecological state of river ecosystems in South Africa. The information will be used to support positive management of these natural resources.

Aquatic communities (e.g. fish, riparian vegetation, aquatic invertebrate fauna) integrate and reflect the effects of chemical and physical disturbances that occur in river ecosystems over extended periods of time. The RHP uses assessments of these biological communities to provide a direct, holistic and integrated measure of the integrity or health of the river as a whole.

The planning, development and implementation of the RHP has been undertaken in the following phases:

1. Design

The objectives, scope, and specifications of the programme were set by local resource managers and scientists in conjunction with international benchmarks. The objectives of the RHP are to:

- Measure, assess and report on the ecological state of aquatic ecosystems;
- Detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems;
- Identify and report on emerging problems regarding aquatic ecosystems;
- Ensure that all reports provide scientifically and managerially relevant information for national aquatic ecosystem management.

2. Conceptual Development

Prototypes have been developed for: a spatial classification scheme, (which allows comparison of biological data from different sites); a protocol for selecting monitoring and reference sites; protocols for selecting and using biological and abiotic indices (to measure the health of river ecosystems); procedures for the storage, management and transfer of data collected by the RHP; and mechanisms for collaboration and networking amongst partners.

In order to ensure a critical level of organisational participation and capacity, a model of shared ownership has been advocated. The Department of Water Affairs & Forestry (DWAF), the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC) became joint custodians of the programme at a national level, assisted by Provincial Champions and Provincial Implementation Teams.

3. Pilot implementation

This phase was necessary to allow testing, refinement, and integration of components of the RHP, and highlighted additional developments where required. It also demonstrated the value of the programme and provided broad guidelines to facilitate the eventual implementation and maintenance of the programme. A further outcome was an improved understanding of the practical and operational factors that influence the sustainable implementation of the RHP.

4. Anchoring phase

The goal of this current phase is to help implementation agencies to go through the different steps of implementing the programme, and to internalise the programme in terms of required expertise, skills and budgets.

A new Water Act for South Africa

The principles of sustainability and equity are the cornerstones of the South African water policy. The protection of aquatic ecosystems is recognised as essential in order to support their sustainable and optimal use.

Therefore, for the first time and through the provision of an ecological reserve, the water required to maintain aquatic ecosystem integrity is guaranteed. The National Water Act (Act No 36 of 1998) has two separate but inter-dependent components related to the proposed strategy for sustainable resource utilisation, namely:

- Protection of water resources in order to ensure their ability to support utilisation for the benefit of current and future generations;
- Utilisation of water resources in the most efficient and effective manner, within the constraints set by the requirements for protection.

An integrated resource protection approach is the best way to adequately address the need to manage water resources on an ecosystem basis, as well as allowing a balance between long-term protection and short-term development needs. The integrated resource protection approach:

- Sets measurable and verifiable resource quality objectives (RQOs) that clearly define acceptable levels of protection for water resources. These RQOs have four critical components, namely requirements for water quantity (water level or flow), requirements for water quality (chemical, physical, and biological characteristics of the water), requirements for habitat integrity (of in-stream and riparian habitats), and requirements for biotic integrity (health, community structure and distribution).

- Imposes source-directed controls (economic and regulatory instruments and self-regulation) for waste discharge, impact generation and rehabilitation, to ensure that the conditions for protection of the receiving environment are met.

The RHP will play an important role in specifying RQOs for habitat and biological components of aquatic ecosystems. Through the RHP, assessments can be made regarding the ecological state of an aquatic ecosystem in terms of:

- The present ecological state (where are we now);
- Ecological reference conditions (where could we potentially be);
- Setting of ecologically sound and feasible RQOs (where we aim to be).

State of Environment reporting

State of the Environment (SOE) reporting was promoted at the United Nations Conference on Environment & Development (UNCED) in Rio de Janeiro in 1992, in response to a call for improved environmental information for decision-making.

In South Africa, the national Department of Environmental Affairs & Tourism initiated a programme of SOE reporting by producing the first national report, on the Internet, and city reports for Cape Town, Durban, Johannesburg and

Pretoria. SOE reporting will soon be a statutory requirement, and regular updates will be required.

SOE reports are designed to:

- Provide information to Government and agencies for improved decision-making in sustainable development
- Compare environmental performances of different areas
- Increase public awareness of environment and development issues
- Empower people and organisations to improve their environment and quality of life for themselves and future generations

The purpose of SOE reports is to answer questions about our environment such as:

What changes are taking place in the condition and functionality of the environment?

What is causing these changes?

What are the consequences of these changes?

What are we doing about it and is it effective?

What more can be done to improve environmental conditions?

In order to answer these questions, most SOE reports use a "Pressure-State-Response" framework, which describes the pressures on the environment, the current state and trends in environmental conditions, and the policies and actions that are in place to manage the environment. This way of presenting information is easy to understand, especially if specific indicators are used to measure changes in pressures, states and responses. In South Africa the national State of the Environment report expands this concept to include "Driving Forces", the human activities which create environmental pressures, and "Impacts", the consequences for sustainability and human livelihoods.

An Overview of the Study Area

Land cover and land use

There are three biomes in the study area, grassland, savanna (bushveld) and forest. The grasslands are found predominently on the higher altitude plateaus and slopes, and the bushveld is dominant in the lower plains. Patches of afromontane forest are found on the Drakensberg Escarpment, in the moist gorges.

A large proportion of the study area has been modified or transformed from its natural condition. The dominant land use is agriculture (pasture, dryland or irrigated cultivation) and forestry production. There are also mining and industrial activities. However, in the low-lying region there are large conservation areas, including the internationally renowned Kruger National Park. Approximately 1.5% of the study area is under urban development, although this is expanding rapidly. There are concerns about this in terms of loss of natural habitat and increased generation of pollution and waste.

Climate

The climate varies considerably due to the large variation in altitude and relief. The highveld region is cooler (10-18°C) with higher rainfall (400 to 1 000 mm per year), which is mostly received in the form of summer storms. This is relatively high for South Africa (average 600 mm), but low in global terms. The inter-annual fluctuations are large, however, and extremes of flooding and drought are not uncommon. In winter frost is common on the high interior plateau, due to clear skies, a dry atmosphere and absence of wind.

On the escarpment, the rainfall is generally higher (600-1 200 mm per year and more), and mean annual temperatures vary from 10-12°C to 20-22°C. In the low-lying areas temperatures are generally warmer, with an annual average of 22°C, although conditions are drier (400-600 mm rainfall per year). These conditions are condusive to the production of subtropical and tropical fruits, with irrigation, and to commercial forestry.

Population

The population is largely rural, although there are a few large towns in the area, and urbanisation is rapid. The study area encompasses a large part of the Kruger National Park, where population is low, but the impact of visitors is evident in infrastructure development, and pressures on water and waste systems. Poverty is widespread, with annual household incomes frequently below R2 000 per month, and high unemployment. There are huge disparities, however, between household incomes. This is reflected in the variation in life expectancy between the poorer communities (61 years) and the wealthier communities (64-77 years). The Human Development index (consisting of life expectancy, literacy and GGP) is similar to the rest of South Africa.

Terrain

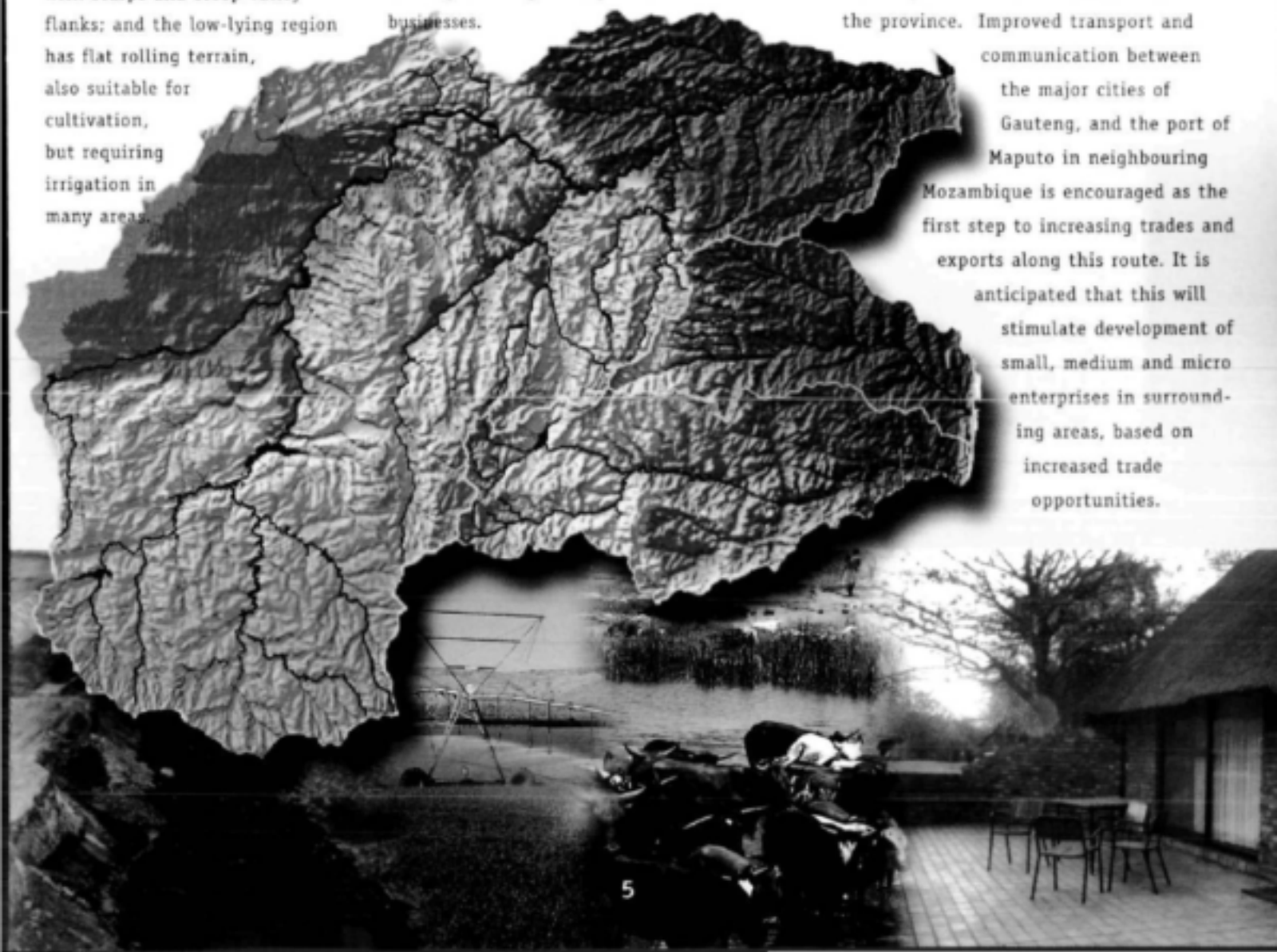
The Drakensberg Escarpment runs north to south almost through the centre of the study area. This creates three distinct physiographic regions, the high interior plateau, the escarpment zone, and the low-lying region, with altitudinal differences from 100 m to 2 300 m above mean sea level. The high interior plateau has relatively flat, rolling terrain, suitable for cultivation or pasture; the escarpment zone is mountainous with scarps and steep valley flanks; and the low-lying region has flat rolling terrain, also suitable for cultivation, but requiring irrigation in many areas.

Economic profile

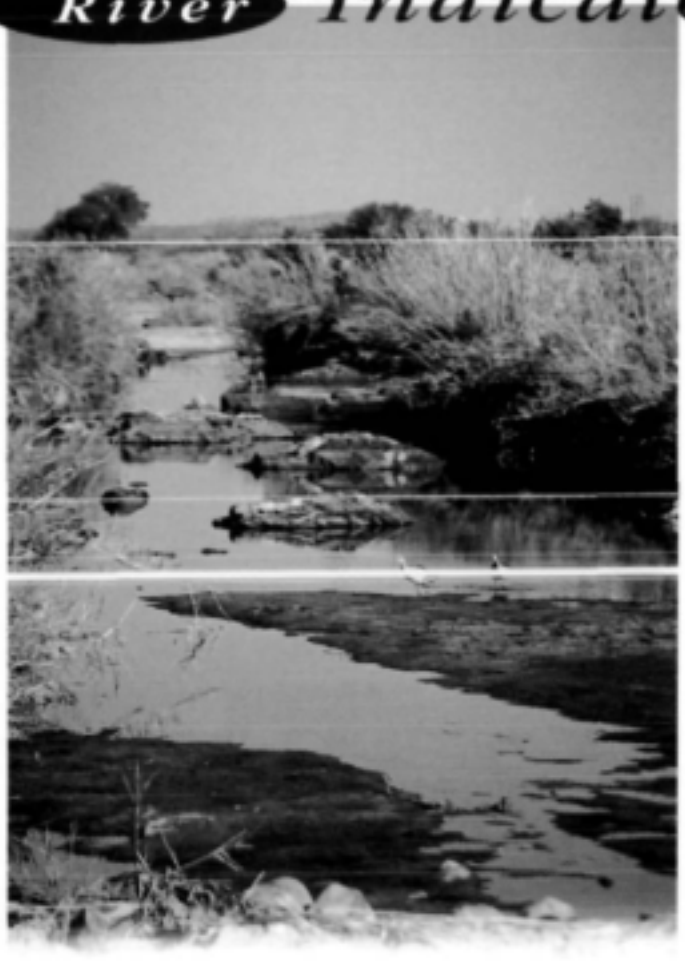
The economy of the area is based largely on the coal mining, electricity generation, oil refining and synthetic products industries, forestry, irrigated soft fruit production, and tourism. However, only 41% of production income accrues to residents of the study area, the remainder being remitted to the head offices of large mining houses and corporations. Similarly, although personal incomes are among the highest in South Africa, often these incomes are earned in industries and activities elsewhere in the country, with homes and farms in the study area representing holiday homes and second businesses.

Development priorities

In 1998 a Strategic Environmental Management Plan was commissioned by the Mpumalanga Provincial Government as an input to planning for a Mpumalanga-Maputo Development Corridor (MMDC). This initiative aims to promote development and economic growth through the upgrading and improvement of transportation and communication infrastructure. In terms of development priorities for the study area, tourism was targeted as an area for growth, due to the unique landscape and natural attributes of the province. Improved transport and communication between the major cities of Gauteng, and the port of Maputo in neighbouring Mozambique is encouraged as the first step to increasing trades and exports along this route. It is anticipated that this will stimulate development of small, medium and micro enterprises in surrounding areas, based on increased trade opportunities.



River Indicators and Indices



Indicators are specific measurements or records, taken to monitor and assess environmental conditions. They are used to capture and present large amounts of detailed information in a format that is easy to understand. For example, if we want to measure water quality (e.g. how fit the water is for drinking), we could measure the amounts of a range of substances known to be harmfull to human health. These would be indicators of water quality, and if they are measured over time, the results will tell us whether water quality is getting better or worse.

The National State of the Environment report for South Africa uses the Driving Force-Pressure-State-Impact-Response model to explain what is causing environmental change, how good or bad the conditions are, and what we can and are doing about it. Each of these categories is described using environmental indicators to give specific measures, benchmarked against international practice, legal requirements, and desired conditions. The National Water Act makes provision for monitoring a river's current health (Present Ecological State) in relation to a desired condition (Desired Ecoloqical State).

Aligned to both these processes, the RHP uses indices, or composite indicators, to report on the current state, the causes of change, the desired state, and makes recommendations for achieving this.

River Health Indices

A multitude of factors determine the health of a river ecosystem: its geomorphological characteristics, hydrological and hydraulic regimes, chemical and physical water quality, and the nature of in-stream and riparian habitats. It is impractical to monitor each of these factors in detail. Therefore, the RHP focuses on selected ecological indices that are representative of the larger ecosystem and are practical to measure. These indices are also mechanisms through which complex ecological data can be summarised and output can be provided in simple numeric format.

While biological indices are the main focus of the RHP, the development and inclusion of indices of physical and chemical parameters (e.g. habitat conditions, geomorphological characteristics, hydrology, water quality) are encouraged to increase the information value of the programme.

River Health Classification

In order to allow objective assessment of, and comparable reporting on, river health, a "scale of river health" has been established. The scale used by the RHP describes five different states of health (natural to unacceptable).
The attributes of a fish or invertebrate community that relates to a natural state for one river will not necessarily be the same for the next river. In fact, the biotic and abiotic charac-

teristics that describe "natural" are likely to be different for different rivers. Therefore, a scale of river health needs to be calibrated for each river or even for distinctly different river reaches. This is done by reconstructing the conditions that represent a "natural state" for a particular river. These conditions are referred to as reference conditions. The rest of the classes then translate as a percentage of the reference conditions or "natural" state.

Ecoregions

For the purposes of this report, reference conditions were determined for each of the ecoregions within the study area. These are reaches which have been demarcated based on ecological similarity. In other words, monitoring sites within an ecoregion are ecologically more similar to each other than to sites in other ecoregions. Because of their similarity, these ecoregions also provide convenient boundaries within which to do ecological assessments and set ecological quality objectives.

Ecoregions referred to in this report

2	Central Highlands
3	Bushveld Basin
4	Great Escarpment Mountains
5	Lowveld
6	Lebombo Uplands
7	Highveld

A decimal value represents a subdivision, e.g. 2.08 is a subdivision of ecoregion 2.

Present Ecological State

The results of applying the biological and habitat indices during a river survey provide the context for determining the degree of ecological modification at the monitoring site. The degree of modification observed at a particular site translates into the present ecological state. In this report, the present ecological state obtained at sites within the same ecoregion has, where possible, been summarised into one overall state.

Ecological state of river	Description	Colour code used in this report
Natural	No measurable modification	Blue
Good	Largely unmodified	Green
Fair	Moderately modified	Orange
Poor	Largely modified	Red
Unacceptable	Seriously or critically modified	Black

Desired Ecological State

In order to put the present ecological state in context, it is important to have an idea of what is desirable and what is not. Understanding of what the ecological state of a river should be could provide resource managers with directions for making decisions and implementing management actions.

Many factors could be considered in determining the desired ecological state for a particular river reach, including the strategic importance of the river for economic development as well as its ecological importance (in maintaining ecological diversity and functioning at local and wider scales) and sensitivity (ability to tolerate disturbances). The ecological importance and sensitivity of the river reach considers biodiversity, rarity, uniqueness, and fragility, from habitat, species and community perspectives.

For this report we have only considered the following in order to suggest a desired ecological state that is practical and achievable as well as protective in terms of ecological processes and functioning:

- The reference conditions - as an indication of what the river used to be like;
- The present ecological state - as an indication of what the river is like now;
- The ecological importance and sensitivity - as an indication of what the river should be like based on ecological considerations.

Abbreviations

amsl	above mean sea level
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
FAII	Fish Assemblage Integrity Index
GGP	Gross Geographical Product
IFR	In-stream Flow Requirements
IHI	Index of Habitat Integrity
RHP	River Health Programme
RVI	Riparian Vegetation Index
SASS	South African Scoring System
SOE	State of the Environment
WRC	Water Research Commission
RQOs	Resource Quality Objectives

Indices in this Report

The South African Scoring System (SASS) for aquatic invertebrate fauna

A variety of invertebrate organisms (e.g. snails, crabs, worms, insect larvae, mussels, beetles) require specific habitat types and conditions for at least part of their life cycle. Changes in the structure of aquatic invertebrate communities are signs of changes in overall river conditions. As most invertebrate species are fairly short-lived and remain in one area during their aquatic life phase, they are particularly good indicators of localised conditions in a river over the short term.

The SASS is based on the presence of families of aquatic invertebrate fauna and their perceived sensitivity to water quality changes. SASS has been tested and is used widely in South Africa as a biological index of water quality. SASS results are expressed both as an index score (SASS score) and the average score per recorded taxon (ASPT value).

The Fish Assemblage Integrity Index (FAII)

Fish, being relatively long-lived and mobile, are good indicators of long-term influences on a river reach and the general habitat conditions within the reach. The numbers of species of fish that occur in a specific reach, as well as factors such as different size classes and the health of fish, can be used as indicators of river health.

This index categorises fish populations according to an intolerance rating which takes into account trophic preference and specialisation, requirement for flowing water during different life-stages, and association with habitats with unmodified water quality. Results of the FAII are expressed as a ratio of observed conditions versus conditions that would have been expected in the absence of human impacts. Although this index has been applied and published, it is being further developed and refined under the leadership of Dr Neels Kleynhans of the Institute for Water Quality Studies.

The Riparian Vegetation Index (RVI)

Healthy riparian zones maintain channel form and serve as filters for light, nutrients and sediment. Changes in the structure and function of riparian vegetation commonly result from changes in the flow regime of a river, exploitation for firewood, or use of the riparian zone for grazing or ploughing.

The RVI determines the status of riparian vegetation within river reaches based on the qualitative assessment of a number of criteria in the riparian zone. These criteria are vegetation removal, cultivation, construction, inundation, erosion, sedimentation and alien vegetation.
The output is expressed as percentage deviation from natural or unmodified riparian conditions.

Index of Habitat Integrity (IHI)

Habitat availability and diversity are major determinants of aquatic community structure. Adverse changes in biological communities may be attributed either to deterioration in water quality or to habitat degradation, or to both. Loss of habitat is regarded as the single most important factor that has contributed towards the extinction of species in the last century. The destruction of a particular type of habitat will result in the disappearance of certain species. Examples of river habitat types are pools, rapids, sandbanks, stones on the riverbed, and vegetation fringing the water's edges. The availability and diversity of habitat are major determinants of whether a given system is acceptable to a specific suite of biota or not. Therefore knowledge of the availability and quality of habitats is very important in an overall assessment of ecosystem health.

The IHI has been developed to assess the impact of major disturbances on river reaches. These disturbances include water abstraction, flow regulation, and bed and channel modification. This index accounts for both the condition of the riparian zone and the in-stream habitats.

The Crocodile River System
Ecoregion and River Characteristics

Catchment overview

The Crocodile Catchment covers about 10 450 square kilometres. The naturalised mean annual runoff is 1 200 million cubic metres per year, with an estimated maximum yield (that is, the maximum amount storable in dams) of 859 million cubic metres per year. The Kwena Dam already commands 10% of the total catchment runoff and the proposed Mountain View Dam will regulate a large portion of the Kaap River runoff.

The estimated water use in 1997 was 580 million cubic metres per year, of which irrigation accounted for 49%, forestry 43% and industry, commerce and mining the remaining 8%.

An assessment for the determination of the Reserve for the Crocodile River has not yet been completed. DWAF is in the process of making provision for supplying all residents of the catchment with a minimum of 25 litres per person per day. The environmental water requirements, domestic water supply objectives, and international obligations (water supply to Mozambique), are priorities for water allocation from present and future dams. Future irrigation and water intensive industries are likely to either be constrained or forced to utilise more resource-conservative methods.

Ecoregion 2.11

The ecoregion is characterised by plains with moderate slopes and mountain or highveld grasslands on deep red to yellow sandy soils, overlying granites, quartzites and basalts. These are relatively high altitude areas, ranging from 1 000 to 2 000 m above mean sea level (amsl) with an average rainfall of 800 mm per year and mean annual temperatures of 12-14°C.

The Crocodile River rises in the Steenkampsberg Mountains at an altitude of more than 2 000 m above sea level. The sources of the streams in this ecoregion are often within wetlands. Further downstream the cold waters gather into fast flowing mountain streams. The Elands River, a tributary to the Crocodile, rises on the grassland plateau of the Drakenberg Mountains near the town of Machadodorp.

Ecoregion 2.13

This ecoregion has greater variation in relief. The lower altitude (800 to 1 500 m) brings slightly warmer temperatures (16-18°C) and lower rainfall

(600-800 mm per year). The dominant vegetation is grassland, on shallow lithosols overlying granites, quartzites and basalts.

Here the Crocodile River is 10-15 m wide, with rocky pools and runs with occasional riffles and some small waterfalls.

Ecoregion 4.01, 4.02 & 4.03

These ecoregions are in the Drakensberg Mountains (1 000 m to 2 000 m amsl) with moderate to high relief and steep slopes. Consequently there is greater variation in mean annual temperature (12-22°C) and mean annual rainfall (600 to 1 200 mm). The geology is more diverse, with the inclusion of some conglomerates and gneiss, and patches of mature soils are found (sometimes leached). Grasslands still dominate, although patches of afromontane forest are found.

4.01

The upper half of the Elands River widens to 15 m with rocky pools and a moderate to steep slope.

4.02

This is a fast flowing section. The river is 15-20 m wide with large rocky pools and abundant riffle and rapid areas.

4.03

Downstream of Kwena Dam the Crocodile River winds through the scenic Schoemanskloof for approximately 55 km to Montrose Falls. In this part the river is 15-20 m wide with large rocky pools interspersed abundantly with riffles and rapids. The river slopes are steep and thick riparian forests cover the riverbank.

Ecoregion 5.05

This ecoregion is typical of lower escarpment reaches and the start of the lowveld. Altitude range falls to 800 to 1 000 m, with moderate relief. The rainfall is variable within the ecoregion with some areas receiving as little as 400 mm per year, although most areas receive within 600 to 1 000 mm. Temperatures are higher (16-22°C), and soils are sandy, sandy loams, and clays overlaying iron, jaspilite, syenite, hornblende granite, foskorite, and gneiss, which is conducive to a shift in vegetation from grassland to bushveld.

The river in this long section is mostly characterised by large rocky pools with occasional rapids. Upstream from Kaapmuiden the river flows through a gorge where rocky habitats and big boulders abound.

Ecoregion 5.06

Typical of the Lowveld proper (300-600 m above mean sea level), this ecoregion has flat to moderate relief, lower rainfall (400-800 mm per year) and high temperatures (20-22°C). These conditions, together with shallow black, brown or red clayey soils, produce sweet lowveld bushveld.

The river is 40-50 m wide, slow flowing and with mostly large sandy pools.

Ecoregion 5.07

Lowland plains (200-400 m above mean sea level) and sweet lowveld bushveld are characteristic of this region, where conditions are warm (often above 22°C) and relatively dry (400-600 mm of rainfall per year).

The river is 40-50 m wide, slow flowing and with mostly large sandy pools.

Ecoregion 6.01

The Lebombo uplands have more moderate relief with Lebombo arid mountain bushveld. Temperatures are high (more than 22°C) and rainfall is slightly higher than in neighbouring ecoregions (400-800 mm per year). Shallow acidic sandy soils overly basalt, tuff, breccia, and rhyolite.

The river is 40-50 m wide, slow flowing and with mostly rocky pools, large sandy pools and occasional rapids.

The Crocodile River System
Present Ecological State

Ecoregion 2.11

The overall ecological status of the Crocodile River in this ecoregion is **good** to fair, with most of the impacts occurring in the riparian zone (habitats and vegetation). The state of the fish assemblage in the Lunsklip River varies from natural in some parts to **unacceptable** in other parts. The invertebrates also provide a varied picture for this river, with river health ranging from natural to fair. The Kareekraalspruit has the highest ecological state (natural to **good**) of the rivers monitored in this ecoregion, with only its riparian habitats and vegetation showing more significant modification.

In-stream and riparian health for the Elands River and tributaries are **good** to fair, except for the Leeuwspruit where conditions are predominantly **poor** to **unacceptable.**

Ecoregion 2.13

Good for all the ecological indicators except fair for riparian habitats.

Ecoregion 4.01

Although the states of in-stream and riparian habitats are **good** and fair for the Elands River, the fish community still appears to be largely natural. Aquatic invertebrates are in a **good** state.

The overall ecological state for the Hartbeesspruit and Blouboskraalspruit is fair. It is interesting to note that at the time of the initial survey in 1996, riparian vegetation conditions along the Elands River, Hartbeesspruit and Blouboskraalspruit were poor. This state has since improved to fair, which can largely be attributed to the removal of alien plants by the Working for Water Programme.

Ecoregion 4.02

Present ecological conditions are **good**, with the fish community reflecting a natural state and the health of aquatic invertebrates ranging from natural to fair. The riparian habitats and vegetation are less healthy, with **poor** and fair states respectively.

Ecoregion 4.03

Good to fair with the in-stream biological components tending to be **good** and the riparian components (habitat and riparian vegetation) fair.

Ecoregion 5.05

The overall state of this section can be described as fair. Upstream from Nelspruit the in-stream biota reflect a **good** to fair ecological state. Around Nelspruit the in-stream and riparian conditions deteriorate as indicated by riparian habitats and vegetation (**poor**), fish (fair to **poor**) and invertebrates (**poor** to **unacceptable**). Downstream from Nelspruit the river gradually recovers to a fair state.

Ecoregion 5.06, 5.07 & 6.01

Throughout this section both in-stream habitats and fish communities show fair health. Experience has shown that invertebrate fauna in this section give a more varied response, both over time and space, ranging from natural to fair. The riparian vegetation on the northern bank of the river is **good**, and generally fair to **poor** on the southern bank.

The Importance of Wetlands

Wetlands are important ecologically, because they moderate water flow and regulate water quality. They act as sponges during wet periods, therefore controlling the extent and impacts of flooding and droughts. They slow down the flow of water, causing suspended matter to settle out or to be absorbed by wetland plants. Wetland plants are specifically adapted to flourish in areas of higher than average concentrations of certain elements.

Wetlands are among the most threatened habitats in South Africa, and it is estimated that up to 50% of wetlands may have been lost country-wide. Threats to wetlands include human activities, such as channelisation, drainage, crop production, effluent disposal and water abstraction. Loss of wetlands leads to a reduction or loss in biodiversity, as the plants and animals that are adapted to wetland habitats are often unable to adapt to new environmental conditions, or to move to more suitable ones. Loss of harvestable resources also occurs when wetlands are lost. For example, reeds and grasses are important materials in traditional construction, and reduction in these resources creates a dependence on other materials such as wood, plastics, and metals, which have negative environmental impacts. Loss of water quality and flow regulation is a further consequence of loss of wetlands, and may result in greater extent or severity of flooding.

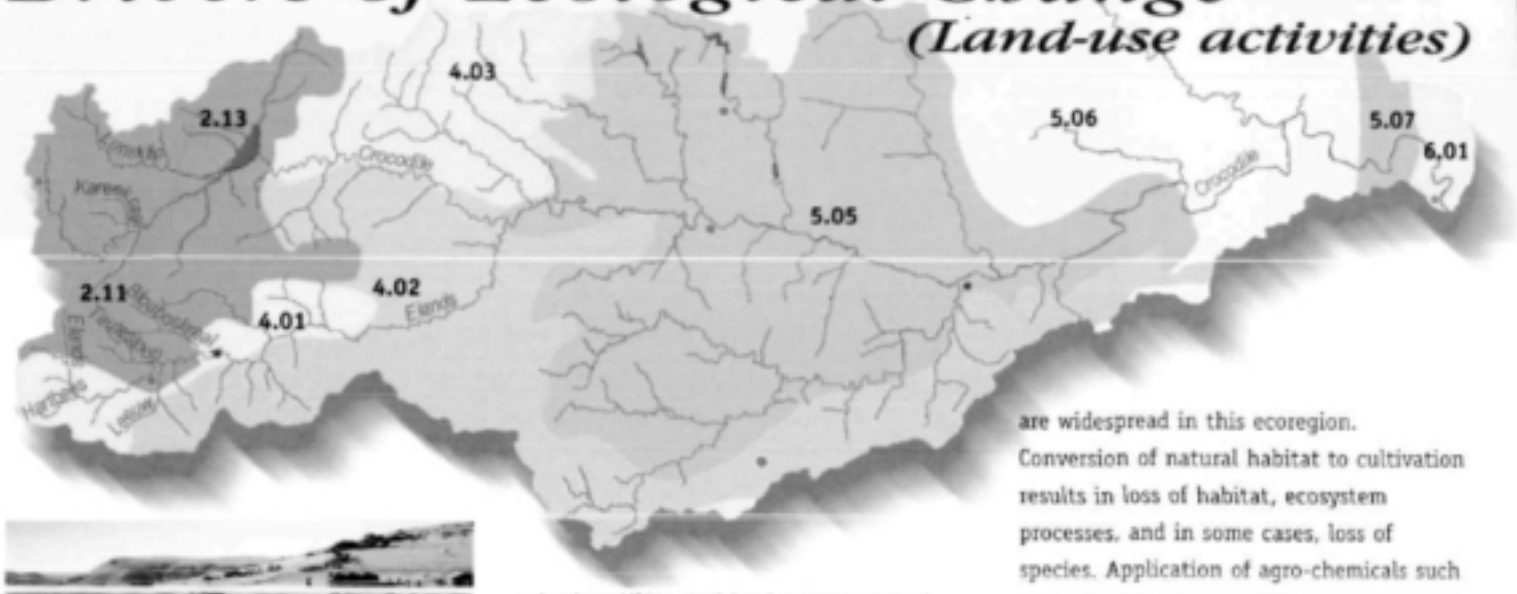
Of the more than 800 naturally-occurring freshwater wetlands in South Africa, 14% have full protection within a national park, provincial nature reserve or wildlife sanctuary and 4% are partly protected. South Africa currently has 16 wetlands designated as wetlands of international importance in accordance with the Ramsar Convention.

Shortspine suckermouth (*Chiloglanis pretoriae*)

Macrobrachium prawn sampled in lower Crocodile River

Hippo occur in middle and lower parts of Crocodile River

The Crocodile River System
Drivers of Ecological Change
(Land-use activities)



Ecoregion 2.11

Dullstroom and Machadodorp have become popular trout-angling retreats and trout-farming activities in the area have increased dramatically. However, the trout industry also represents the greatest threat to river health in this region, for the following reasons. The construction of weirs and dams to contain the trout has resulted in a loss of wetlands, and modification of natural in-stream and riparian characteristics. Trout is not a native species, but it now occurs in most of the streams in this part. Trout is a predaceous fish, and has caused the indigenous chubbyhead barb (*Barbus anoplus*) to be lost from some streams, for example most of the Lunsklip River.

Fish are not the only invasive biota in this area. Alien trees occur in the lower parts of this ecoregion, with wattles being the most common. This is a problem because they are replacing the natural vegetation, and use more water than indigenous trees, thereby reducing runoff, and impacting on the flow regimes in the river.

The poor state of the Leeuwspruit can be attributed to a combination of agricultural activities (flow modification as result of water diversion and construction of several weirs, and modification of the riparian zone) and pollution from domestic origin (solid waste and effluent entering the stream in the Machadodorp vicinity). Alien species of fish, namely trout, large-mouth bass and smallmouth bass have been sampled in the Leeuwspruit.

The Verlorenvallei Nature Reserve outside Dullstroom is an important conservation area, perhaps best known as a home for the rare wattled crane, and has been proposed as a Ramsar site. The national Department of Environmental Affairs and Tourism is implementing a programme of wetland rehabilitation in this area. Such efforts to maintain ecological integrity by excluding human activity, form a vital component of an integrated landscape management plan.

Ecoregion 2.13

Agricultural activities (irrigated and dry-land cropping, cattle and sheep grazing) are widespread in this ecoregion. Conversion of natural habitat to cultivation results in loss of habitat, ecosystem processes, and in some cases, loss of species. Application of agro-chemicals such as fertilisers and pesticides can also result in contamination or eutrophication of water bodies, altering their functioning and the water quality. Grazing by only one or a few species of herbivores also impacts on the condition of the veld, especially if the stocking density is high. The composition and structure of the vegetation may change and thus alter the water uptake and runoff in the catchment. Invasion by exotic vegetation, particularly woody plants, is also a threat to the natural vegetation and water availability in this ecoregion.

Ecoregion 4.01

Agriculture and forestry are the dominant land-use activities. In-stream habitat modifications are the result of inundation by weirs as well as water quality deterioration due to trout farming activities and urban development (Machadodorp and Waterval Boven). Encroachment by alien trees, especially wattles, poplars and eucalypts also account for riparian habitat modification.

Ecoregion 4.02

Irrigated agriculture and forestry plantations are the primary land-cover features. Both these activities use significant amounts of water, and change the quality of the water returning to the river (in some cases the quality of the water returning to the river can be better than that of the water abstracted). Encroachment of the riparian zone by alien plants (e.g. wattles, eucalypts, poplars, mulberry, seringa, jacaranda and Spanish reed) is severe, and further reduces water availability and quality. The biomonitoring survey in 2000 indicated that alien stream bank vegetation is being eradicated and controlled. However, removal of natural vegetation, cultivation and construction of dirt roads close to the river edge has modified the riverbank in places, resulting in increased erosion. This increases sedimentation in-stream, which, in turn, smothers interstitial habitats as well as the gills of fish, thus changing species abundance and community composition. This is considered the biggest impact of land-use activities (forestry, agriculture, infrastructure development) in these catchments.

Ecoregion 4.03

Irrigated cultivation predominates, impacting on natural habitats, ecosystem processes, and water quality. Construction of a new toll road in the Schoemanskloof valley has resulted in extensive soil disturbance, associated erosion, and increased sedimentation in the riverbed. In the long term, the risk of accidents and spills of chemicals and oil from the road into the river is also cause for concern.

Alien trees and shrubs are a significant problem in this ecoregion due to their impacts on runoff and biodiversity. Eucalypts, jacarandas, syringas, lantana and guavas are the most common species.

A further cause of ecological change is the flow modification as a result of the Kwena Dam. Releases from the dam do not follow the natural seasonality of flow regimes and has changed habitats.

Ecoregion 5.05

This section is under pressure from intensive agricultural, industrial and urban land uses. Large areas are used for irrigated agriculture, ranging from fruit (predominantly citrus) orchards to vegetable and tobacco cultivation. Sugar cane becomes more dominant in the lower parts of this section. Water is abstracted from the Crocodile River for irrigation and domestic use. In addition to formal agricultural activities, alien plants and aquatic weeds such as water hyacinth have an impact on the riparian and in-stream health respectively. A sampling site near Schagen, which has been used since the 1970's, is now so densely infested with alien vegetation that it is barely accessible. Domestic runoff and urban and industrial waste from Nelspruit have a significant impact on the health of the Crocodile River.

Ecoregion 5.06

The river forms the southern boundary of the Kruger National Park, which gives it high conservation importance. At the same time, the southern bank of the river is heavily utilised. Vegetation removal for citrus and sugar cane farming as well as tourist lodges have modified large parts of the southern bank.

The water that returns to the river after irrigation is often enriched with nutrients. The aquatic weed, water hyacinth, is a periodic problem, compounded by slow flowing water and excess nutrients.

Ecoregion 5.07

This ecoregion experiences the same pressures as ecoregion 5.06. In addition, the cumulative effect of water abstraction, primarily for irrigation purposes, often results in lower than desired flow. This has a negative impact on the availability and diversity of in-stream habitats as well as overall water quality. This impact is, in turn, affecting the composition of invertebrate and fish communities.

Ecoregion 6.01

The driving forces in this ecoregion are similar to those in neighbouring ecoregions 5.06 and 5.07. The Crocodile River flows into Mozambique at Komatipoort, and South Africa has an obligation to allow sufficient flow in the river at this point. This places further restrictions on the volume of water that can be abstracted, and thus increases the pressure on the resource to meet all the needs.

The Crocodile River System
Desired Ecological State and Response by Resource Managers

Ecoregion 2.11

Rivers and streams in this ecoregion should be maintained in a **good** ecological state. This will not only ensure that the headwaters of this river system remain of high integrity, but will also ensure the sustainability of the trout industry.

To maintain a **good** ecological state it is essential that the trout industry develop in an environmentally responsible and sustainable manner. This includes not constructing trout dams in wetland areas or riffle areas, maintaining refuge areas, and controlling the release of trout so that impacts on indigenous species are minimised. A Strategic Environmental Assessment of the trout industry in this region is required to ensure optimal economic development and optimal environmental protection.

The riparian zone of rivers and streams must be protected against too much physical modification and encroachment by alien plants, and removal of alien vegetation from the riparian zone is a priority for management. A **fair** state is recommended as a realistic goal for the Leeuwspruit, although some work and improved practices (especially related to domestic waste disposal and agricultural activities) will be required in order to achieve this goal.

Ecoregion 2.13

This section of the Crocodile River should be maintained in a **good** state. Protection of riparian habitats, through exclusion of livestock from these areas, is the highest priority. Responsible use of the riparian zone by the agricultural sector is important, as well as to protect the riparian zone against invasion by alien vegetation. The Working for Water Programme (WfW) and local landowners have already done significant clearing of alien vegetation in this part. Monitoring of roads in or near the riparian zone is recommended:
New roads should not be constructed within a 20-30 m buffer zone; where possible, existing roads should be removed and riparian vegetation restored; and only essential roads should be maintained and managed in order to reduce erosion.

The Crocodile River during the 2000 floods (Cascades, Nelspruit).

Ecoregion 4.01

It is desirable for the Elands River to be in a good ecological state. The tributaries of the upper part of this ecoregion, above the waterfall at Waterval Boven, could however, be managed in order to maintain a fair state.

Ecoregion 4.02

This section of the Elands River should be maintained in a good state.
Restoring of the riparian zone through clearing of alien vegetation is the most important management intervention required.

Ecoregion 4.03

The desired ecological state is good. Two aspects require attention, namely 1) management of water releases from Kwena Dam and 2) the overall condition of the riparian zone.
Releasing water according to ecological flow requirements will vastly improve the in-stream habitat downstream of Kwena Dam. Clearing of the riparian zone for agricultural as well as for recreational purposes (lodges and guesthouses) must be managed and invasion by alien plants must be controlled.

Ecoregion 5.05

It is desirable to manage this section of the Crocodile Catchment to achieve a good ecological state. This is regarded as an achievable and realistic goal. The biggest challenge is in the vicinity of Nelspruit, where multiple disturbances need to be managed. These disturbances include disposal of solid wastes that often end up in and close to the river, and the quality of effluents that are being discharged. An improvement in water quality, through improved pollution control, is required to achieve a good ecological state for in-stream biota at and downstream from Nelspruit. Improved management of the riparian zone is also required.

Ecoregions 5.06, 5.07 & 6.01

Given the mandate of the Kruger National Park as well as the strategic importance of development for tourism in this part of the catchment, the desired state of the Crocodile River is natural to good. To be realistic, a goal of a good state is suggested for the medium-term (5 to 10 years), with an ultimate aspiration to achieve a natural state over the long term. The most important management action for achieving a good state is to ensure ecologically sound flows in this section.

Developments within the riparian zone of the river's southern bank should be monitored to ensure sustainable utilisation and protection of a buffer area. In particular, sugar cane is planted right to the water's edge in some areas, and this should be replaced by natural vegetation to preserve the stability and functionality of the banks.

The Sabie-Sand River System

Ecoregion and River Characteristics

Catchment overview

The Sabie-Sand Catchment covers some 6 320 square kilometres and forms part of the larger Incomati System, which extends into Swaziland and Mozambique. The Sabie River is the main-stream of the catchment, with the Sand and Marite Rivers acting as major tributaries, and the Mac Mac River being a tertiary drainage.

The Sabie River has its source at 2 130 m above mean sea level (amsl) in the Drakensberg Escarpment, drops into the lowveld and joins the Sand River inside the Kruger National Park. Mean annual rainfall in the catchment varies between 2 000 mm on the Escarpment to around 600 mm in the Lowveld. Most of this falls between November and March, in the form of tropical storms. Summer maximum temperatures are high and evaporation averages at 1 700 mm per year in the Lowveld region. Mean annual runoff in the Sabie-Sand Catchment is approximately 762 million cubic metres. Flows in the Sabie River peak in summer, and low flows are experienced at the end of the winter dry season, although no-flow conditions have never been recorded.

Ecoregion 4.03

This ecoregion covers the upper section of the Drakensberg Escarpment, with altitudes between 1 000 and 2 000 m amsl, and high mountainous relief. As a consequence of the range in altitude and relief, there is a large variation in rainfall (600 to 1 200 mm per year) and mean annual temperature (10-18 °C). The dominant vegetation is a combination of mountain grassland (on the upland areas) and afromontane forest (in gorges and lower slopes). These overlie shallow lithosols and well-developed, sometimes leached, mature soils, respectively. The main geological types are quartzites, shales, basalts, andesites, conglomerates, irons, granites and gneiss.

The headwaters of the Sabie River and its tributaries (the Sand, Marite, Mutlumuvi, Motitsi and Mac Mac Rivers) arise in the upper parts of the escarpment. These rivers are cold mountain streams, narrow with moderate to steep gradients, and hence fast flowing. Waterfalls are common, and rocky pools and rapids abound.

Ecoregion 4.04

This ecoregion is in the lower reaches of the Drakensberg Escarpment, bordering on the Lowveld. Altitude is therefore much lower (400-1 500 m amsl) although terrain is still highly varied with mountainous relief. Mean annual rainfall varies from 600-1 200 mm, and temperatures much warmer than in ecoregion 4.03 (16-22°C). This is suitable for bushveld in the lower regions, although patches of afromontane forest are found in the upper slopes of this ecoregion. Sandy, loamy and clayey soils are found, which are well developed, although they may be leached. Geological formations include quartzites, granites, and sandstones. Here, the Sabie and Sand Rivers (and their tributaries) enter the Middleveld.

River characteristics include extensive bedrock runs (often with large granite boulders or cobbled beds) and slow, deep, sandy pools. Riparian vegetation consists of riparian old growth forest with shrubs and some reeds along the edge.

Ecoregion 5.05

Most of this ecoregion is in the Lowveld proper with upstream parts showing characteristics of more mountainous areas. The altitude is between 800 and 1 000 m amsl with moderate relief. Rainfall is still variable (400-1 200 mm per year), due to the variation in relief, and mean annual temperatures are warm (16-22°C). Sandy, sandy loam and clayey soils overlying iron, jaspilite and granite, support sour lowveld bushveld. In the upper parts cascades and rapids abound, in the lower regions rivers are wide, have gentle gradients, riffles and sandy pools, and mature riparian forests extending some hundred metres from the river. The river flows over sandy runs, characterised by reed beds, rapids, and through deep pools, where hippos are not uncommon.

Ecoregion 5.06

Typical of the Lowveld, this ecoregion has an altitude range of between 300 and 600 m amsl, plains with moderate relief. Mean annual precipitation (400-800 mm) is much lower than the higher ecoregions, and temperatures are higher with less variation (20-22°C). Sweet lowveld bushveld is the dominant vegetation type, supported by shallow black, brown, or red clayey soils, sandstones, granites and shales. Bilharzia may be present in some reaches of this ecoregion.

The Sabie and Sand Rivers converge in this region, in the Kruger National Park. River characteristics include a low gradient, some bedrock, pools and sandbars. Tall trees dominate the riparian zone, with reeds in open areas. The river is wide, with both a slow deep flowing channel and a broad chute over unfractured bedrock.

Ecoregion 5.07

Low plains (200-400 m amsl) with low relief characterise this ecoregion. Limited precipitation (400-800 mm per year) and high annual temperatures (over 22°C on average) are conducive to sweet lowveld bushveld, which is largely untransformed due to the protection afforded by the Kruger National Park.

The Sabie River is characterised by sand bars and deep-water channels. Stretches of unfractured bedrock are also found, with isolated patches of large bedrock boulders and some loose cobble. Hippos are found in deep pools, and reeds dominate the water's edge.

Ecoregion 6.01

The very flat, low plains (100-300 m amsl) in this region experience relatively low rainfall (400-800 mm per year), and high temperatures (annual average exceeding 22°C). Bushveld is the dominant vegetation, on shallow, acidic, sandy soils.

The river rejuvenates through the Lebombo Mountains and has a relatively higher gradient than other sites in the Lowveld. The river has multiple channels, with water flowing over roughened bedrock slabs, gravel and through deep pools.

The Sabie-Sand River System
Present Ecological State

Ecoregion 4.03

Overall good. Invertebrates indicate that the water quality is very good, although the fish populations are somewhat impaired, reflecting a fair to **poor** state. Some natural riparian forests occur in the upper parts. In general, the ecological state is better in the upper reaches of this ecoregion with increasing degradation further downstream.

Ecoregion 4.04

The Mac Mac River is in a **good** state, the Ngwaritsana River is **natural**, and the Mutlumuvi is **good**.

Ecoregion 5.05

Sabie River: Overall the ecological state is good. In-stream habitats and fish are good; riparian habitats and riparian vegetation varies between good and **poor**. The invertebrate index also reflects a varied picture, with results in this section ranging between natural and **poor**.

Sabane River: **Poor** to **unacceptable**. The riparian zone and in-stream habitats are severely degraded. The Sabane River and Langspruit have been dammed and impacted in several places for irrigation of banana plantations. The clearing of ground cover for banana plantations has also increased erosion and sedimentation in-stream.

Mac Mac River: The ecological state is good. The fish populations show natural health, and the invertebrate community varies between natural and good.

The Ngwaritsana River is in an overall **good** state, but riparian vegetation is fair to **poor**.

Maritsane River: Overall **good** state but riparian vegetation is fair to **poor**.

Marite River: In-stream habitats and fish are generally good to fair. Riparian habitats and vegetation are fair to **poor**. Invertebrates give a highly variable picture, with results ranging from good to **unacceptable**.

Phasa Phasa River: Generally fair, but the invertebrate health is **unacceptable**.

Motitsi: Invertebrates and fish reflect a natural and good state respectively. In-stream habitats are good to fair and riparian habitats and vegetation are **poor**.

Mutlumuvi: The overall state is fair, although the state according to invertebrates ranges from good to **unacceptable**.

Ecoregion 5.06

Due to the Kruger National Park and private conservation activities, much of this area is in a natural state. However, urbanisation and other land uses threaten the unprotected areas.

Sabie River: The in-stream components (habitats, fish and invertebrates) reflect a natural to good state, whereas the riparian components (habitats and vegetation) reflect a good to fair state.

Sand River: In this reach, parts of the riparian zone can be regarded as natural, whereas parts upstream of the Sabie Sand Game Reserve are **unacceptable**. The in-stream habitats and biota are generally good, and even approach natural in places.

Mutlumuvi River: In-stream biota represents a good state, and habitats and riparian vegetation are fair.

Klein Sand River: This reach is predominantly good to fair, but a **poor** score was obtained with invertebrates. The riparian zone is one of the worst affected areas in terms of infestation by alien vegetation.

Ecoregion 5.07

The Sabie River is in a predominantly natural state in this ecoregion.

Ecoregion 6.01

The riparian zone is natural and the in-stream habitats and biota are natural to good.

The Importance of Riparian Vegetation

The riparian zone is the area adjacent to the river or water body. It forms part of the river ecosystem and is characterised by inundation or flooding sufficiently frequently to support vegetation distinct from surrounding areas. The riparian zone plays many essential roles in the functioning of the river ecosystem, including:

- Flow regulation: the riparian vegetation slows the flow of water, both by physically blocking the passage of water, and by absorbing the water into its root systems. This moderates the impacts of flooding on surrounding areas.
- Water quality regulation: the riparian vegetation acts as a buffer or filter between nutrients, sediments, contaminants, and bacteria from the surrounding land and air, and the river channel itself. The riparian vegetation therefore prevents soil, pesticides, fertilisers and oil from entering the river and impacting on in-stream communities.
- Habitat provision: The riparian zone is an important habitat for many plants and animals, because it is an area of transition between the land and the river. These relatively steep environmental gradients (moisture, temperature, topography, and soil) generally support higher levels of biodiversity than more homogeneous areas.
- Corridor functions: because it follows the river, the riparian zone serves as a corridor, connecting two or more habitats that may otherwise be isolated by land transformation of areas in between. Many species of animals use corridors to disperse, and find food and mates.

Riparian zones are particularly vulnerable to invasion by alien vegetation (because they are good dispersal routes for seeds) and this is becoming a huge ecological problem in South Africa. Alien vegetation is a problem because:

- it takes up more water than indigenous vegetation (which may impact on the river's flow regime)
- it takes up habitat for indigenous vegetation (which supports a greater variety of flora and fauna),
- it changes the aesthetic characteristics of the riparian zone and
- it damages buffering capabilities of the riparian zone.

The Sabie-Sand River System

Drivers of Ecological Change

(Land-use activities)

Ecoregion 4.03

Forestry activities close to or within the riparian zone are the primary threat to health of the riparian habitats and vegetation. Lack of ground cover underneath the trees causes instability and erosion of soils. If close to the waters edge, this can cause massive destabilisation of the banks, and erosion. Alien vegetation uses more water than indigenous vegetation and is also a threat to natural vegetation and may reduce biodiversity in the riparian zone.

Trout is a threat to in-stream ecological health, through diversion of water for dams and weirs, which impact on the water flows in the area. Trout also preys on, and competes with, indigenous fish species, changing the composition of fish populations, and rivers may become enriched with nutrients from fish feed and waste.

Ecoregion 4.04

Trout and alien vegetation have an influence on the health of the Mac Mac River. Sewage from Graskop and impacts related to a sawmill also lower water quality in the Mac Mac River.

Due to a waterfall that obstructs fish movement, no fish occur in the upper parts of the Ngwaritsana River. This is a natural situation.

Some of the streams that form part of the upper Mutlumuvi Catchment have started flowing for the first time in 60 years. This is largely attributed to the removal of alien trees by the Working for Water Programme and the Save the Sand initiative.

Ecoregion 5.05

General: There is extensive forestry in this region of the catchment. Roads and plantations close to streams impair in-stream and riparian health due to erosion, sedimentation and the resultant smothering of habitats. The extent of invasion/encroachment by alien vegetation is a serious threat to ecosystem health. Madumbi (similar to sweet potato) farming takes place in wetland areas. Loss of natural vegetation and water uptake in these areas destabilises the soils and the filtering functions of the wetlands. Black bass, an alien fish species, occurs in this ecoregion. These threaten indigenous species by preying on them.

Sabie River: Sawdust from sawmills impacts the riparian zone and washes into the river during rain events. Cresols and phenols leach out of sawdust, acidifying the soil and water. The dust itself also smothers vegetation and in-stream habitats, lowering vegetation health and invertebrate diversity and abundance. Finer dust particles clog the gills of fish. Erosion and sedimentation result from dirt roads and fruit orchards such as banana plantations close to the river. This impairs in-stream water

quality and reduces habitat availability. Blue gill sunfish, an alien species, is found in the Langspruit.

Sabane River: This is the third worst affected river by alien plants in this catchment. Sedimentation, associated with floods, occurs in places, primarily due to agricultural activities.

Although development in the Sabie Catchment is restricted by law (due to the conservation importance of this river), and all development requires an Environmental Impact Assessment, several banana plantations have developed along the Sabane River, and are causing severe erosion and sedimentation.

The Klein Sabie River is impacted by industry and urban development in the area. The riparian zone is affected by alien vegetation and forestry activities.

Marite: Disturbance and erosion from the construction of the Injaka Dam have caused sedimentation downstream. This results in loss of in-stream habitat through smothering of interstitial spaces between rocks on the riverbed. Sedimentation may also lead to increased frequency or severity of flooding.

Mutlumuvi: The Zoeknog Dam failed during 1993, resulting in severe scouring, sedimentation and habitat changes downstream. However, most of the habitats have since, at least, partially recovered. Of the approximately 30 ha of disturbed soil which elevated the rate of erosion, some 5 ha have already been rehabilitated by the Save the Sand initiative.

Ecoregion 5.06

General: Land use in the upper part of this ecoregion is characterised by forestry. Some 20 000 ha of the upper catchment were cleared of alien plant species, which has resulted in recovery of winter flows in parts of the Sand River. The middle parts of the catchment experiences rural community activities such as subsistence and small scale farming of livestock and fruit. Overgrazing is a problem in this area, and where it occurs close to the riparian zone, has caused extensive erosion and sedimentation. The lower parts of the catchment are protected by conservation activities, in particular the Kruger National Park.

Sabie: Agricultural activities have an impact on the northern bank in some areas. The southern bank falls within the Kruger National Park. Although riparian vegetation and habitats here are largely natural, some alien vegetation does occur, and in some areas riparian vegetation has been cleared to provide tourists with clear views of the rivers and pools.

Sand: The central section of the catchment is densely populated. Overgrazing by livestock, including riparian areas, is evident, and results in erosion of riverbanks and sedimentation in-stream. The demand for water and the generation of wastewater are relatively high compared to less densely populated areas.

Ecoregion 5.07

Conservation and eco-tourism are the dominant activities in this region. Although impacts are generally low, some erosion may occur due to clearing of riparian zones along tourist roads.

Ecoregion 6.01

Conservation and eco-tourism are again the dominant activities. The Corumana Dam inside Mozambique pushes up into the Kruger National Park, resulting in reduced velocity of flows, damping of seasonal flow fluctuations and increased deposition of sediments. This, in turn, leads to a loss of natural habitats, which has an effect on the health of especially the fish population.

The Sabie-Sand River System

Desired Ecological State and Response by Resource Managers

Ecoregion 4.03

The headwaters of the Sabie River are important wetland areas that regulate water flow and quality. These areas provide habitat for many species of animals and plant. For this reason, a natural health state should ideally be maintained. However, in view of the extensive forestry activities and occurrence of alien vegetation and trout, a good state is recommended as a more pragmatic goal.

Ecoregion 4.04

The desired state of the Mac Mac and Ngwaritsana Rivers is good. The vision for developing the bigger area around headwaters of the Mutlumuvi into a conservation area, with only a relatively small portion reserved for community forestry, gives the Mutlumuvi a desired ecological state of **good**. At present the run off from this area resembles that of hardened surfaces in urban areas, and extensive rehabilitation and firm management is required to control this.

Ecoregion 5.05

It is desirable that streams in this region be maintained in a good state. Exceptions are the Mutlumuvi and Sabane, where only fair and **poor** states respectively are deemed realistically achievable.

Clearing of alien vegetation is a priority management action, together with planning and maintenance of forestry roads to minimise impact on streams, due to erosion and sedimentation. The forestry and agricultural operators should protect the riparian zone by maintaining a buffer strip (at least 30 m) between the outer boundary of the riparian zone and formal plantations or areas of cultivation. Roads within 20 m of the riparian zone must

have a management plan for controlling erosion and sedimentation. The forestry companies have instituted a joint biomonitoring programme of streams and rivers in areas under their control. Implementation of recommendations forthcoming from this programme will be an important step towards marrying activities of the forestry sector with the health and sustainability of aquatic ecosystems.

Alien vegetation clearing in this region has also been successful, with extensive rehabilitation of wetlands and removal of alien vegetation in the upper Sand and Mutlumuvi Rivers.

Ecoregion 5.06

The ecological state of the Sabie should be good in the upstream parts and should improve to natural downstream. The first part of the Sand, and the Mutlumuvi, can realistically only be managed for a fair state. The desired state for the Klein Sand and the lower half of the Sand River is good.

Ecoregion 5.07

Due to the conservation importance of this region, the Sabie should be maintained in a natural state.

Ecoregion 6.01

Due to the conservation importance of this region, the Sabie should be maintained in a natural state.

Alien Vegetation and the Working for Water Programme

Invasive alien plants affect nearly one tenth of the surface area of South Africa, including waterways, riparian zones, and grassland or scrubland. More than 150 introduced plant species have become invasive. These plants use more water than indigenous plants, because indigenous plants are adapted to the dry conditions in South Africa and become dormant during the dry season. Alien plants have longer roots and continue to draw water from the rivers and groundwater reserves during dry seasons, thus reducing the amount of water available to support other terrestrial and aquatic communities.

Alien plants also destabilise riverbanks, because chemicals from their leaves and roots penetrate the soil and prevent other plant species from growing underneath them. This creates large areas of bare soil along the banks, which are thus more susceptible to erosion. Eroded soil causes increased turbidity and sedimentation in the rivers, smothering of interstitial habitats and fish gills, and increasing the likelihood and severity of flooding.

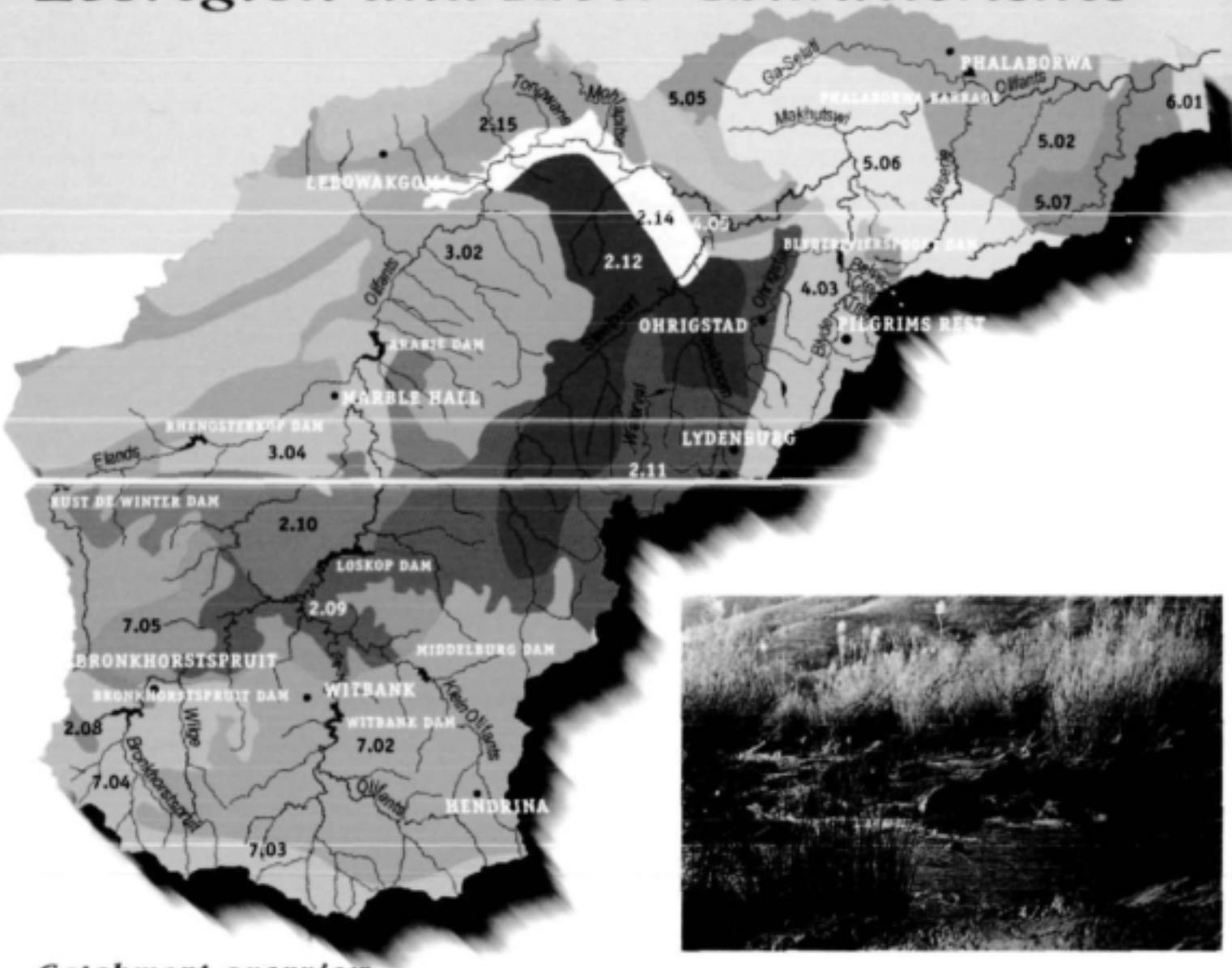
South African ecosystems are adapted to regular burning, but when alien trees dominate the system the fires are often more intense because of the additional fuel load. This can result in damage to the soil, vegetation and surrounding infrastructure, and a reduction in the viability of indigenous seeds.

Alien vegetation also poses a threat to biodiversity. South Africa is an exceptionally biologically diverse country, with nine times more plant species, eight times more breeding bird species, six times more mammal species, and twice as many amphibian species, compared with the world average. Alien invasive plants dominate natural habitats, by competing with natural species for space, water, sunlight, and other resources. They also reduce the structural diversity of the vegetation, and disrupt ecosystem dynamics, which can impact on the number and type of animal species that can be supported by the vegetation in that habitat.

The Working for Water Programme was launched by the national Department of Water Affairs and Forestry to try to control the problem of alien invasive plants. The Programme uses a combination of methods to tackle the problem:

- Manual clearing (felling, removing, or burning)
- Chemical control (using environmentally safe herbicides)
- Biological control (using species-specific insects and diseases from the alien plants' country of origin).

The Olifants River System
Ecoregion and River Characteristics



Catchment overview

The Olifants Catchment covers about 54 570 square kilometres and is subdivided into 9 secondary catchments. The total mean annual runoff is approximately 2 400 million cubic metres per year. The Olifants River and some of its tributaries, notably the Klein Olifants River, Elands River, Wilge River and Bronkhorstspruit, rise in the Highveld grasslands.

The upper reaches of the Olifants River Catchment are characterised mainly by mining, agricultural and conservation activities. Over-grazing and highly erodible soils result in such severe erosion, in parts of the middle section, that after heavy rains the Olifants River has a red-brown colour from all the suspended sediments.

Thirty large dams in the Olifants River Catchment include the Witbank Dam, Rhenosterkop Dam, Rust de Winter Dam, Blyderivierspoort Dam, Loskop Dam, Middelburg Dam, Ohrigstad Dam, Arabie Dam, and the Phalaborwa Barrage. In addition, many smaller dams in this catchment, have a considerable combined capacity.

The Olifants River meanders past the foot of the Strydpoort Mountains and through the Drakensberg, descending over the escarpment. The Steelpoort and Blyde tributaries, and others, join the Olifants River before it enters the Kruger National Park and neighbouring private game reserves. Crossing the Mozambique border, the Olifants River flows into the Massingire Dam.

Ecoregion 7.02, 7.03 and 7.04

This is an area of flat grasslands with rolling rocky zones on top of the escarpment (1 500 to 1 750 m amsl). Sandstone and shale harbor rich coal deposits, covered by deep, red to yellow sandy soils. Wetlands that overlie these deposits are threatened by potential mining activities. Precipitation is 600-800 mm per year, frequently in the form of summer storms. Mean annual temperatures range from 14-16°C.

The Wilge, Bronkhorstspruit and Klein Olifants Rivers are tributaries of the Olifants River that, together with the Olifants River, originate in the Highveld grasslands in these areas. The river structure varies from a narrow channel with no definite riparian zone up to a 20-30 m wide channel with well-defined riparian habitat. The Witbank and Doringpoort Dams are in this section of the Olifants River.

Ecoregion 2.08, 2.09 and 2.10

This section of the Olifants River Catchment extends from the Highveld Plateau (2.08), descending the Drakensberg Escarpment (2.09) and bordering on the Bushveld Basin (2.10). The vegetation changes from highveld grassland to mixed bushveld with decreasing altitude (from 1 500m to 1 000 m amsl). Mean annual precipitation decreases from 600-800 mm to 400-800 mm, and mean annual temperatures rise from 16-18°C to 18-20°C. Conglomerates, granites and quartzites predominate, as do shallow, rocky, sandy soils, across the ecoregions. In the upper parts, where wetlands are common, and threatened by mining for coal deposits, Working for Water, DEAT and Mpumalanga Parks Board have completed a wetlands inventory and prioritisation for rehabilitation.

The confluence of the Olifants and Klein Olifants Rivers is in ecoregion 2.09. From here the Olifants River flows in a north-westerly direction where it joins the Wilge River, upstream of the Loskop Dam. The Loskop Dam is situated at the lower end of a scenic gorge with high aesthetic value. The river varies from a single channel to multiple channels with afforested islands. Riverbanks are steep in some areas. Riparian vegetation is sparse, comprising of a few grasses and reeds. Rapids and pools are common, as are boulders and large rocks in the riverbed. Floodplains are narrow.

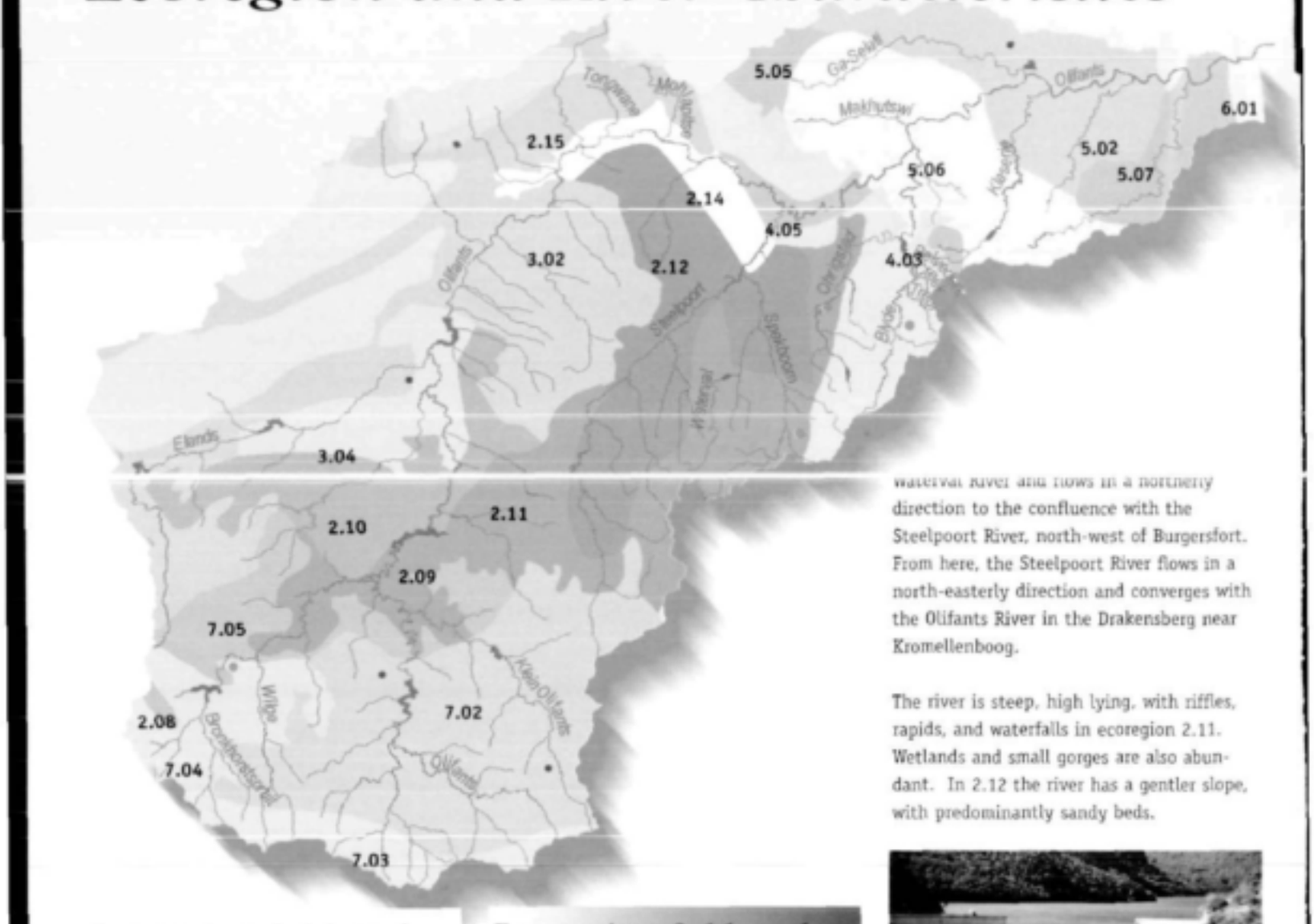
Ecoregion 3.02 and 3.04

This is an area of middle slopes (800-1 500 m) with mixed bushveld overlying shallow coarse sandy soils on mudstone, sandstone and shale. Average annual precipitation is 400-800 mm and temperatures range from 16-22°C.

The Rust de Winter Dam is situated in the Elands River, which rises east of Bronkhorstspruit. The Olifants River meanders from the Loskop Dam through relatively flat landscape past Groblersdal and Marble Hall to the Arabie Dam, at the confluence of the Elands and Olifants Rivers. The riverbed is sandy due to alluvial deposits. From the Arabie Dam, the Olifants River flows through the Springbok Flats, which forms part of the Bushveld Basin.

The river is steep with many riffles in ecoregion 3.02, becoming gentler with a sandy soft bed in ecoregion 3.04.

The Olifants River System
Ecoregion and River Characteristics



Ecoregion 2.14 and 2.15

This area has moderate to high relief, being in the foothills of the escarpment (1 000 to 1 500 m amsl). Granite, quartzite, mudstone, sandstone and shales are the main geological types, which give rise to coarse, sandy shallow soils. This, together with moderate to high temperatures (16-22°C) and relatively low mean annual precipitation (400-800 mm), supports a mixed bushveld vegetation type.

The Olifants River in this region is characterized by a single channel. After passing south of the foothills of the Strydpoort Mountains, the Olifants River converges with the Mohlapitse River. The source of the Mohlapitse River is in the Wolkberg Wilderness Area.

Ecoregion 2.11 and 2.12

These ecoregions span the escarpment. Ecoregion 2.11 is situated on the Highveld Plateau and the upper slopes of the escarpment, and is characterised by highveld grasslands. Ecoregion 2.12 is on the lower slopes, and sees the conversion to mixed bushveld. Moderate to high relief and sandy shallow soils are found in both regions, as is moderate rainfall (600 to 1 000 mm per year). Temperatures however, show greater variation, ranging from 10-16°C on the upper slopes and 16-20°C on the lower slopes.

The Spekboom and Steelpoort Rivers, tributaries of the Olifants River, arise in these ecoregions. The Spekboom has its source in the mountains near Lydenburg. It joins the Waterval River and flows in a northerly direction to the confluence with the Steelpoort River, north-west of Burgersfort. From here, the Steelpoort River flows in a north-easterly direction and converges with the Olifants River in the Drakensberg near Kromellenboog.

The river is steep, high lying, with riffles, rapids, and waterfalls in ecoregion 2.11. Wetlands and small gorges are also abundant. In 2.12 the river has a gentler slope, with predominantly sandy beds.

Ecoregion 4.03 and 4.05

This area lies in the upper slopes of the Drakensberg Mountains and the grasslands are interspersed with patches of afromontane forest. The high altitude (1 000 to 2 000 m amsl), shallow soils covering quartzite and shale, moderate to high rainfall (800 to 1 200 mm per year), and generally cool to moderate temperatures (10-18°C), are typical of the upper escarpment slopes.

The Steelpoort River joins the Olifants River

where it meanders through the mountainous landscape of the Drakensberg. The stony riverbed varies between 50 and 80 m wide at the confluence with deep alluvial sands and silt deposits. In some areas the river forms secondary channels, floodplains and woody islands. The Ga-Selati and Makhutswi Rivers arise near Leydsdorp. From here the rivers flow in an easterly direction. The Ohrigstad River joins the Blyde River at the Blyderivierspoort Dam in the Blyderivierspoort Nature Reserve.

Ecoregion 5.05 and 5.06

These ecoregions are lowveld regions, with a mean altitude of 300-600 m amsl, and a warm, dry climate (22°C on average, with 400-800 mm precipitation per year). Lowveld bushveld is the major vegetation type.

The Blyde River meanders through the Drakensberg and enters the Lowveld before its confluence with the Olifants River. The riverbed is characterized by an abundance of big rocks, stones and pebbles. The riparian zone alternates between narrow zones close to the stream and broad zones with sandbanks and floodplains. The floodplains are elevated in relation to the riverbed.

Ecoregion 5.02 and 5.07

Mopane bushveld characterises ecoregion 5.02. It is a lowland area (200-600 m amsl) with rolling plains, moderate rainfall (400-800 mm per year) and high temperatures (20-22°C and above). Loamy sand and clay soils overlie iron, jaspilite, granite, sandstone and shale. In ecoregion 5.07, sweet lowveld bushveld is dominant, on shallow clayey soils overlying a variety of geological types including mudstone, sandstone and shale. Moderate rainfall (400-800 mm per year) and high temperatures (20-22°C and above) characterise this region.

The first stretch of the Olifants River in this section is a broad, sandy channel with large trees, like wild figs and mahogany, on the banks. The river changes as it flows eastwards through the Kruger National Park, forming several channels with permanent reed-grown islands. Dominant tree species on the islands are Common Cluster Fig (*Ficus sycomorus)* and Jakkalsbessie (*Diospyros mespiliformis)*. The Letaba River joins the Olifants River west of the Olifants Rest Camp. A narrow gorge forms where the Olifants River flows through the Lebombo Mountains.

Environmental Flow Requirements

Both the volume and pattern of water flow play a role in maintaining the long-term ecological health of a river. Only a natural or close to natural flow regime can ensure that the biota and ecological processes in a river approximate a "natural" state of ecological health. However, as developments in catchments have increased the demand for water, few streams and rivers still experience completely natural flow regimes.

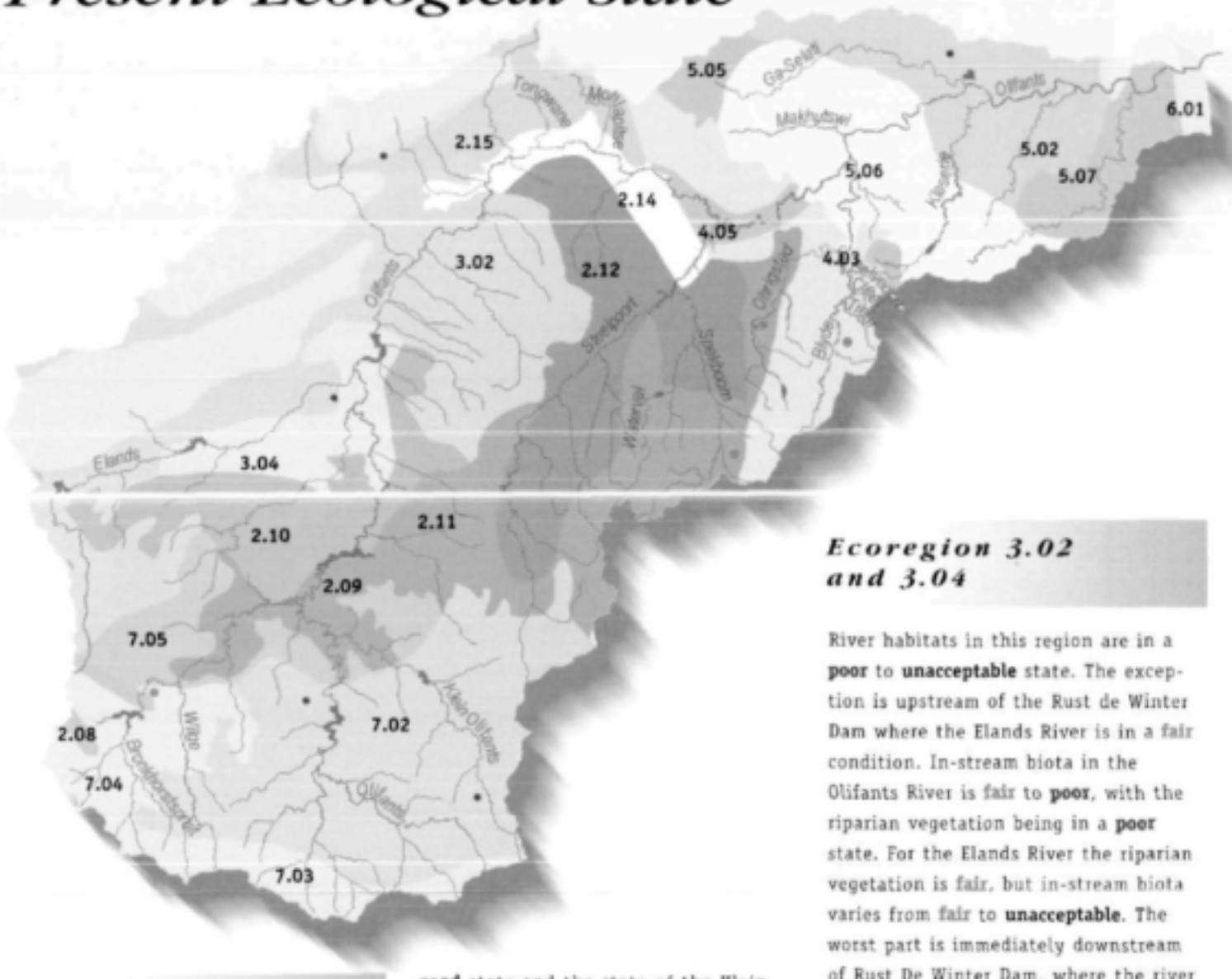
In particular, large impoundments have been constructed to store water for later use for domestic or irrigation purposes, and the altered flow patterns can impair river health. In such cases the Department of Water Affairs and Forestry supports the determination of an In-stream Flow Requirement (IFR), to define the nature of the required releases that will at least maintain the river in a pre-determined state of health. The IFR specifies different flow conditions that are needed during different times of the year, and recognises that these flows may differ for wet, normal, and dry years.

The factors that are considered when setting an IFR for a river include:

- The minimum depth required at rapids and riffles to maintain fish passage and habitat for flow-dependent species;
- Seasonal flow variations to stimulate fish spawning and to provide refuges and nursery areas for juvenile fish;
- Flows that would ensure the presence of a range of habitat types;
- The frequency and size of floods required for inundating riparian vegetation and dispersing seeds of riparian plants as well as for maintaining necessary geomorphological processes;
- Minimum flows for periods of drought that would provide survival conditions for river ecosystems;
- Flows required for sediment movement down the river bed and for maintaining required flows in estuaries downstream;
- Frequency and size of floods required to flush sediment and organic matter from the system.

The specified flow releases should be interpreted in combination with climatic events in the catchment. Floods should be simulated during rain events, and the first high flow after a dry season should coincide with the first rains.

The Olifants River System
Present Ecological State



Ecoregion 7.02 and 7.04

The in-stream and riparian habitats in these ecoregions show a fair to **unacceptable** state, with the general condition being **poor** and fair in ecoregions 7.02 and 7.04 respectively. Biological communities also reflect fair to **unacceptable** health, with the streams in ecoregion 7.04 in a slightly better state than those in ecoregion 7.02.

Ecoregion 2.08 and 2.09

This section of the Bronkhorstspruit is good to fair. The Wilge is in an overall **good** state and the state of the Klein Olifants is fair. The riparian habitats and vegetation of the Olifants River in this section are generally in **good** health. In-stream conditions are more variable, ranging from **good** to fair

Ecoregion 2.10

This includes the Olifants River downstream of the Loskop Dam and the Moses River. In-stream habitat is in a fair state; fish are in fair to **poor** health, and invertebrates reflect **good** health. Riparian habitats and vegetation are in fair condition.

Ecoregion 3.02 and 3.04

River habitats in this region are in a **poor** to **unacceptable** state. The exception is upstream of the Rust de Winter Dam where the Elands River is in a fair condition. In-stream biota in the Olifants River is fair to **poor**, with the riparian vegetation being in a **poor** state. For the Elands River the riparian vegetation is fair, but in-stream biota varies from fair to **unacceptable**. The worst part is immediately downstream of Rust De Winter Dam, where the river is often dry because releases from the dam are insufficient or non-existent.

Ecoregion 2.14 and 2.15

The ecological state of the Tongwane and upper Mohlapitse Rivers is natural. Habitat conditions in the lower parts of the Mohlapitse River are more impacted, being fair, with invertebrates, fish and riparian vegetation reflecting natural **good** and fair health respectively. For both the Olifants and Steelpoort Rivers in this region, the biological indicators reflect a predominantly **poor** state with river habitats being in an **unacceptable** state.

Ecoregion 2.11

The Spekboom River is in a good state, with riparian vegetation slightly more impacted and reflecting fair health. The overall state of the Beetgekraal River is fair, with fish and invertebrates being good.

Ecoregion 2.12

The ecological state of the Steelpoort River is fair to **unacceptable**. The Spekboom River is generally in a good state. The habitats and riparian vegetation of the Waterval River are fair, while fish populations are good and invertebrates reflect a natural state of health.

Ecoregion 4.03 and 4.05

The Ga-Selati, Makhutswi, Blyde and Treur Rivers, as well as the Belvedere Creek are in good to natural ecological states. The present ecological state of the Spekboom River is slightly lower with the riparian habitats (good to fair) and fish (**poor**) being the worst components for this river. The Ohrigstad River has the lowest ecological state of the rivers in this region, with its overall condition being fair to **poor**. At places the state of in-stream and riparian habitats are **unacceptable**.

Ecoregion 5.05

The ecological state of the Klaserie River is good in terms of in-stream and riparian habitats, and in terms of fish populations. Invertebrates and riparian vegetation reflect a fair state.

Ecoregion 5.06

Upstream of the Phalaborwa Barrage, the Olifants River is in a fair to **poor** state in terms of in-stream and riparian habitat, while the biological indicators in general reflect a fair state.

The Blyde River is in an overall good state and in parts the fish population occasionally reflects natural health conditions.

The Klaserie River is in an overall good state, with fish and invertebrates occasionally reflecting natural health.

Ecoregion 5.02

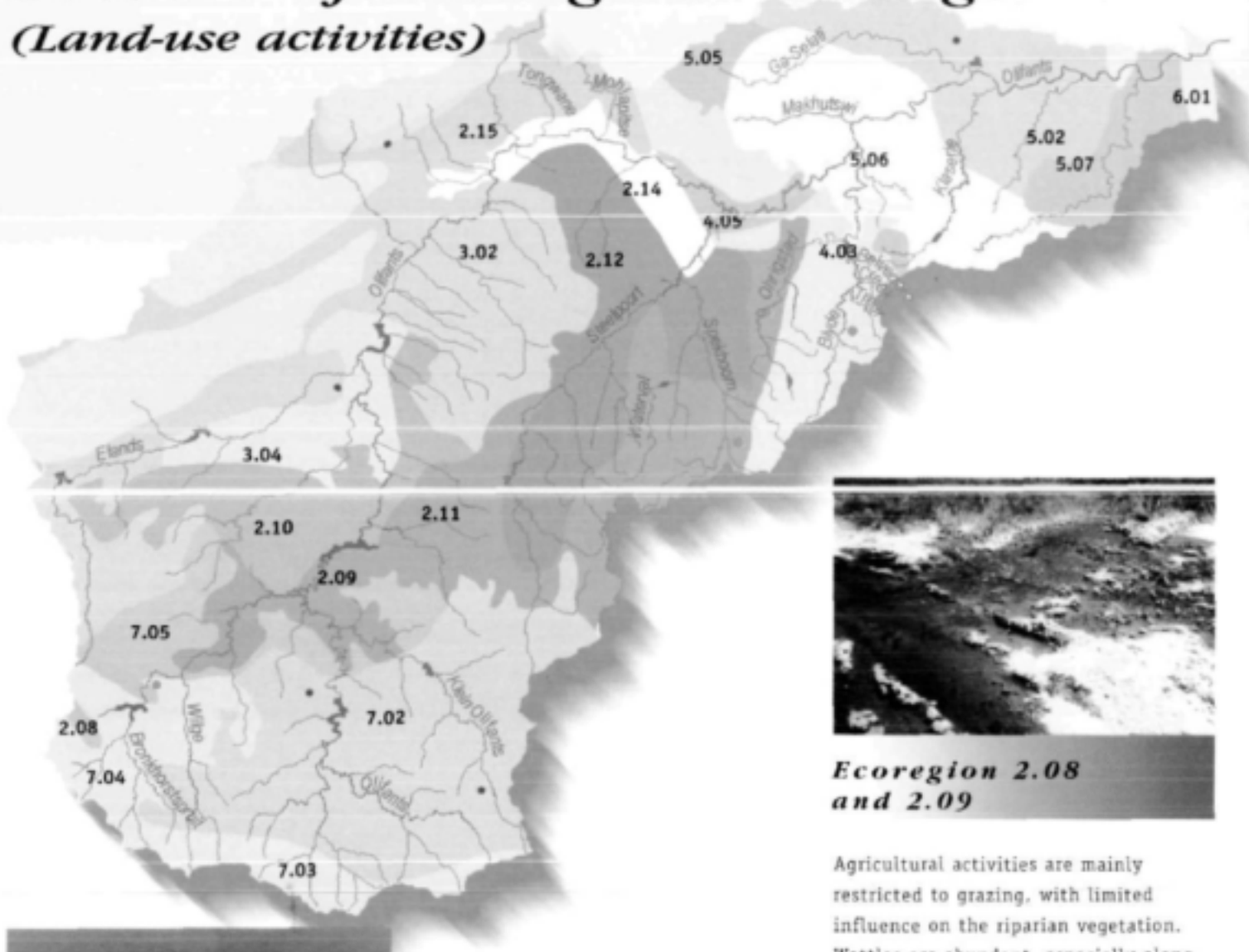
The Olifants River is generally in a fair state with fish and invertebrates occasionally reflecting **poor** conditions.The Ga-Selati is generally in a fair state with the state of fish and riparian vegetation being **poor**.

Ecoregion 5.07

In this region the Olifants River in general is in a fair state with good riparian vegetation.

Tree roots stabilise river banks and provide a refuge for fish.

The Olifants River System
Drivers of Ecological Change
(Land-use activities)



Ecoregion 7.02 and 7.04

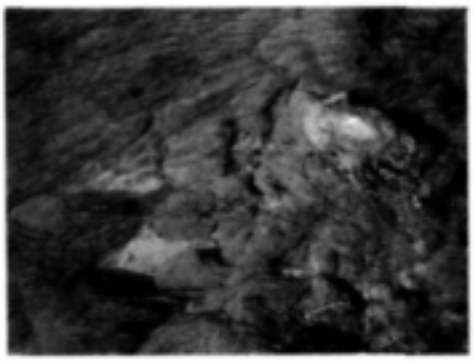
Mining, predominantly for coal, and other industrial activities in this area are the main contributors to poor in-stream and riparian habitat conditions. In-stream conditions are impaired by poor water quality, where acid leachate from mines is a primary contributor. Low pH (high acidity) and high concentrations of dissolved salts are characteristics of streams in this section. Stream diversions occur as a result of agricultural and mining activities. In some parts, access roads, mostly related to mining and industrial activities, have resulted in severe disturbance of riparian habitats, and increased erosion of both land and riverbed. In some places the riverbeds are eroded down to the bedrock, leaving little suitable habitat for fish and aquatic invertebrates. Alien plants such as wattles also occur within the riparian zone, competing with indigenous vegetation and reducing available water in the riparian zone. Overgrazing occurs in some areas.

Ecoregion 2.08 and 2.09

Agricultural activities are mainly restricted to grazing, with limited influence on the riparian vegetation. Wattles are abundant, especially along the Klein Olifants River. Conditions improve upstream of the Loskop Dam and downstream of the Bronkhorstspruit Dam, which overflows regularly. Water quality in the Olifants River is negatively impacted by the high acidity and high concentrations of dissolved salts in some of the tributaries, especially the Klip River.

Ecoregion 2.10

Intensive irrigation of crops (including fruit trees) extends from the Loskop Dam to Marble Hall. The heavy abstraction of water that this causes may reduce the available water for ecological functioning downstream. Commercial agricultural activities reach up to the



riverbanks. The clearing of ground cover associated with these activities increases the potential for erosion and sedimentation in the river channel. Alien vegetation is abundant. Pump houses and weirs impact negatively on the river ecology through changes to the flow regime. Aseasonal and ecologically insensitive releases from, or retention in, the Loskop Dam have an adverse impact on in-stream biological communities and cause erosion of the riverbed, through scouring.

Ecoregion 3.02

The riparian zone is in a degraded state due to deforestation within the riparian zone for small scale and subsistence agricultural activities or firewood collection. Cattle and goats graze in the riparian zone. Alien vegetation, including seringa (*Melia azedarach*), is abundant.

On the Elands River, downstream of the Rust de Winter Dam, river flow is extremely regulated with very infrequent releases. The regulation of flow has a severe impact on in-stream biota but does not seem to affect riparian vegetation, probably due to groundwater availability. Eucalypts grow very aggressively and infestations occur.

On the Olifants River the riparian vegetation is overgrazed and over-utilised. As a result, riverbanks are collapsing due to erosion, and sedimentation occurs in the riverbed.

Ecoregion 3.04

The Olifants River, upstream of the Arabie Dam, is impacted by agricultural activities. Runoff from commercial agricultural areas contains agro-chemicals, which cause eutrophication or contamination of water, either of which can impair the health of invertebrates and fish. Increased erosion and sedimentation is also a problem. The primary impact in the Elands River is ecologically insensitive releases of water from the Rhenosterkop Dam, for example no flow on one day followed by flooding the next. These artificial flow regimes change the riverbed, cause erosion and result in undesirable conditions for in-stream biological communities.

Ecoregion 2.15

The Wolkberg Wilderness Area is a high priority conservation area, and river conditions within the reserve reflect this. The Mohlapitse River is a very good refuge for fish species, as it runs through part of the Wilderness Area, where stream conditions and habitat integrity are good.

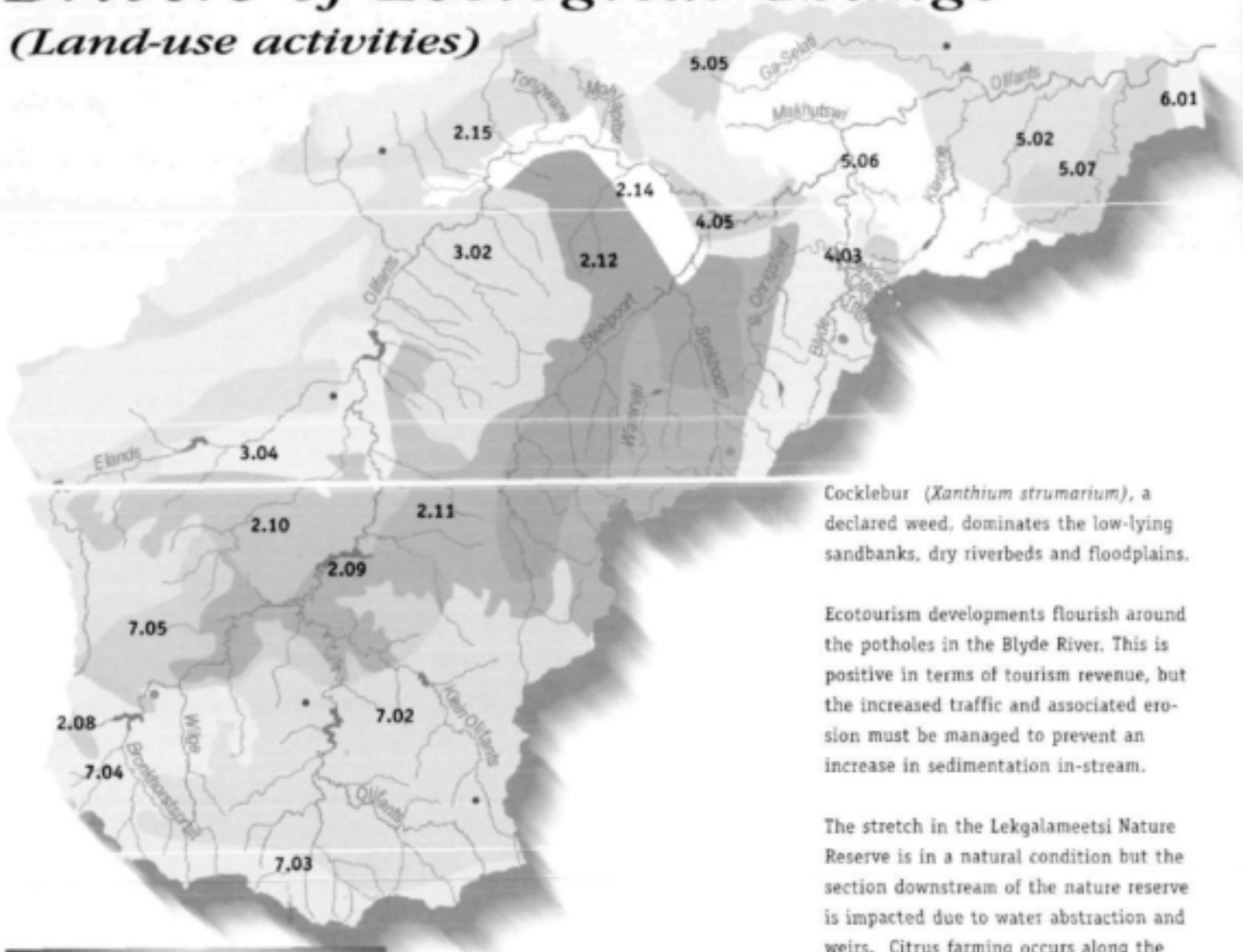
Ecoregion 2.14

Outside the Wolkberg Wilderness Area, land and vegetation are generally highly degraded due to bad land practices and over utilisation. In most parts riparian vegetation is completely absent. Small-scale and subsistence crop cultivation are found in this region, as well as commercial banana plantations. Sections of the riverbank are seriously degraded due to clearing for planting of these crops, and for collection of fuel. The riparian vegetation is heavily grazed, and donga erosion is common in the riparian zone.

Ecoregion 2.11 and 2.12

Overgrazing, and dryland cultivation throughout the ecoregions, including in the riparian zone, leads to erosion, which causes high silt levels in the rivers. Smothering of in-stream habitats and fish gills results in loss of invertebrate and fish species. Siltation also increases the risk of flooding. Runoff from mines and other activities lowers the water quality in this ecoregion, and conditions are not likely to improve in the short term.

The Olifants River System
Drivers of Ecological Change
(Land-use activities)



Ecoregion 4.03 and 4.05

Soils in this ecoregion are highly erodible. The situation is worsened by intensive cultivation and grazing, which have caused general degradation of land cover. Serious erosion of the riparian zone of the Olifants and Ohrigstad Rivers occurs. In particular, sediment from Sekhukuneland settles here, resulting in siltation and loss of habitat.

Cultivation and grazing also causes the riverbanks to destabilise, undercutting occurs and riverbanks are swept away by floods. Increased silt loads lead to high water turbidity and sedimentation on the riverbed. In addition to the loss of physical habitat, fine particles also have an irritating and clogging effect on the gills of fish and some aquatic invertebrates.

Agricultural activities next to the Blyde River include commercial citrus irrigation. Runoff contaminated with agrochemicals may result, as well as increased erosion and sedimentation due to the clearing of land under the fruit trees.

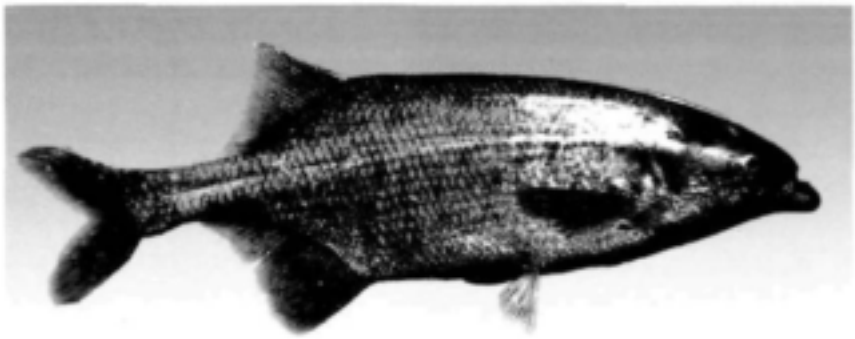
Cocklebur (*Xanthium strumarium*), a declared weed, dominates the low-lying sandbanks, dry riverbeds and floodplains.

Ecotourism developments flourish around the potholes in the Blyde River. This is positive in terms of tourism revenue, but the increased traffic and associated erosion must be managed to prevent an increase in sedimentation in-stream.

The stretch in the Lekgalameetsi Nature Reserve is in a natural condition but the section downstream of the nature reserve is impacted due to water abstraction and weirs. Citrus farming occurs along the banks.

The Makhutswi River flows through a reserve area and the ecological status is good to natural. Trout farming in the Spekboom River has resulted in the loss of indigenous fish species. Many weirs impact the river flow and change the habitat. In spite of this, the water quality is very good. The Blyde River gorge has been cleared of alien species like wattles and pines, and water from the Blyde River generally improves the water quality in the Olifants River downstream of their confluence.

The Belvedere Creek flows through the Blyderivierspoort Nature Reserve. Rare fish species like the Rosefin Barb



Bulldog fish (*Marcusenius macrolepidotus*): indicator of good water and habitat quality.

(*Barbus argenteus*) have been recorded in this ecoregion. The Belvedere Creek is the only place in the Limpopo system where this species is found.

The Treur River forms part of the Blyderivierspoort Nature Reserve. *Barbus treurensis* disappeared from the Treur River in the 1960's. It was, however, rediscovered in the upper Blyde River during the 1970's. This section of the Blyde River was proclaimed a National Heritage Site in 1985. The Natal Mountain Catfish (*Amphilius natalensis*) also occurs in this part of the Blyde River (the only isolated population in the Limpopo System). The reintroduced Treur River Barb now flourishes in the upper reaches of the Blyde River. The Treur River is also one of the few places where dobson flies are found (they usually occur in mountainous areas of the Western Cape, KwaZulu-Natal and Mpumalanga).

Alien vegetation occurs in the riparian zone of the upper reaches.

Trout are found in the Ohrigstad River. Flow regulation and abstraction, especially in the upper parts of the Ohrigstad River, cause the river to dry up in places during dry periods. Tobacco farms near Ohrigstad have an impact on river habitats. Water abstracted for agricultural purposes changes river flow downstream. The river is completely dry in areas. Flow regulation by Ohrigstad Dam during dry periods results in sedimentation and scouring of the riverbed. Alien vegetation is abundant along the Ohrigstad River.

Ecoregion 5.05

This area is mainly an agricultural (citrus farming) and conservation area, with forestry in the uppermost part. Plantations close to the river, cause in-stream sedimentation.

Ecoregion 5.06

The health of the Olifants River improves downstream of the confluence with the Blyde River, as the water coming in from the Blyde River is of better quality than that in the Olifants River. Timeshare developments and other houses have been built in the riparian zone, requiring clearing of vegetation and increased risk of erosion. Mango and citrus orchards, which also allow little ground cover, flourish. Ecologically insensitive releases for irrigation are a major problem to habitats and communities downstream of the Blyderivierspoort Dam. Very wide stretches of exceptionally well-developed riparian vegetation occur. The Bulldog fish (*Marcusenius macrolepidotus*) are abundant in the lower Blyde River. This species is particularly sensitive to high salinity as it uses electromagnetic pulses to find food and mates, and thus its presence is indicative of good water and habitat quality.

Ecoregion 5.02

Sediment, from upstream activities including overgrazing and industrial and mining activities, accumulates in the Phalaborwa Barrage. When the barrage is flushed out from time to time, large quantities of sediment are released. This causes severe damage to in-stream habitats and biota in the downstream part of the Olifants River. Fish die from oxygen depletion or are smothered by silt clogging their gills.

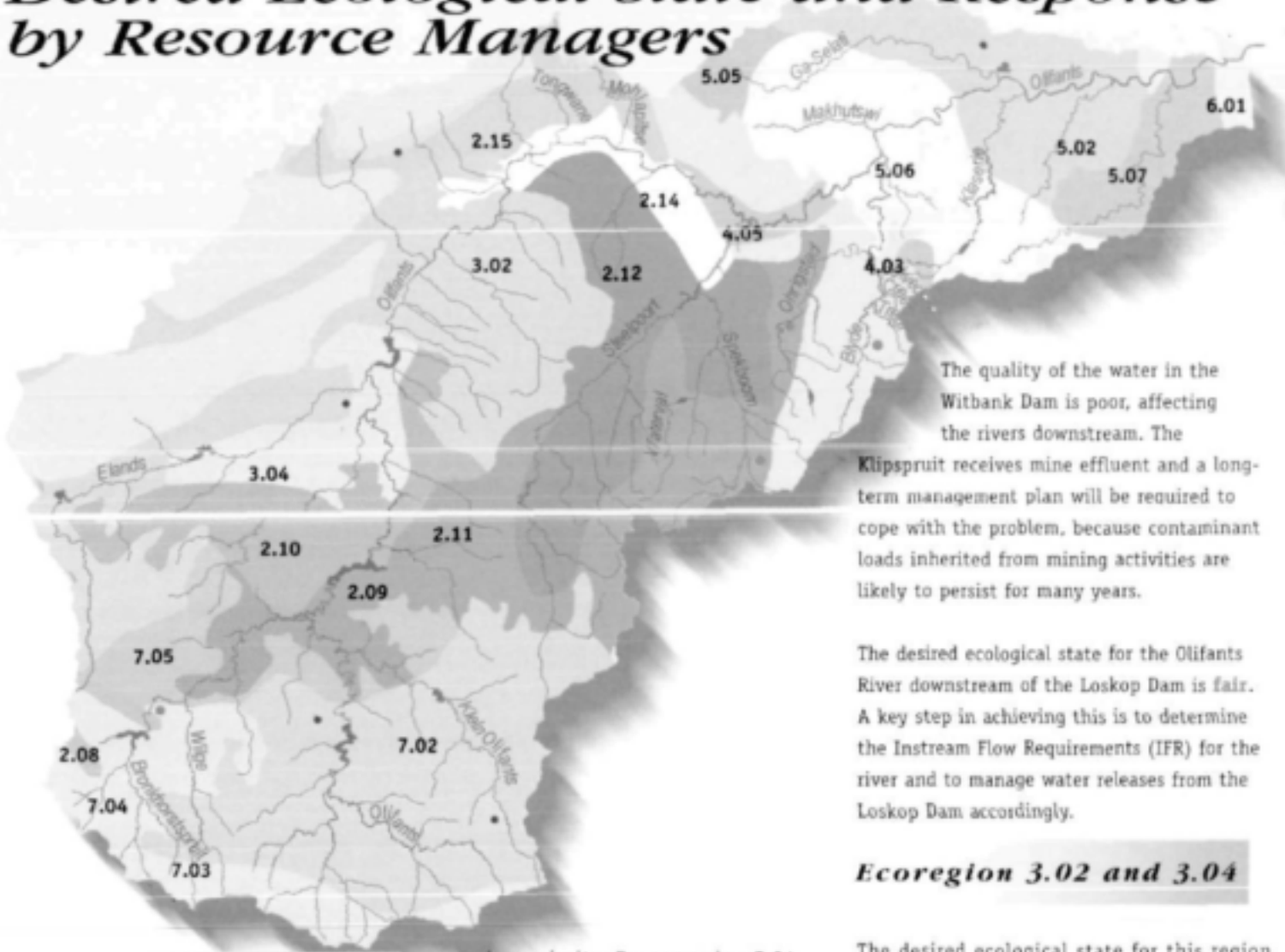
Heavy metals and chlorides from industrial and mining origin in the Phalaborwa area may reach unacceptable levels during low flow periods. Upstream abstractions from the Ga-Selati River cause flow to cease during winter. The lower section of the Ga-Selati is impacted by upstream water abstractions.

Ecoregion 5.07 and 6.01

The water quality of the Olifants River in this section is lower than is desirable, with high concentrations of dissolved salts having accumulated due to the activities in the upper reaches of the catchment. The Massingire Dam, across the border in Mozambique, causes the river flow to decrease during floods and results in sediment being deposited in the gorge.

The Olifants River System

Desired Ecological State and Response by Resource Managers



The quality of the water in the Witbank Dam is poor, affecting the rivers downstream. The Klipspruit receives mine effluent and a long-term management plan will be required to cope with the problem, because contaminant loads inherited from mining activities are likely to persist for many years.

The desired ecological state for the Olifants River downstream of the Loskop Dam is fair. A key step in achieving this is to determine the Instream Flow Requirements (IFR) for the river and to manage water releases from the Loskop Dam accordingly.

Ecoregion 7.02 and 7.04

The upper reaches of the Olifants River system are heavily utilised. Yet, in the interest of downstream users, and to ensure sustainable development of the entire catchment, the ecological state of this section cannot be compromised. A short-term management state of poor may be the only realistic option for streams within ecoregion 7.02. However, the long-term goals should be to aim for a fair state. Both in-stream water quality and riparian conditions will need to improve to achieve this. The effluent from mining and other heavy industry will have to be treated before release into the river, and clearing of alien vegetation in the riparian zone is a priority. For ecoregion 7.04, the recommended management state is fair. Rehabilitation and protection of the many important wetlands in the upper part of this ecoregion are management priorities.

Ecoregion 2.08, 2.09 and 2.10

A good ecological state is desirable for the Wilge and Olifants Rivers. A large part of the Olifants River in this region lies in a scenic gorge with relatively high ecological importance and sensitivity. The desired ecological state for the Klein Olifants River and the Bronkhorstspruit is fair.

Wattles pose a threat to river health throughout these ecoregions. Their control or eradication is essential.

Ecoregion 3.02 and 3.04

The desired ecological state for this region is fair. Eucalypts (*Eucalyptus spp.*) Sesbania (*Sesbania punicea*), Jacaranda (*Jacaranda mimosifolia*) and Seringa (*Melia azedarach*), have the ability to spread aggressively, especially along streams and riverbanks, and should be contained and eradicated where possible. Water release management from Rust de Winter, Rhenosterkop and Arabie Dams must be improved. On the Olifants River the lowland floodplain is ecologically significant as it serves as a refuge area for fish. For this reason the area around the floodplain must be maintained in a good condition.

The determination of an ecological reserve and associated in-stream flow requirements will provide the basis for future improvements.

Ecoregion 2.14 and 2.15

The desired ecological state for the Tongwane River and the part of the Mohlapitse in ecoregion 2.15 is natural. These are high priority conservation areas. The Mohlapitse River further downstream is utilised more intensively, but also represents an important refuge area for many fish species and lies near a wilderness area. As such, the short-term desired state could be **good**, with a long-term aim of upgrading this section to a natural state. The Working for Water Programme has identified this as a priority area for clearing of triffid weed (*Chromelaena ordata*).

Ecoregion 2.11 and 2.12

The desired ecological state for the Spekboom River is **good**, and for the Beetgekraal, Steelpoort and Waterval Rivers it is fair.

Ecoregion 4.03 and 4.05

The desired state for the Makhutswi, Blyde and Treur Rivers, as well as for the Belvedere Creek, is natural. The Ga-Selati and Spekboom Rivers should be managed for a **good** state. A pragmatic management goal for the Origstad River is to achieve a fair state. However, the gorge-section that falls within the Blyderivierspoort Nature Reserve should be managed so as to maintain a good state. The Working for Water Programme has earmarked that area for alien clearing in 2001, particularly with respect to wattle, pine and eucalypts.

Flow regulations during dry periods should be improved.

Realistically, the Olifants and Steelpoort Rivers can only be maintained in a **poor** state, due to the nature and extent of activities in the catchment, which are likely to continue for a long time.

Ecoregion 5.05 and 5.06

The Blyde River in this area forms part of the "Kruger to Canyon" biosphere reserve initiative. This initiative will focus management towards conservation for a natural river state, as good water quality in this region is critical for maintaining water quality downstream in the Kruger National Park and other conservation areas.

The management goal for the Klaserie River is to maintain the river in a **good** ecological state.

Alien species like the wattle should be controlled. In order to control *Xanthium strumarium*, programmes will have to include the bigger catchment area since the seeds are spread by water.

The desired state for the Olifants River is fair.

Ecoregion 5.02 and 5.07

Given the conservation importance of this region, the desired ecological state of the Olifants River is set at **good**. The reason why it is not natural is because of the intensive utilisation of the water resource in the upper and middle parts of the catchment, which deems a natural state for the lower part to be unrealistic.

Water quality should be improved. Silt should be cleaned from the Phalaborwa Barrage. Flow regulation can be improved to reduce negative impacts on downstream fish and invertebrate communities.

Lantana (*Lantana camara*), wild tobacco (*Nicotiana glauca*), common cocklebur (*Xanthium strumarium*) and castor oil bush (*Ricinus communis*), amongst others, are declared weeds and should be eradicated.

Private land owners have formed a conservancy and set aside more than 33 000 ha of land (from Gravelotte to Phalaborwa) to be managed as the Selati Game Reserve. This change in land-use is expected to improve river health conditions in this area and downstream. The long-term aim of this conservancy should be to reach a **good** ecological state for the Ga-Selati.

Summary

What is the overall state of the rivers in the Crocodile, Sabie-Sand and Olifants Catchments?

The Crocodile System

The overall condition of river ecosystems in the Crocodile system is **good** to fair, although there is considerable variation in condition between the different components of river health. Riparian habitats and vegetation appear to suffer most in this catchment, mainly due to alien infestation and clearing of ground cover in or near the riparian zone. Fish and invertebrate communities are generally in better health, reflecting **good** water quality and in-stream habitat conditions. An exception occurs in the middle parts of the Crocodile River in the vicinity of Nelspruit, where both in-stream biota and riparian vegetation are in fair to **poor** health.

The Sabie-Sand System

The overall condition of river ecosystems in the Sabie-Sand system is **good**, aided in the lower parts by the conservation measures implemented by the Kruger National Park and neighbouring private game reserves. However, there are patches where the conditions are **poor** and even **unacceptable** (e.g. Sabane and Klein Sand Rivers), especially with reference to invertebrates and riparian vegetation. This again is caused by the clearing of riparian vegetation and a subsequent increase in erosion, together with infestation of alien plants in the riparian zone. The health of invertebrate communities suffer due to siltation and sedimentation.

The Olifants System

The Olifants Catchment experiences extreme demand for natural resources, and associated land modification and pollution. Thus, river ecosystems in this area are generally in a fair to **poor** condition. Exceptions are the Tongwane, upper Mohlapitse, and most of the Blyde Rivers, where a natural state prevails, and the lower reaches of the Olifants River, which is protected by conservation activities.

In the upper parts of the catchment, mining-related disturbances are the main causes of impairment of river health. There is also an extensive invasion by alien vegetation, and to a lesser extent, alien fauna. Ecologically insensitive releases of water and sediment from storage dams are another major cause of environmental degradation downstream, which is particularly relevant in the middle and lower parts of the catchment.

What are the consequences of poor river health?

River health is an integrated measure of various conditions that are necessary for proper ecosystem functioning and the ability to supply good quality water and other services (such as shade, food, grazing, medicinal plants, and denitrification). Poor river health reflects a drop in one or more of these conditions, which may in turn, lead to a disturbance in trophic level interactions due to increased levels of toxicity or loss of predator or prey species, reduced ability to regulate water quality and flow, and reduced water availability to support domestic water requirements, agricultural irrigation and industrial processes. When water quality is compromised, it can become unfit for human consumption (drinking, cooking, and sanitation). Severe reduction in water quality may render it unfit for irrigation of crops or for industrial processes. Lack of water to meet these needs constrains our human subsistence and development.

These impacts have other knock-on effects such as increased expenditure and effort on water treatment, loss of biodiversity and increased dependence by humans on a few species of plants and animals to meet food, fibre and construction needs. It also renders ecosystems more vulnerable to change. Extreme events such as flooding and drought can be more frequent and more severe, when river ecosystems are compromised. For example, when in-stream sedimentation rates are enhanced (due to erosion in the riparian zone), the water level in a river is raised. Such a river is more likely to flood during heavy rainfall, because the buffering capacity has been reduced, and the area inundated is likely to be larger, than a river with a lower initial water level. Outbreaks of pests and diseases often have a bigger impact in communities of fewer species, and communities may take longer to recover to their natural state.

Furthermore, reduction in river health in one part of the river may have knock-on effects downstream, such as increased siltation and blocking of river mouths. The cumulative effects of poor river health upstream will have a far greater impact on downstream stretches, and if downstream stretches are themselves compromised, the river may not be able to tolerate and recover from the effects. For this reason it is important to monitor the pressures and the management responses as well as actual river conditions, in order to establish if conditions are likely to improve or worsen, and if the responses are being effective.

The importance of sustainable water use cannot be over-emphasised for long term economic, social and environmental security.

Priority actions for these catchments include:

- Wetland protection and rehabilitation in the areas of the headwaters of these rivers
- Control of alien plants especially in riparian zones, in all catchments
- Control of effluent and mining related seepage in the upper reaches of the Olifants Catchment
- Release from storage dams should be based on ecological flow requirements, especially in the Olifants Catchment
- Strategic assessment and management of the trout industry in the Crocodile Catchment
- Control of agricultural activities that involve clearing of ground cover (especially near to the riparian zone) in the Sabie Catchment

Where to from here with State of the Rivers reporting?

This is the first in a series of products that have been specifically designed to communicate the results and recommendations of the River Health Programme.

In time, all the major catchments in South Africa will be covered, and the assessment will be repeated to show whether conditions are improving or declining, and whether our responses and management activities are effective.

To find out more about the River Health Programme, visit
www.csir.co.za/rhp/

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