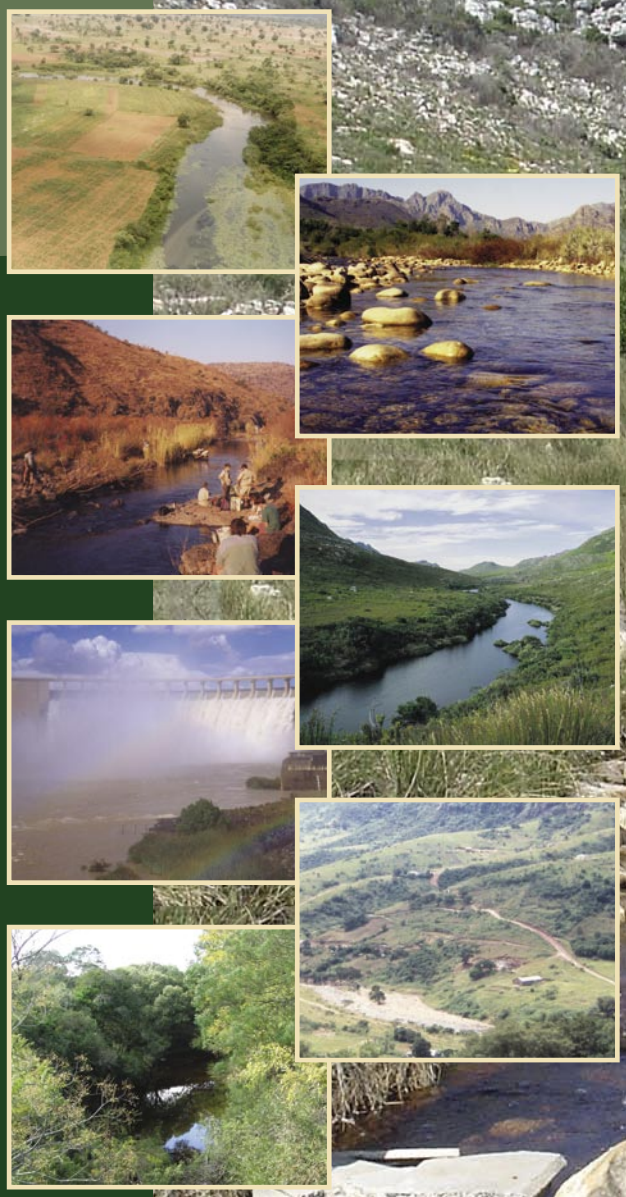
Achievements of the River Health Programme 1994 - 2004: A national perspective on the ecological health of selected South African rivers

The National Aquatic Ecosystem Health Monitoring Programme
(River Health Programme)



Water Affairs and Forestry
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Foreword

The principles of sustainability and equity are the cornerstones of the SA water policy. The protection of aquatic ecosystems is recognized as essential in order to support ecosystem sustainability and optimal use. The Aquatic Ecosystem Health Monitoring Programme (or the South African National Aquatic Ecosystem Biomonitoring Programme as it was known at the time) was initiated 12-years ago, in 1994 through collaboration with the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC). During the past 12 years the programme has mainly focused on the health of river ecosystems, and has become generally known as the River Health Programme (RHP). The RHP has truly become the flagship for the water resources monitoring programmes operated by the Department of Water Affairs and Forestry (DWAF). It is therefore proper that the RHP reflects back to its humble beginning, by producing a comprehensive picture of the ecological health conditions in the rivers assessed by the RHP in the past 10 years. Since 1998 the RHP has systematically produced eleven State of Rivers (SoR) reports.

These reports were based on the information collected by a large number of stakeholders on a national, local and regional level and embraces their commitment in terms of co-operative governance. Though the RHP was initiated by the Department of Water Affairs and Forestry (DWAF), it received huge voluntary support from various organizations, such as the South African National Parks, the Universities, and several Water Boards as well as some provincial governments. This informal set-up was largely driven and sustained by a committed willingness by all participants and DWAF greatly acknowledges all participants for their dedicated commitment and ongoing support. Financial assistance for production of the reports, was provided by DEAT. These reports serve as important inputs into DEAT's State of the Environment reporting. Throughout these years the WRC provided support in terms of research and development of biomonitoring methods. The WRC also contributed to a highly successful capacity building drive and environmental awareness processes and continues to do so.

The RHP products in the past ten years have proved to be of immense value to water resource managers as well as the public. Water resource managers regularly use the information for the protection and sustainable utilization of our water resources, whilst the State of River's reports are also used very effectively as training materials by schools and universities. There is for example no Water Week event that takes place without reference to the RHP benefits, in terms of creating awareness of the health of aquatic ecosystems and their importance in keeping our rivers fit for use.

The programme is currently expanded to link up with wetlands and estuarine monitoring initiatives, to fulfill in the requirements of integrated water resource management and to promote sustainable use of our aquatic resources.

Mbangi Nepfumbada
Chief Director: Water Resource Information Management
Department of Water Affairs and Forestry

The Department of Environmental Affairs and Tourism, as one of the custodians of the River Health Programme (RHP), is proud to be associated with this progressive initiative. Over the past 10 years, the programme has grown from strength to strength, providing critical baseline information for water resource managers. One aspect of the RHP that is particularly commendable is the special emphasis that is placed on the transformation of information into forms more useful for decision-making and on targeting information at different user groups. The considerable effort that has gone into disseminating the information generated by the RHP to the general public through the publication of State of River reports and posters, using both electronic and non-electronic formats, is starting to pay off. There surely is increased awareness and understanding of the challenges we face in managing our water resources in rivers. Information generated by the RHP also proved its worth in the Spatial Biodiversity Assessment and is an invaluable source of information for the National State of the Environment Report.

This publication highlights some of the achievements of the last decade. My wish is that through the continued efforts of the RHP, the health of all our river systems will be assessed and that in 10 year's time, we can report on the ecological health of all our major rivers systems.

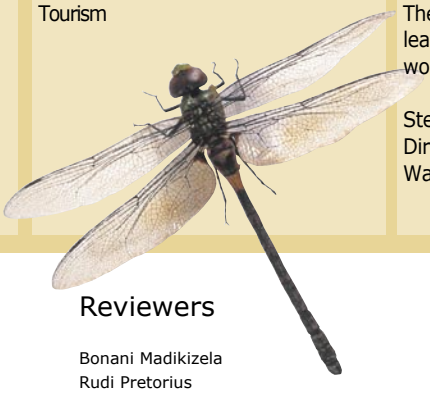
Rudi Pretorius
Director: State of the Environment
Department of Environmental Affairs and Tourism

The River Health Programme (RHP) is unique and it is a privelege for the WRC to be one of the custodian organisations. From the beginning the decision was taken that this would not be a wholly government funded programme. The RHP has grown from strength to strength and has reached right across the country and across the spectrum of water users. The process has served to bring people from both public and private sectors into close collaboration and this has strengthened the governance networks in the catchments which have been covered by the RHP. A number of 'State of the River' reports have been produced and these reflect the evolution of the programme. Innovations have been introduced throughout the process which reflect both the growth of the Programme as a whole as well as the specific needs of the catchments being addressed. The one thing that has not changed, however, is the dragonfly. The dragonfly has been the emblem of the RHP from the beginning and has served to brand all the RHP products, providing continuity in an otherwise diverse programme.

The RHP has proved its worth for the Department of Water Affairs where it provides benchmark data against which future changes will be measured. It has equally proved its worth for industry where water utilities are able to cost-effectively monitor the resource frequently enough to ensure the safety of their customers. It is used by a range of other industries to monitor their activities.

The achievements of the first decade lead us to anticipate an exciting and worthwhile future.

Steve Mitchell
Director: Water-linked Ecosystems
Water Research Commission



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Executive Summary

The formal name of the programme was the National Aquatic Ecosystem Biomonitoring Programme (NAEBP). Since the focus was on riverine ecosystems, the rivers component of the NAEBP was popularly known as the River Health Programme. To conform to the National Water Act (Act No. 36 of 1998) the biomonitoring programme expanded to include other monitoring programmes and is now called the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The brand name RHP will continue to be used for the riverine component of the national monitoring programme.

This report is an overview of the planning, implementation and operation as well as the achievements of the River Health Programme (RHP) during the first decade of its existence, from 1994 until 2005. It also provides a national perspective on the ecological health or integrity of a number of South African rivers that have been reported on as part of the RHP during this period.

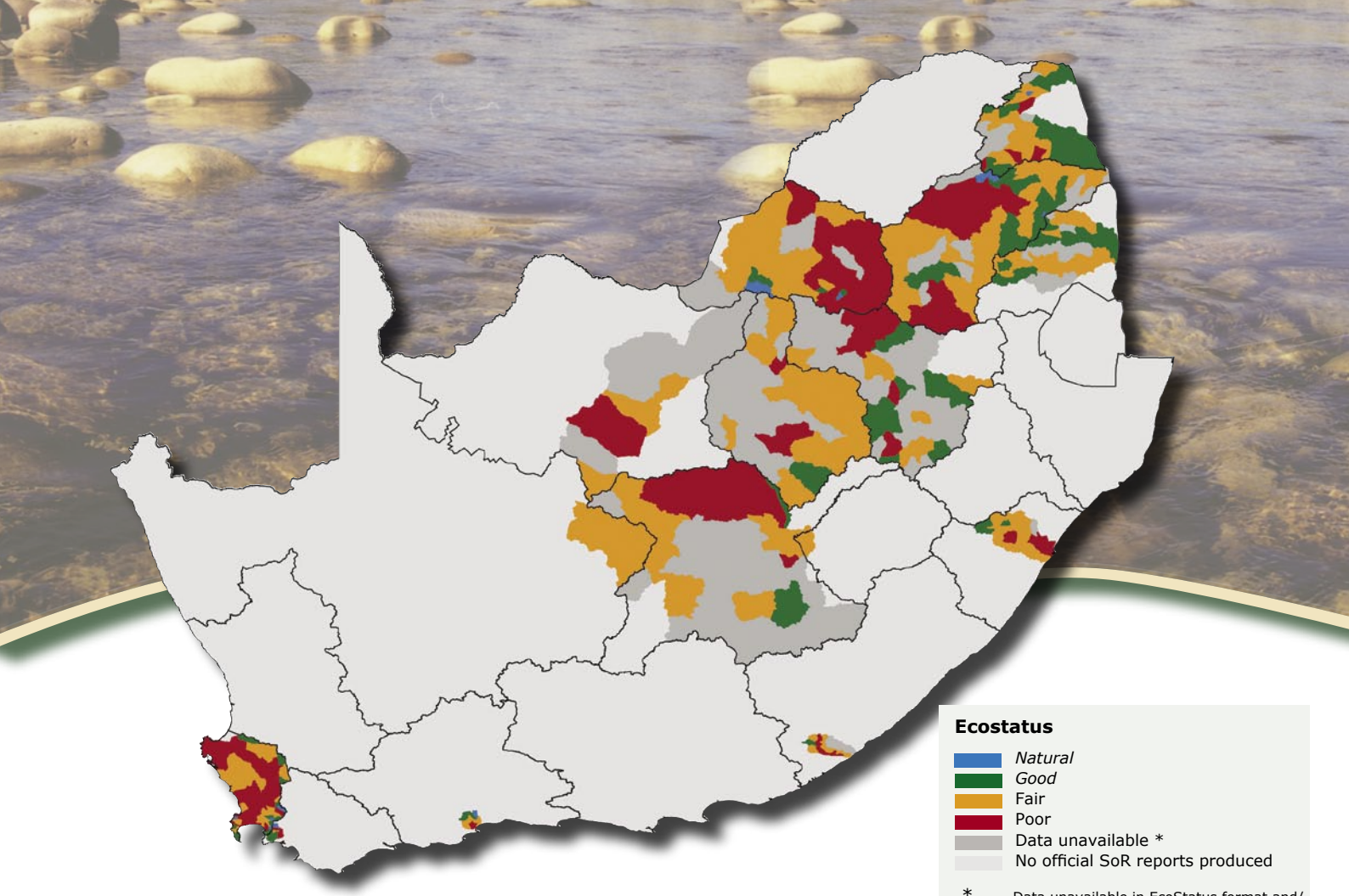
The RHP was initiated as a response to the need for more detailed information on the state of South Africa's aquatic ecosystems, at a time when the Department of Water Affairs and Forestry's management focus was broadening from end-of-pipe monitoring to an integrated water resource management approach. It was gradually realised that water resource quality information alone would not be sufficient to supply the right type of reliable and sophisticated information needed to manage our water resources on a sustainable basis. One of the shortcomings of conventional water resource quality information is that it is not able to detect the cumulative effects of stressors on aquatic ecosystems. The RHP uses several ecologically based approaches and methods to determine the state of river ecosystems. In short, the RHP measures the effect of change in the environment as it manifests in the composition and abundance characteristics of biological communities.

The people who initiated the RHP in the Department of Water Affairs and Forestry (DWAF), the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC) saw the potential for ecosystem health assessments to provide the information needed for informed water resource management actions. Their vision and foresight, combined with the dedication and tenacity of those who joined the RHP, have built a national programme that monitors our rivers and provides Water Resource Managers with valuable information that enables them to make informed decisions.

The RHP followed a phased approach: The initial Framework Design Phase (1994 – 1995) was followed by the Conceptual Development Phase (1995 – 1996). Thereafter, during the Pilot Implementation Phase (1996 – 1999), the concepts were tested and refined in the Crocodile River in Mpumalanga. After this successful pilot testing the programme was rolled out in all provinces - Anchoring Phase (2000 – 2003). The National Coverage Phase (2004 onwards), with the purpose to establish the RHP as a national programme, review the objectives of the programme and align it with the requirements of the NWA.

The information that the RHP provides from detailed monitoring site data is a condensed summary of the present state of the river at that site. The present state of a river system, when determined for several sequential years, can show whether the people in a catchment are using their resource in a sustainable way: is the resource improving, staying constant or is it in decline? If it is in decline, then those responsible for managing the catchment have advance warning that they need to prevent degradation of the system to a point where it can no longer meet the needs of society or, even worse, presents a hazard to society. If the present state is improving or remaining constant, then the river is able to continue delivering the goods and services expected of it. The four classes that the RHP uses for classifying rivers are poor, fair, good and natural. A river in the poor class has been exploited and degraded to such an extent that it presents a potential hazard to users: for example, children playing in the water could contract diseases, or farmers irrigating crops could contaminate their produce, rendering it unfit for consumption. A river in the fair class is seen as a "workhorse" river, delivering its maximum capacity (although with some loss of quality). A good class river provides much benefit to users, with some additional capacity to improve the health of ecosystems downstream. The rarest class, natural, describes rivers that are located in ecologically important and sensitive areas and which are virtually untouched by human activities. Maintaining the biodiversity and integrity of these natural rivers is important for ensuring that they supply downstream aquatic ecosystems and users with a consistent supply of good quality water.

Many of South Africa's rivers originate in protected areas or in high lying headwater areas where human impact is minimal. As a result, these rivers, or some of their upper reaches, are in a good or natural state. Further downstream, the increasing demands for water to meet human needs such as urban developments, road construction, and industrial, mining and agricultural activities degrade the ecological state of our rivers to fair or poor classes. The EcoStatus values are a useful summary of the ecological state or health of rivers. Fortunately, a river system is resilient and has a remarkable ability to restore or rehabilitate itself, provided the correct set of conditions prevail. This is seen, for example, in areas where fair to poor rivers enter conservation areas where human interference is minimal. Aquatic ecosystem data recorded downstream of such areas show an improvement in river health. The map on the next page summarises the EcoStatus results for those South African rivers for which State-of-Rivers (SoR) reports were produced.



The map above shows the ecological status (EcoStatus) of the rivers discussed in this report. The EcoStatus refers to the overall condition or health of a river.

The RHP faces many challenges, but there are also excellent opportunities to develop the RHP into a successful national programme. For the RHP to have a meaningful effect on the state of South Africa's rivers the following matters need urgent attention:

- Finalisation and implementation of the classification system
- Setting of the Reserve and resource quality objectives (RQOs) and implementation of in-stream flow requirements
- Ensuring compliance with control measures through continued monitoring
- Expanding the capacity and expertise base through support, training and guidance
- Refining and implementing indices in all regions
- Clarification of roles and responsibilities between DWAF and other government departments where overlaps exist regarding the management of wetlands, estuaries and groundwater
- Assisting all implementation functions through the neces-sary managerial support in the form of budgets allocated and resources allocated
- Continuing communication and awareness creation to convince decision-makers and water resource managers that action should be taken in response to RHP monitoring results
- Expanding the RHP and continuing River Health Monitoring and Reporting to become representative of South Africa

Water Resource Managers have a responsibility to ensure that our rivers are not exploited beyond sustainable levels. However, The Department of Water Affairs is not solely responsible for implementing the necessary management actions. Other responsible authorities and individuals that share responsibility for the implementation of management actions include: Department of Environmental Affairs and Tourism; National Department of Agriculture; Department of Minerals and Energy; Provincial Departments of Conservation and Environmental Affairs; Working for Water; individual landowners and agricultural organisations; property developers; rural communities; district and local municipalities; industry and mining; Water User Associations and the future Catchment Management Agencies.

During the past decade, the different State-of-Rivers reports have become flagship products of the River Health Programme, and have gained wide acceptance and popularity amongst managers, specialists and the general public. This system of monitoring and reporting should be expanded and used as a means of continuing to inform South Africans on the state of our rivers, to show areas where irreversible damage may have been done, and to show trends where appropriate management actions have been successful.

Introduction and Background

Just over a decade ago, the Department of Water Affairs and Forestry initiated the South African River Health Programme (RHP). This report reflects on how the Programme has developed and matured into a fully fledged National Programme, driven by dedicated scientists and managers at national and provincial level. The report also highlights the achievements of the programme and sets out the challenges for the future.

The information provided by the RHP helps water resource managers to understand how aquatic ecosystems function and respond to multiple stressors. This knowledge enables managers to intervene appropriately. The ecological integrity or health of a river can therefore be managed in such a way that it ensures a continuous stream of sustainable benefits to society. Without the information provided by the RHP, the returns from such widely divergent economic activities as agriculture and industry would be reduced; human health would be compromised; and the benefits derived from sense of place or aesthetic beauty would ultimately be reduced. Seen in this light, the worth of the RHP far outweighs the running costs.

Why do we Protect our Aquatic Resources?

Water is the natural resource most fundamental to human and wildlife survival. In South Africa water is a scarce and precious commodity and efficient management of our water resources has a direct bearing on our standard of living and economic benefit.

Rivers have a natural ability to resist negative changes induced by humans. There are however limits beyond which this capacity can become overloaded. If these limits are exceeded for extended periods, a river will lose its ability to adapt to changes and to restore or rehabilitate itself. It will lose its value as a habitat for plants and animals, lose important functions and, ultimately, become worthless to people as a natural resource.

In order to effectively manage, conserve and protect aquatic resources, we have to understand how different water and land uses affect the health of aquatic ecosystems. By measuring the biotic and habitat components of aquatic ecosystems, we are able to assess the overall condition or health of these ecosystems. This provides important information to water resource managers to make informed decisions and to take action.

The Value of our Rivers

River ecosystems provide goods and services to society.In the past, society paid little attention to the importance of ecosystems and their value. River ecosystem goods and services are used as inputs to other production systems, for supporting ecological functioning and for improving human well-being. These goods and services may be used now or set aside for potential use in the future. Typically ecosystem goods are used directly as they are harvested for consumption or production, for example: water for drinking or industrial cooling, medicinal plants, firewood, fishing and reeds for thatching. Ecosystem services tend to be used indirectly because they support other activities, for example: eco-tourism (such as swimming or bird-watching), medicinal plants, cultural rituals, ground water recharge and waste disposal. The diagram on the facing page explains the use value (direct value and indirect value) and non-use value of our river ecosystems. When the health of a river deteriorates, the use values - all the direct and indirect values obtained from the river system - are compromised and the economic contribution of the river system to society declines.

Vision & Objectives of the River Health Programme

The long term vision of the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) is to implement, maintain and improve biomonitoring for all inland aquatic ecosystems in South Africa and throughout the southern African region. It is envisaged that the programme will eventually cover all surface water resources, including wetlands and estuaries.

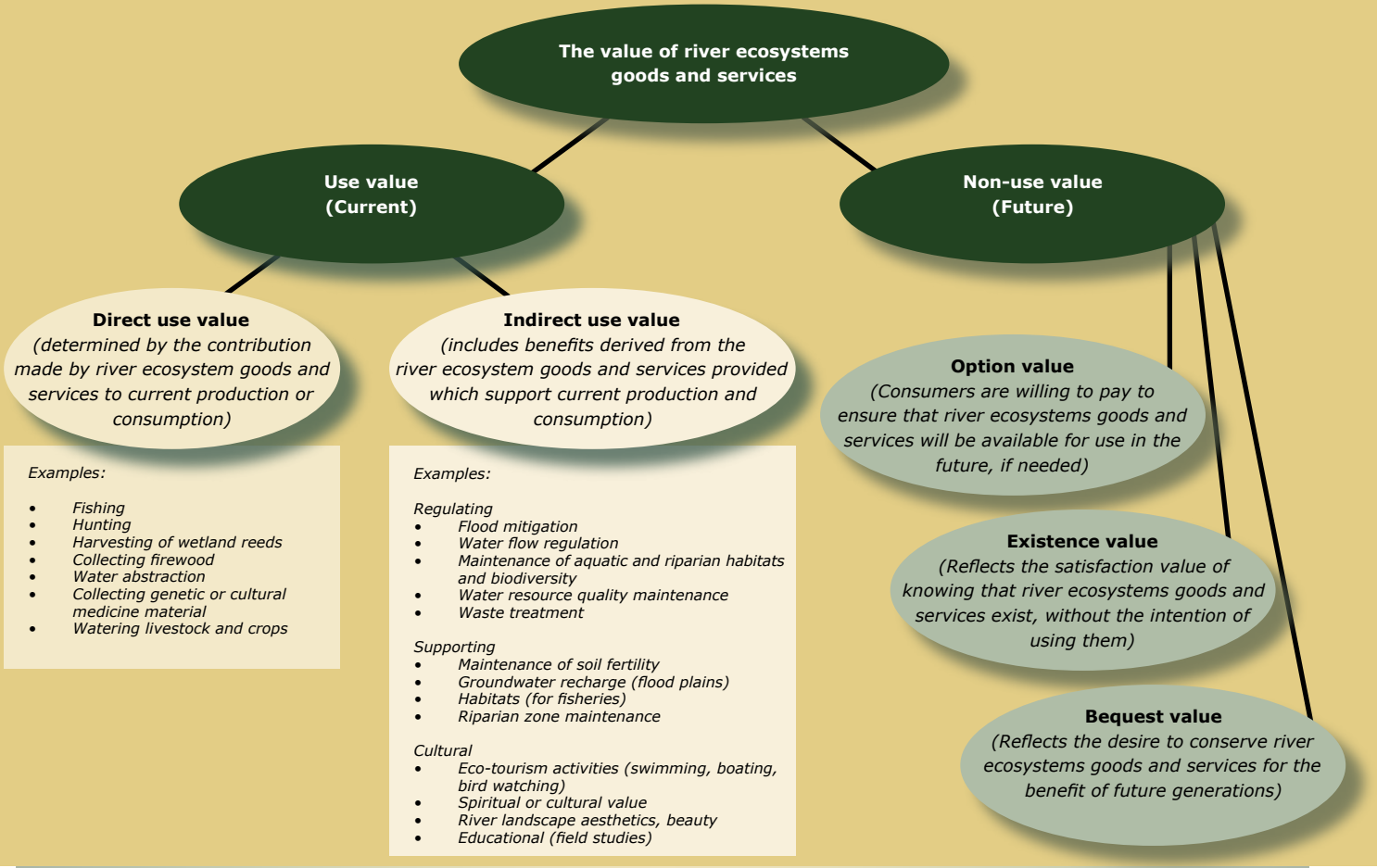
The River Health Programme (RHP) provides information regarding the ecological state of river ecosystems in South Africa to support the management of rivers.

The RHP was designed to meet the following **objectives**:

- Measure, assess and report the ecological state of aquatic ecosystems;
- Detect and report spatial and temporal trends in the ecological state of aquatic ecosystems;
- Identify and report emerging problems regarding aquatic ecosystems;
- Ensure that all aquatic ecosystem health reports provide scientifically relevant information for the management of aquatic ecosystems; and
- Create public capacity and environmental awareness.

The River Health Programme Name

When the programme was launched in 1994 it was known as the National Aquatic Ecosystem Biomonitoring Programme (NAEBP). The programme initially focused on riverine ecosystems only, and as a consequence the short name River Health Programme (RHP) was adopted. To conform to the terminology used in the National Water Act (Act 36 of 1998) the name NAEBP was changed to National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The NAEHMP will be expanded to, apart from the riverine component, in the foreseeable future include Wetlands and Estuaries and eventually also Aquifer Dependent Ecosystems.



National Water Resource Quality Monitoring Programmes of South Africa

The Department of Water Affairs and Forestry (DWAF), as custodian of freshwater resources in South Africa, is responsible for water resources management at national level. This entails the development, implementation and maintenance of monitoring programmes at national level. Water resources management at a regional and local level on the other hand will be the responsibility of the catchment management agencies (CMAs) and local management institutions.

DWAF's suite of national water resource quality monitoring programmes are currently all aligned, or are in the process of being aligned with the requirements of the National Water Act (NWA).

The National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) is currently one of eight national surface water resource quality monitoring programmes of DWAF (see diagram below). Together these programmes provide information regarding the status of several different aspects of surface water resources that is required for their protection and management. The other seven programmes are the:

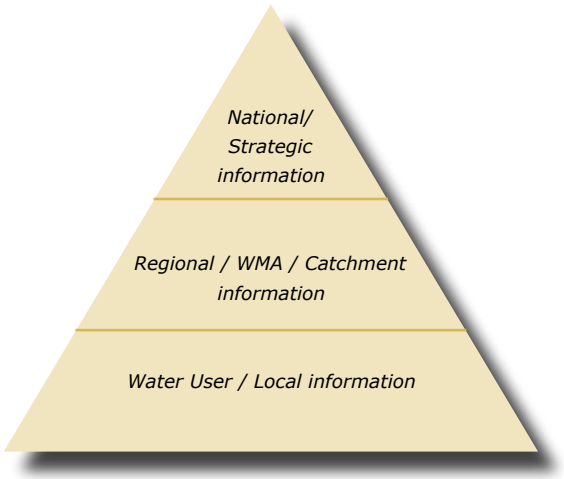
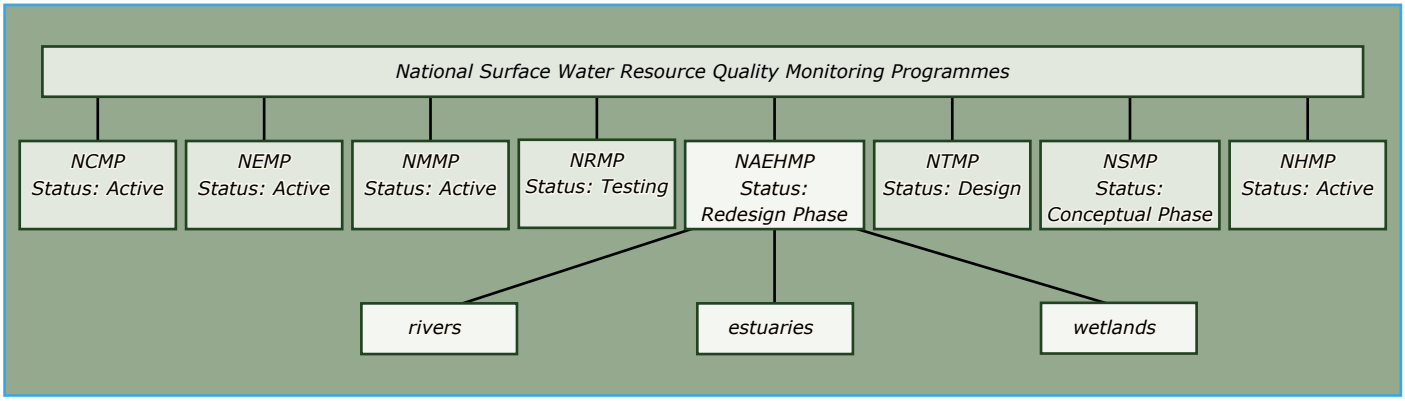


Diagram to illustrate that different water management levels have different information requirements. The most detailed information is required at local level while less detailed information is needed at the national/strategic level.



- National Chemical Monitoring Programme (NCMP);
- National Eutrophication Monitoring Programme (NEMP);
- National Microbial Monitoring Programme (NMMP);
- National Radioactivity Monitoring Programme (NRMP);
- National Toxicity Monitoring Programme (NTMP);
- National Sediment Monitoring Programme (NSMP); and
- National Hydrological Monitoring Programme (NHMP).

The NWA requires that these national programmes are also co-ordinated with relevant programmes of other departments in order to give effect to co-operative governance and the National Environmental Management Act (NEMA).

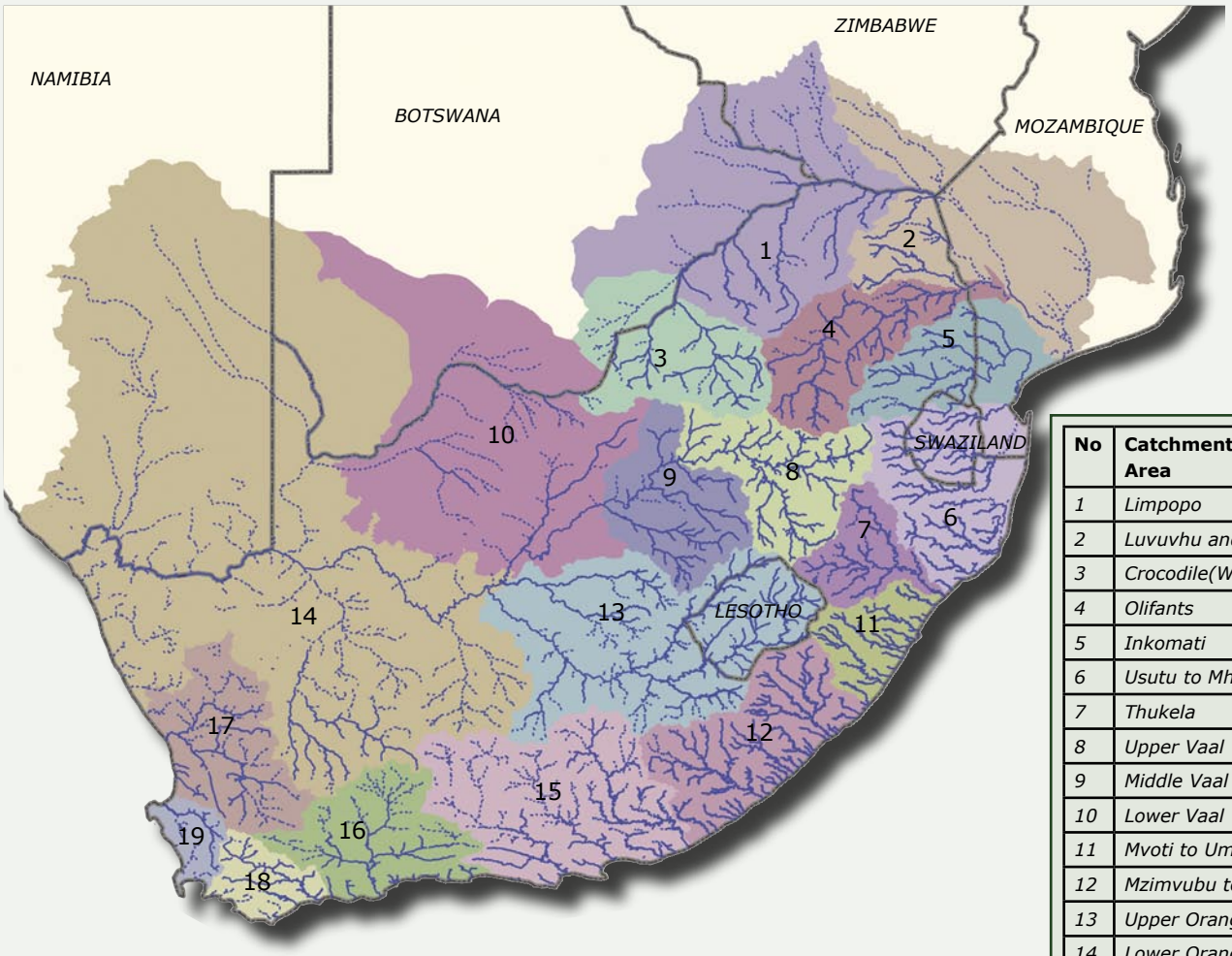
Although the NAEHMP has to date focused on rivers, the objective from the start was also to include wetlands and estuaries in the foreseeable future. The same model of collaboration and sharing of resources between various organisations and government departments, which has made the RHP the successful programme it is today, will be applied. Since the responsibility to protect and manage wetlands and estuaries resides with various government departments (national and provincial), one of the first steps will be to identify the various mandates, roles and responsibilities of these organisations, with particular emphasis on those at a national level.

Strategic Framework Document

The Strategic Framework for National Water Resource Quality Monitoring Programmes provides guidelines to ensure that all DWAF's national monitoring programmes are aligned with the requirements of the NWA. This framework document highlights the importance of effective and coordinated governance of water resource quality monitoring at local, catchment and national levels and by all institutions involved in water resource management. Also, the roles and responsibilities of all the stakeholders involved in providing the required water resources quality information for the management of water resources from a national to the local level are clarified.

International Obligations

South Africa shares four major river systems - Limpopo, Inkomati, Usutu/Pongola/Maputo and the Orange/Senqu River system - with its six immediate neighbours: Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe. As a result, eleven of the country's 19 water management areas share international rivers (see map below). DWAF has certain international obligations to meet which include the sharing of data and information on these shared watercourses. An objective of the NAEHMP is to establish partnerships and closely collaborate with the relevant government departments in our neighbouring countries as well.



Map to illustrate the South African Water Management Areas as well as those river basins shared between South Africa and neighbouring countries.

No	Catchment Management Area
1	Limpopo
2	Luvuvhu and Letaba
3	Crocodile(West)Marico
4	Olifants
5	Inkomati
6	Usutu to Mhlatuze
7	Thukela
8	Upper Vaal
9	Middle Vaal
10	Lower Vaal
11	Mvoti to Umzimkulu
12	Mzimvubu to Keiskamma
13	Upper Orange
14	Lower Orange
15	Fish to Tsitsikamma
16	Gouritz
17	Olifants/Doorn
18	Breede
19	Berg

The Law and the River Health Programme

Requirements in terms of the National Water Act

The principles of sustainability and equity are cornerstones of South African Water Policy and form the fundamental objectives for managing South Africa's water resources, namely to achieve equitable access to water resources and their sustainable and efficient use. To give effect to these interrelated objectives, an approach to managing water resources has been adopted that introduces measures to protect water resources by setting objectives for the desired condition of resources, and putting mitigation measures in place to control water use to limit impacts to acceptable levels. The approach comprises two complementary strategies referred to as Resource Directed Measures and Source Directed Controls.

The NAEHMP plays a complementary role in one of these strategies in particular, namely the Resource Directed Measures. These measures focus on water resource quality which reflects the overall health or condition of the water resource. The health condition of the resource is a measure of its overall ecological status (EcoStatus).

Recognising that the protection of aquatic ecosystems is essential to their sustainable and optimal use, the National Water Act (NWA) (Act No. 36 of 1998) emphasizes the role of monitoring in the protection and assessment of the country's water resources. Chapter 14 (Sections 139 and 145) of the Act requires that DWAF must, among other things, monitor the health of aquatic ecosystems. The NWA furthermore mandates the Minister of DWAF to establish early warning systems for risks posed by various events, including the deterioration in water quality (Section 145 (2)). The NAEHMP is ideally placed to contribute to each of these aspects.

Requirements in terms of the National Environmental Management Act (NEMA) and the Biodiversity Act

Water resources management is subject to the requirements of national environmental Legislation, as contained in the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Environmental Management Biodiversity Act (Act No. 10 of 2004).

The National Environmental Management Act (NEMA) is largely concerned with governing the sustainable use of the environment and the protection of ecosystems. This implies the collection of information about the current ecological state of ecosystems, the location of environmental impacts and the provisional guidance for the planning of future developments. The National Environmental Management Biodiversity Act on the other hand, makes provision for the management and conservation of biological diversity, including aquatic ecosystems and the sustainable use of indigenous biological resources. The NAEHMP is ideally suited to provide information on water resources as part of ecological systems and was designed to provide data and information that would also support national environmental legislation (see State-of-Environment reporting on the facing page).

Resource Directed Measures

Resource Directed Measures consists of three aspects:

1. The development and implementation of a classification system

The classification of water resources is designed to protect aquatic ecosystems, as well as terrestrial ecosystems that are dependent on groundwater, in order to ensure sustainable utilisation and protection of the resources. The classification of water resources will therefore assist in achieving a balance between the long-term ecological integrity of all water resources and the continuing availability of water for social development and economic activities (NWRS, 2004).

2. The Reserve (basic human needs and ecological)

The highest priority is afforded to provision of water for the purposes of the Reserve. The Reserve is set to ensure that quantities of water of appropriate quality are available to meet basic human needs and to protect aquatic ecosystems.

3. Resource Quality Objectives (RQOs)

RQOs describe the quality of a resource at the desired level of protection. Thus resource quality objectives might describe, among other things, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian and instream habitat, and the characteristics and condition of the aquatic biota.

Links to Other Initiatives

State-of-Environment Reporting

State of Environment (SoE) reporting was developed in response to the need for improved environmental information for decision-making, as called for by the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 and Agenda 21. State-of-Environment reporting informs people about the changes that are taking place in the environment, the causes and consequences of these changes, and the corrective action needed to improve the environment.

The focus of the NAEHMP is primarily the ecological state of aquatic systems. River health survey data and assessments were initially only accessible in thick technical reports and a need was identified for user-friendly reports that would complement these technical reports. It was also envisaged that these reports would be read by a broader audience that would in turn have a greater influence on water-related management decisions. This gave rise to the development of State-of-Rivers (SoR) reporting which was developed so that it could provide information to SoE reporting.

State-of-Rivers reporting is subsequently aligned with SoE reporting and uses the "Pressure-State-Response" framework to report on the current state of rivers, the causes of change, the desired state and recommendations for achieving this.

Freshwater Conservation Planning

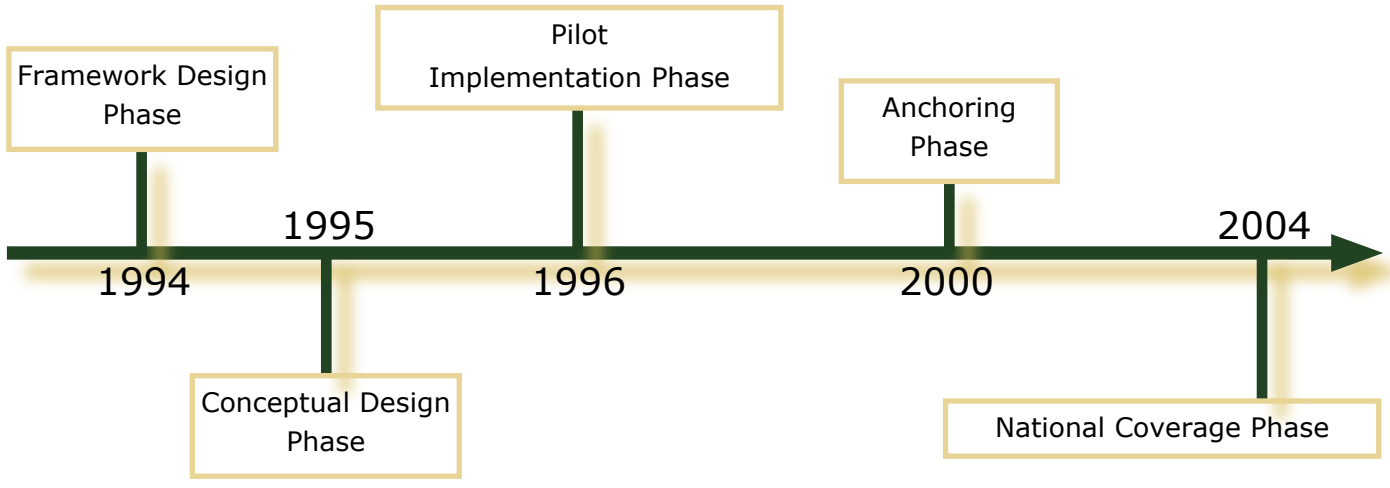
An aspect that has not been explicitly addressed in national policy and legislation is the setting of national conservation targets for inland water ecosystems. There is no operational guidance regarding the desirable number of these ecosystems to be conserved or the mechanisms through which conservation should be achieved. The present thinking is to deal with this issue on a case-by-case basis. A shortcoming of the case-by-case approach is highlighted through the monitoring results produced by the RHP, where the results of river surveys are expressed in health classes (natural, good, fair, poor). For each of the river systems, the acceptability of the monitoring outcome may be argued in the context of the social, economic and ecological considerations of the specific river basin. However, when the overall picture of the rivers of a catchment, province or the country is assessed, there is no guideline or answer for the question of whether these results are acceptable or not.

Freshwater conservation planning can provide a bridge between river health assessments and the setting of ecological targets and priorities for rivers that should receive the highest level of protection. In essence, freshwater conservation planning is used to identify spatial options for conserving a sample of the full variety or diversity of inland water ecosystems that occur in an area of concern, including all species as well as habitats, landscapes and rivers in which they occur. Furthermore, the ecosystem processes responsible for maintaining and generating this diversity are also considered. This relatively new discipline draws from the fields of systematic conservation planning, conservation biology, aquatic ecology (including hydrology, biology, geomorphology), water resources planning and management, and spatial information technology.

The River Health Programme: Where did it start?

In 1994, the Department of Water Affairs and Forestry (DWAF), as the lead agent, initiated the formal design of the South African National Aquatic Ecosystem Biomonitoring Programme (NAEBP). Since the programme focused on riverine ecosystems it was called the River Health Programme (RHP). The programme was a response to the need for information on the state of aquatic ecosystems, at a time when DWAF's management focus had broadened from end-of-pipe monitoring to a more integrated ecosystems response approach.

The River Health Programme History Time Line



Framework Design Phase (1994 – 1995)

The Department of Water Affairs and Forestry (DWAF) realised from the outset that they did not have the capacity to develop and implement a programme of this nature at a national scale. DWAF approached the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC) to become joint custodians of the River Health Programme (RHP). From 1994 to 1996 the three custodians, assisted by the CSIR, Southern Waters, the Institute for Water Research and other consultants, developed the conceptual framework for the programme. The objectives, scope and specifications of the programme were established during this phase.

Achievements

South Africa's first national biomonitoring programme for river ecosystems kicks off.

Programme Governance

The way in which the River Health Programme (RHP) is governed is key to the effective ongoing development and sustainable implementation of the Programme. In the RHP context, governance is the process whereby individuals and institutions, public and private, manage their common concerns. Although programme governance has played a role in the success of the earlier phases of the RHP, through the institutional and collaborative models that emerged, it did not feature as an explicit concept during the first ten years of the Programme's existence.

A model of national development and coordination, together with provincial implementation was adopted. The national level model was characterised by visionary thinking, concept and method development and quality assurance; and the provincial level by pragmatic considerations. Structures have been put in place to support these functions since the start of the project and are discussed below under each phase.

Project Initiation and Framework Design Phase (1994 - 1995)

A **guiding team**, under the visionary leadership of Dr Henk van Vliet, consisted of:

- DWAF (Dirk Roux)
- DEAT (Geoff Cowan)
- WRC (Steve Mitchell)
- CSIR (Dirk Grobler, Derek Hohls, Jane Harris)

The **project team**, consisting of members of the guiding team and included individuals from the following organisations:

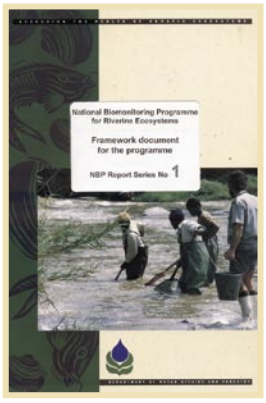
- DWAF (Liesl Hill, Neels Kleynhans)
- Rand Water (Ralph Heath)
- Southern Waters (Cate Brown, Sean Eekhout, Jackie King)
- Institute for Water Research (Jay O'Keeffe and Patsy Scherman)

Conceptual Design Phase (1995 – 1996)

The Conceptual Design Phase saw the development of a prototype for spatial classification, protocols for selecting monitoring and reference sites, biological and abiotic indices, systems to store, manage and transfer the data collected, as well as mechanisms for collaboration and networking amongst partners.

Achievements

- Establishment of the National Coordinating Committee (NCC), comprising representatives from DWAF, DEAT and WRC. The responsibilities of the NCC included funding, implementation, communication & marketing, research & development, and the identification of training requirements & opportunities.
- Appointment of provincial champions.
- Publication of the first River Health Programme newsletter and information brochure.



The first of the RHP Report series

The first RHP newsletter

Conceptual Design Phase (1995 – 1996)

A **National Coordinating Committee** (NCC) was established to take responsibility for overall project coordination and guidance. Members included individuals from DWAF (Henk van Vliet, Liesl Hill), DEAT (Geoff Cowan), WRC (Steve Mitchell) and the CSIR (Dirk Roux and Jane Harris).

The **project team** included members from:

- DWAF (Neels Kleynhans, Christa Thirion)
- Manyaka Greyling (Tisha Greyling and Vassie Maharaj)
- Southern Waters (Cate Brown, Sean Eekhout, Jackie King, Helen Dallas)
- Institute for Water Research (Jay O'Keeffe, Patsy Scherman, Mandy Uys)
- Various organisations contributed to this phase, including: Natal Parks Board, Northern Cape Nature Conservation, Eastern Cape Nature Conservation, Albany Museum, National Parks Board, Umgeni Water, Mpumalanga Nature Conservation, Western Cape Nature Conservation, Onderstepoort Veterinary Research Institute, Rhodes University, University of the Free State, JLB Smith Institute for Ichthyology and private consultants.

Pilot Implementation (1996 - 1999)

During pilot implementation, the programme components were tested, refined and integrated. This helped to improve the understanding of the practical and operational factors that influence the sustainable implementation of the RHP. This phase began with a consultative planning meeting attended by representatives of provincial government departments, conservation agencies, the Rand and Umgeni water boards and others. Provincial Champions chosen at this meeting would eventually drive the implementation of the RHP in the provinces.

The Crocodile River in Mpumalanga was selected for the implementation of the programme at a pilot scale. The ecoregion approach for monitoring and reference site selection was introduced for the first time. Biomonitoring teams from the then Institute for Water Quality Studies (IWQS), [now called Resource Quality Services (RQS)], Environmental Affairs, Mpumalanga Parks Board and Kruger National Park were responsible for the river surveys and assessments that resulted in the first prototype State-of-Rivers publication that appeared in 1998.


RIVER HEALTH

INCWAJANA YOKWAZISA

LUYINI UHLELO LOKUHLANZEKA KWEMIFULA?

RHP grassroots communication

Achievements

- Appointment of three scientific advisors to serve on the National Coordinating Committee.
- Agreement on the short, medium and long term goals of the Programme.
- General awareness of River Health among schools and rural communities.
- Implementation of the River Health Programme in the provinces, based on the Crocodile River pilot study.
- Acknowledgement of the need for a data storage component.
- A technical workshop towards standardisation of techniques in August 1997.
- Joint funding agreement by DWAF, DEAT, WRC and CSIR.
- Development of a biomonitoring short course by CSIR and DWAF.
- Development of monitoring tools and methods.
- Establishment of a South African Scoring System (SASS) forum and revision of the SASS 4 index, initiated and funded by the WRC.
- Communication of the River Health concept at grassroots level through flyers in several official languages.

Pilot Implementation (1996 - 1999)

Executive Committee (EXCO). The EXCO was the core coordination team with representation from the national custodian organisations, namely DWAF, DEAT and WRC, one representative of the provincial champions, the CSIR and the secretariat (Manyaka Greyling Meiring).

Provincial champions coordinate provincial initiatives.

Scientific advisors: Professor Jay O'Keeffe (Rhodes University), Dr. Jackie King (Southern Waters) and Dr Neels Kleynhans (Institute for Water Quality Studies, now Resource Quality Services).

Anchoring Phase (2000 - 2003)

Since the River Health Programme is intended for national and long-term application it was tailored to suit local capacity and resource availability. A key objective of this phase was to assist agencies with the implementation steps and to internalise the programme in terms of required expertise, skills and budgets. One example is the WRC's continued financial assistance to various research and development initiatives.

Key components of the anchoring phase included:

- Procedures for quality control and assurance
- Procedures for data management
- Information packaging and dissemination
- Refinement of communication and awareness creation activities
- Coordination of national and provincial initiatives
- Training opportunities

Provincial Champion meeting: November 2002

Achievements

- River Health open days in various provinces, involving a broad stakeholder group which included schools, industries and local communities, to create awareness of the activities of provincial initiatives and to demonstrate the value of biomonitoring in managing water resources.
- Appointment of process coordinators for each of the key components comprising the anchoring phase.
- Launch of the Mini-SASS technique, developed by Umgeni Water and the KZN Nature Conservation Services.
- Development and hosting of the official website of the River Health Programme at CSIR.
- Launch of the first State-of-Rivers report, the Crocodile, Sabie-Sand and Olifants River Systems during Water Week 2001. Since then another nine reports and 12 posters have been produced.
- Adoption of a new version of SASS, SASS5
- Accreditation of the SASS method by Umgeni Water. SASS proficiency testing is the first step towards assuring standardised quality measures in the RHP.

Anchoring Phase (2000 - 2003)

Executive Committee (EXCO) became the **Management Committee** (MANCO) in 2000. The MANCO was the core coordination team with representation from the national custodian organisations, namely DWAF, DEAT and WRC, portfolio managers (training, funding, research and development and communication), one representative of the provincial champions and the CSIR.

National Coordinating Committee (NCC) – the NCC fulfilled a liaison role (opposed to a coordination role as was originally intended) and served as a forum for provincial champions to share and exchange information and experiences. The NCC comprised MANCO members, provincial champions and scientific advisors.

National Coordination Team (NCT) – The NCT consisted of a small group which functioned at the operational level and was responsible for the coordination of the day to day activities within the RHP and for providing direction, guidance, priorities and recommendations to the MANCO. Members of the NCT included the DWAF project team, a member from the Communications portfolio and the CSIR as project administrator.

Process coordinators for the key components of the Anchoring Phase:

- Procedures for quality control and assurance (Chris Dickens and Mark Graham)
- Procedures for data management (Helen Dallas and Justine Ewart-Smith)
- Procedures for information packaging and dissemination (Wilma Strydom)
- Communication and awareness creation (Vassie Maharaj)
- Coordination of national and regional initiatives (Dirk Roux)

Provincial Implementation Teams (PITs) were also created - each team was led by a Provincial Champion and included members of various provincial government departments, conservation agencies, tertiary institutions and Water Boards.

Provincial champions and organisations involved in the RHP since 1996

Champion	Province	Organisations
Mr Mick Angliss and Mr Paul Fouche	Limpopo	Provincial DEAT Univerisity of the North University of Venda
Dr Johan Engelbrecht	Mpumalanga	Mpumalanga Parks Board
Ms Candice Haskins (1996) Mr Mukhetho Neluvhalani (1999) Mr Piet Muller	Gauteng	GDACE DWAF
Prof Braam Pieterse (1996) Dr Margaret Kalule-Sabiti and Mr Stuart Mangold (1999) Ms Tharina Boshoff	North West	Provincial DEAT North West University
Mr Maitland Seaman, Mr Ben Benade and Mr Pierre de Villiers (on a rotating basis for Free State and Northern Cape) (1996) Ms Gerda Venter and Mr Pierre de Villiers	Free State	DWAF DTEEA CEM Bloem Water Working for Wetlands FS Wetland Forum
Dr Chris Dickens	KwaZulu Natal	Umgeni Water Institute of Natural Resources
Mr Nicholas Scarr (1996) Dr Nikita Muller and Dr Patsy Scherman (2003) Ms Pumza Gasa-Lubelwana	Eastern Cape	DWAF Provincial DEAT Institute for Fresh Water Research Coastal and Environmental Services
Mr A.B. Abrahams (2002) Mr Ncamile Dweni and Mr Ramogale Sekwele	Northern Cape	DWAF NC Nature Conservation DTEC
Dr Barbara Gale and Dr Kas Hamman (1996) Mr Jannie van Staden (1998) Ms Toni Belcher	Western Cape	DWAF CapeNature Cape Metro Tertiary Institutions
Dr Andrew Deacon	Kruger National Park	SANParks

KwaZulu-Natal Provincial Meeting: 2001

Production of the first State-of-Rivers report

Discussing the development of the Rivers Database

Launch of the first State-of-Rivers report by the then Minister of Water Affairs and Forestry, Mr Ronnie Kasrils, and the Deputy Minister of Environmental Affairs and Tourism, Ms Joyce Mabudafhasi during Water Week 2001.

Members of the RHP committees during the Anchoring Phase were:

MANCO

Henk van Vliet and Mbangiseni Nepfumbada (DWAF and MANCO Chairperson)
Dirk Roux (CSIR)
Geoff Cowan (DEAT)
Steve Mitchell (WRC)
Chris Dickens (Umgeni Water)
Tisha Greyling (Manyaka Greyling Meiring (Pty) Ltd
Vassie Maharaj (Manyaka Greyling Meiring (Pty) Ltd
Liesl Hill (DWAF)

NCC

Geoff Cowan (DEAT)
Chris Dickens (Umgeni Water)
Tisha Greyling (Manyaka Greyling Meiring)
Vassie Maharaj (Manyaka Greyling Meiring)
Liesl Hill (DWAF)
Ulrich Looser (DWAF)
Steve Mitchell (WRC)
Mbangiseni Nepfumbada (DWAF)
Suzan Oelofse (DWAF)
Dirk Roux (CSIR)
Henk van Vliet (DWAF)
Anna Balance (CSIR)
Justine Fowler (Southern Waters)
Provincial Champions
Scientific Advisors: Neels Kleynhans, Chris Dickens

NCT

Bonani Madikizela (DWAF)
Ulrich Looser (DWAF)
Mike Silberbauer (DWAF)
Liesl Hill (DWAF)
Dirk Roux (CSIR)
Anna Balance (CSIR)
Wilma Strydom (CSIR)
Vassie Maharaj (Manyaka Greyling Meiring)
Mary Jean Gabriel (DWAF)

National Coverage Phase (2004 onwards)

The main objectives of the National Coverage Phase are to review the design of the Programme and to align it with the requirements of the National Water Act (Act No. 36 of 1998), and to formalise and establish the RHP as a national programme.

During this phase, specialists will agree on national monitoring sites that represent the diversity of South Africa's river types. DWAF will take overall responsibility for ensuring that these sites are monitored at an appropriate frequency, and will report on the state of the nation's rivers every five years. The first full cycle of monitoring should be completed by 2010. During this phase priority will be given to the refinement and further development of the Rivers Database, Quality Assurance & Control procedures and the Biomonitoring Short Course.

A further important aspect to be addressed is the governance of the NAEHMP. To date, adoption and implementation of the Programme by the various stakeholders and role players has been largely voluntary, leaving the Programme vulnerable. In order to succeed as a national programme over the longer term, a more formal model of programme governance is required to make the institutional responsibilities of the different stakeholders explicit.

RHP Achievements

During the past ten years, the RHP has brought the importance of aquatic ecosystems to the attention of stakeholders, through awareness creation and capacity building. The success of the River Health Programme can be attributed to the partnerships that were established over the years and to the high levels of commitment of the various stakeholders in water resource management that are involved.

National Coverage Phase (2004 onward)

National Study Team – currently responsible for coordination and management of the day to day activities of the Programme as well as to guide and drive the process towards establishing the River Health Programme at a national scale as the NAEHMP. Members include individuals from DWAF: RQS, Institute of Natural Resources, and the CSIR.

Steering Committee – the overall role of this committee is to offer strategic guidance and support to the national Programme. The committee consists of members of inclusive stakeholder organisations, which include DWAF, DEAT, WRC, Water Boards, CSIR, SANParks and Tertiary Institutions.

Programme Manager – will be responsible for the overall coordination and management of the NAEHMP, including the RHP.

Provincial champions and **Provincial Implementation Teams**

Assessing River Health

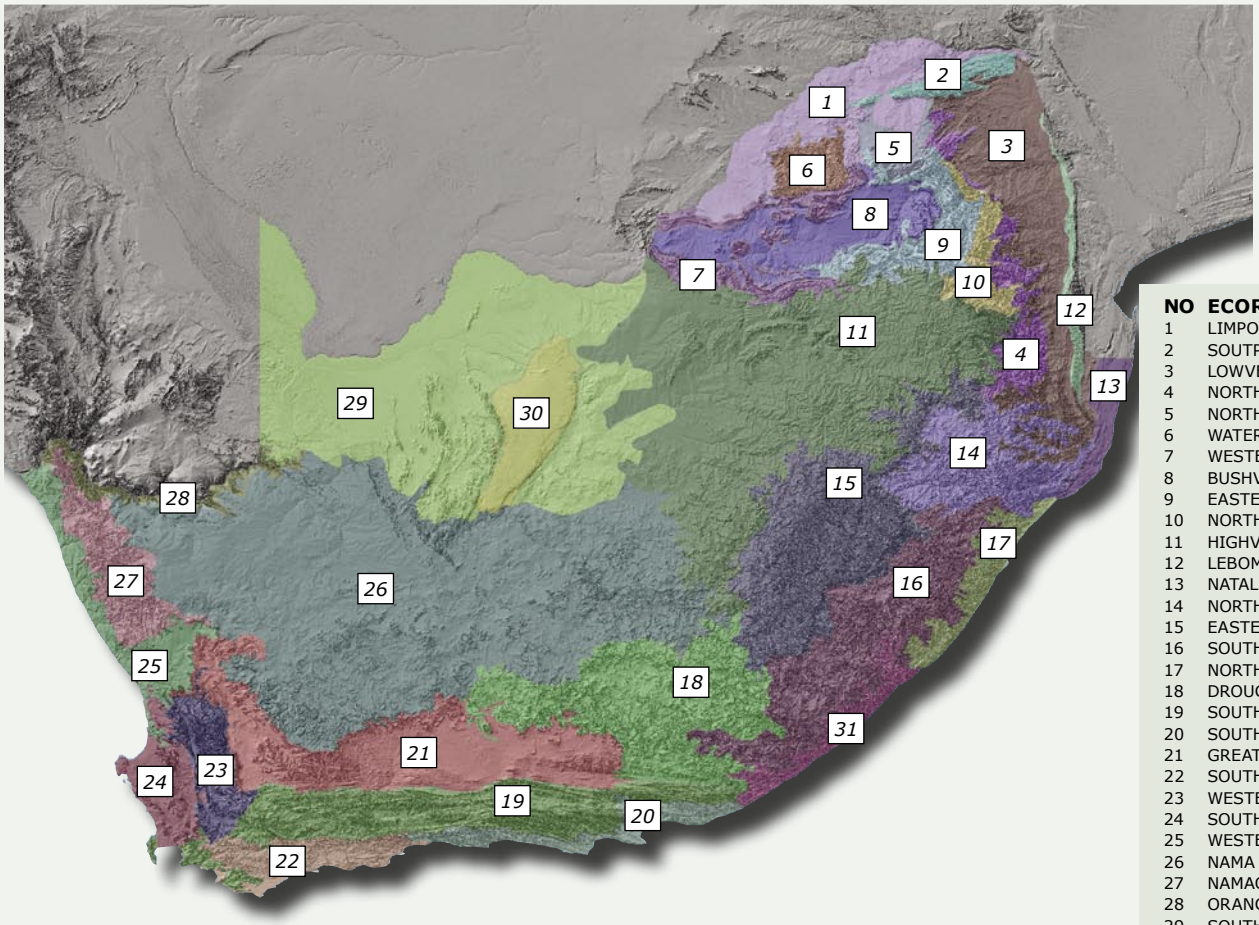
The NAEHMP (RHP) focuses primarily on biological characteristics as indicators of river health. The rationale for a "biomonitoring programme" is that the measurement of only physical and chemical water quality variables cannot provide an accurate account of the overall condition of an aquatic ecosystem. For example, chemical monitoring alone is insufficient to detect the cumulative effects of multiple stressors on aquatic ecosystems. Since biological communities are adapted to certain environmental conditions, changes within their environment disrupt their composition and abundance characteristics in a measurable way. The River Health Programme aims to detect and interpret these integrative measures of ecosystem status.

The ecologically-based appoaches and methods on which the NAEHMP (RHP) relies to determine the state of a particular river system, are explained below and on the following pages. They are Ecoregions, River Health Indices, EcoStatus and River Health Categories.

Ecoregions

Ecoregions are areas of broad ecological similarity in terms of physiography, climate, geology, soils and potential natural vegetation. Rivers occurring in a particular ecoregion will be shaped by similar processes and will thus have certain similarities.

In the RHP, reference sites or reference conditions provide a template against which assessments of the present ecological state of sites, reaches or rivers within the same ecoregion can be compared. Ecoregion boundaries are used in the process of selecting reference sites. Ecoregions also provide convenient boundaries for ecological assessments.



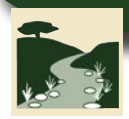
Ecoregion map showing the 31 regions of broad ecological similarity in South Africa

NO	ECOREGION
1	LIMPOPO PLAIN
2	SOUTPANSBERG
3	LOWVELD
4	NORTH EASTERN HIGHLANDS
5	NORTHERN PLATEAU
6	WATERBERG
7	WESTERN BANKENBERG
8	BUSHVELD BASIN
9	EASTERN BANKENBERG
10	NORTHERN ESCARPMENT MTNS
11	HIGHVELD
12	LEBOMBO UPLANDS
13	NATAL COASTAL PLAINS
14	NORTH EASTERN UPLANDS
15	EASTERN ESCARPMENT MTNS
16	SOUTH EASTERN UPLANDS
17	NORTH EASTERN COASTAL BELT
18	DROUGHT CORRIDOR
19	SOUTHERN FOLDED MOUNTAINS
20	SOUTH EASTERN COASTAL BELT
21	GREAT KAROO
22	SOUTHERN COASTAL BELT
23	WESTERN FOLDED MOUNTAINS
24	SOUTH WESTERN COASTAL BELT
25	WESTERN COASTAL BELT
26	NAMA KAROO
27	NAMAQUA HIGHLANDS
28	ORANGE RIVER GORGE
29	SOUTHERN KALAHARI
30	GHAAP PLATEAU
31	EASTERN COASTAL BELT

River Health Indices

Indicators of river ecosystem health are physical, chemical and biological characteristics of rivers that can provide quantitative as well as qualitative information on a river. The River Health Programme focuses mainly on biological characteristics as indicators of river health. The selected river health indices represent the larger ecosystem aspects that are feasible to measure by using standardised and proven scientific techniques. Data on each indicator group are collected, assessed and expressed in an easily understandable format. An explanation of each of the river health indices and the symbolic picture or icon used to represent them, are given below.

Index of Habitat Integrity (IHI)



Worldwide, the loss of habitat has been an important contributor to the decline and extinction of species, particularly during the rapid human population expansion of the past century. River habitat consists of an in-stream and a riparian vegetation component, both of which are vulnerable. Examples of river habitat types are pools, rapids, sandbanks, stones on the riverbed and vegetation fringing the water's edges. Knowledge of the availability and quality of habitats is central to an overall assessment of ecosystem health, since these are major determinants of whether a given system can sustain a specific suite of biota or not. The index of habitat integrity assesses the impact of human disturbance factors on the riparian and in-stream habitats. Human disturbances include water abstraction, flow regulation, bed and channel modification, removal of indigenous riparian vegetation and encroachment of exotic vegetation.

Fish Assemblage Integrity Index (FAII)

Fish are good indicators of long-term influences on the general habitat conditions within a river reach, since they are relatively long-lived and mobile. 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. The FAII assesses fish assemblages and their range of sensitivity to environmental conditions in homogenous fish habitat segments within the reach of a river. The result of the FAII is expressed as a ratio of observed conditions versus theoretical near-natural conditions.

Fish sampling in the Crocodile River

Western Cape Provincial Task Team assessing invertebrates

Biomonitoring activities in the Olifants River catchment

South African Scoring System (SASS)

A variety of macro-invertebrate organisms (e.g. snails, crabs, worms, insect larvae, mussels, beetles) require specific habitat types and water quality conditions for at least part of their life cycles. A change in the structure of aquatic invertebrate communities is a sign 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 South African Scoring System (SASS) is the biological index used to assess aquatic invertebrate fauna. This index is based on the presence of families of aquatic invertebrates and their perceived sensitivity to water quality changes.

Riparian Vegetation Index (RVI)

The riparian zone is the area next to a river, forming part of the river ecosystem and including the river banks. Healthy riparian zones help to maintain the form of the river channel and serve as filters for sediment, nutrients and light. Plant material from the riparian zone is also an important source of food for aquatic fauna. Changes in the structure and function of riparian vegetation commonly result from changes in the flow system of a river, exploitation for firewood, or use of the river bank for grazing or ploughing. The Riparian Vegetation Index is a measure of the degree of modification of the riparian zone from its natural state.

Other indices, although not formally RHP indices, supply valuable information and are explained below:

Geomorphological processes determine the size and shape of river channels, which in turn provide the physical framework within which the stream biota live. The geomorphological index reflects the channel condition and channel stability. The index consists of the river zone and the channel type; the extent of bank erosion; the condition of the bed and the degree of direct structural modification due to human impact. The potential response of a channel to external change depends on the type of channel, of which some are inherently stable, while others are naturally more prone to change.

Water quality data are invaluable, especially in urban rivers where the river habitat is degraded and the natural river function is lost. The present water quality is classified according to its suitability for aquatic biota. Some assessments are based on the total phosphorus, total nitrogen, ammonia and dissolved oxygen measured in water samples from each sampling site. Assessments may also include physical measurements, such as suspended solids, pH and conductivity.

A microscopic analysis of diatom species composition can assist in the assessment of water quality. Diatoms are unicellular algae with uniquely-shaped silica cell walls allowing for reliable identification. Each species represents its specific water quality preference and tolerance. After identification of the dominant diatom species in the water samples, conclusions can be drawn regarding the water quality at a particular site, provided that the water quality preferences of these species are known.

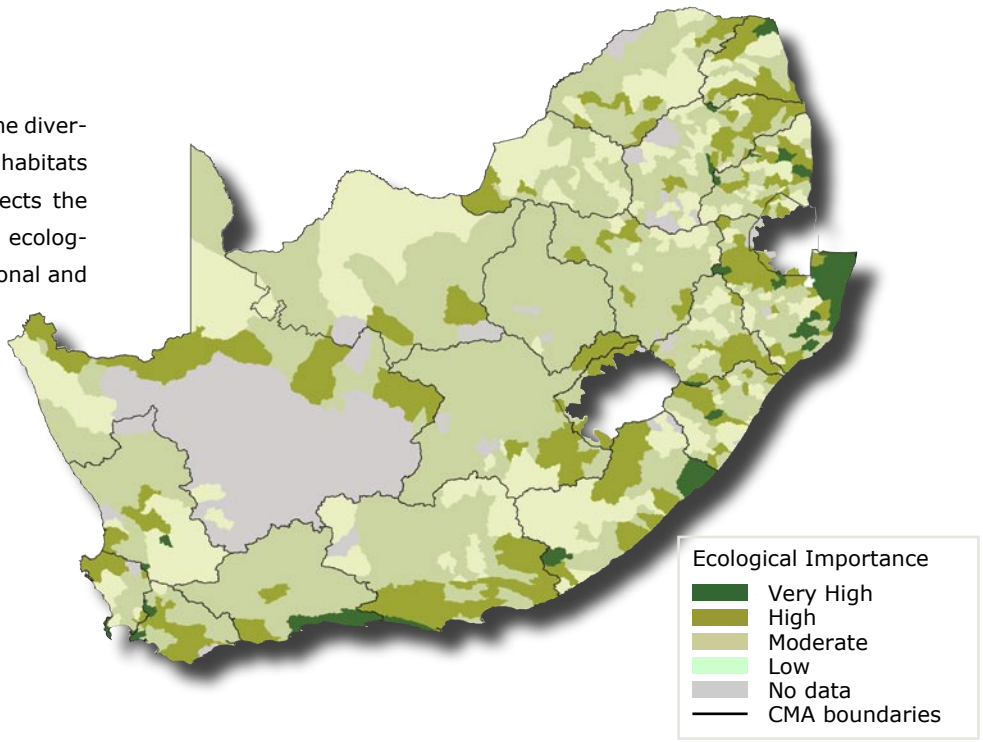
Geomorphology, water quality and diatom information are not covered in the rest of this report.

Ecological Importance & Sensitivity

South Africa's rivers are very diverse and some river reaches are more sensitive than others. The ecological importance and sensitivity (EI&S) of river reaches provide an indication - from an ecological perspective - of the level of protection that a river should receive. The maps below show the ecological importance and ecological sensitivity of river reaches in South Africa.

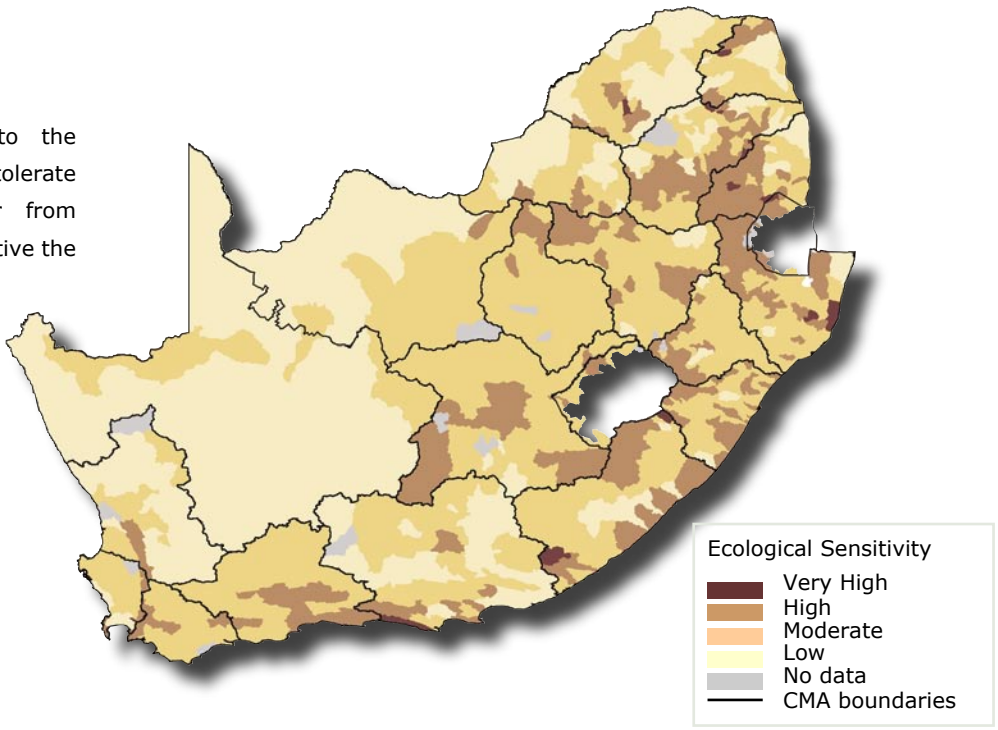
Ecological Importance

Ecological importance refers to the diversity, rarity or uniqueness of the habitats and biota. Consequently, it reflects the importance of protecting these ecological attributes, from a local, national and even international perspective.



Ecological Sensitivity

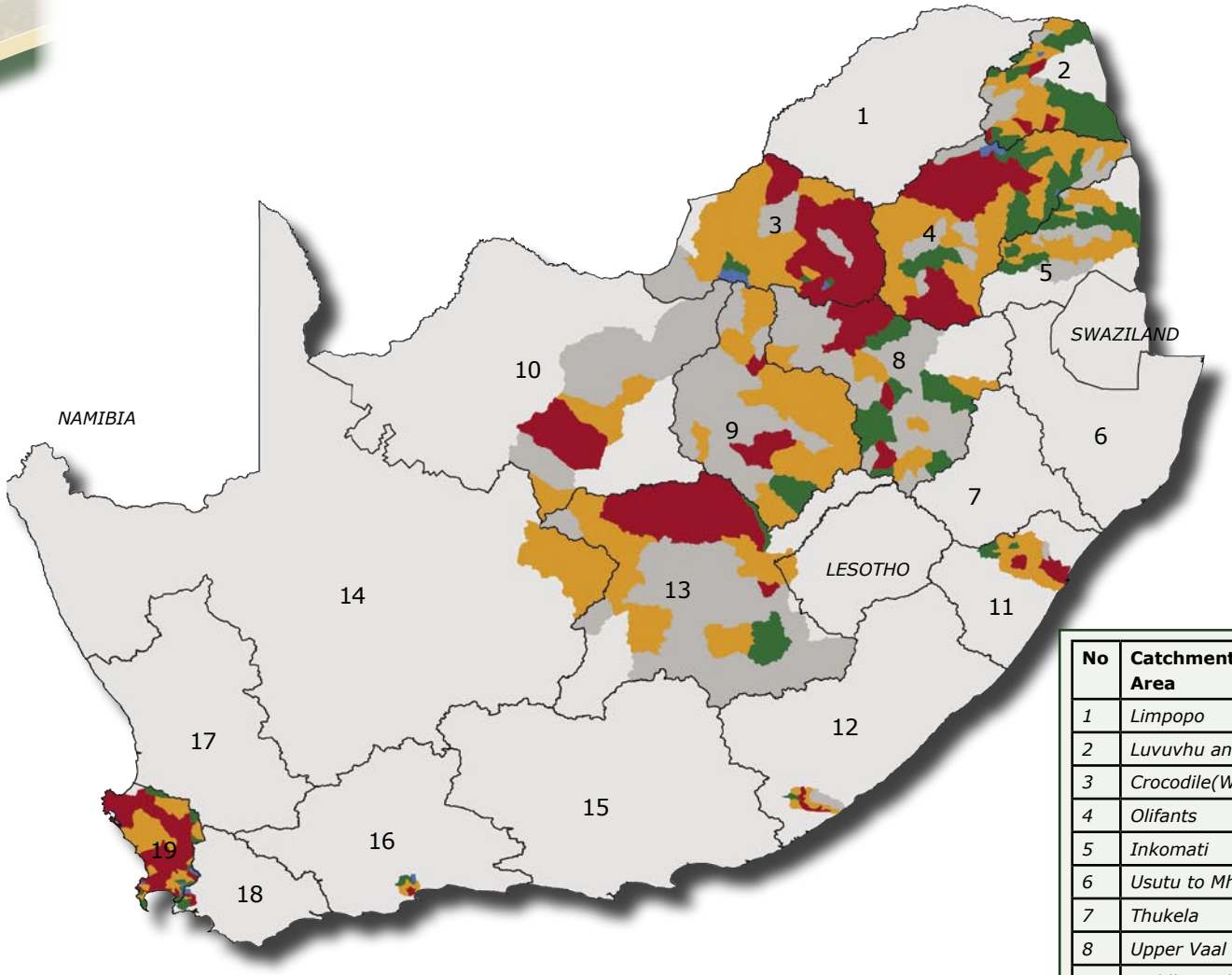
Ecological sensitivity refers to the ability of the ecosystem to tolerate disturbances and to recover from certain impacts. The more sensitive the system, the lower its tolerance.



EcoStatus

The ecological status (EcoStatus) of a river refers to its overall condition or health. EcoStatus incorporates a range of features and characteristics of a river and its riparian areas, and summarises these data into a single assessment condition. The health of a river indicates its ability to support a natural array of species and relates directly to the ability and capacity of a system to provide a variety of goods and services to society. After initial investigations, the RHP now applies this approach. The EcoStatus approach can be explained by way of the diagram on the next page.

On the map below, the EcoStatus data are captured for those rivers in South Africa on which State-of-Rivers reports were produced between 2000 and 2005.



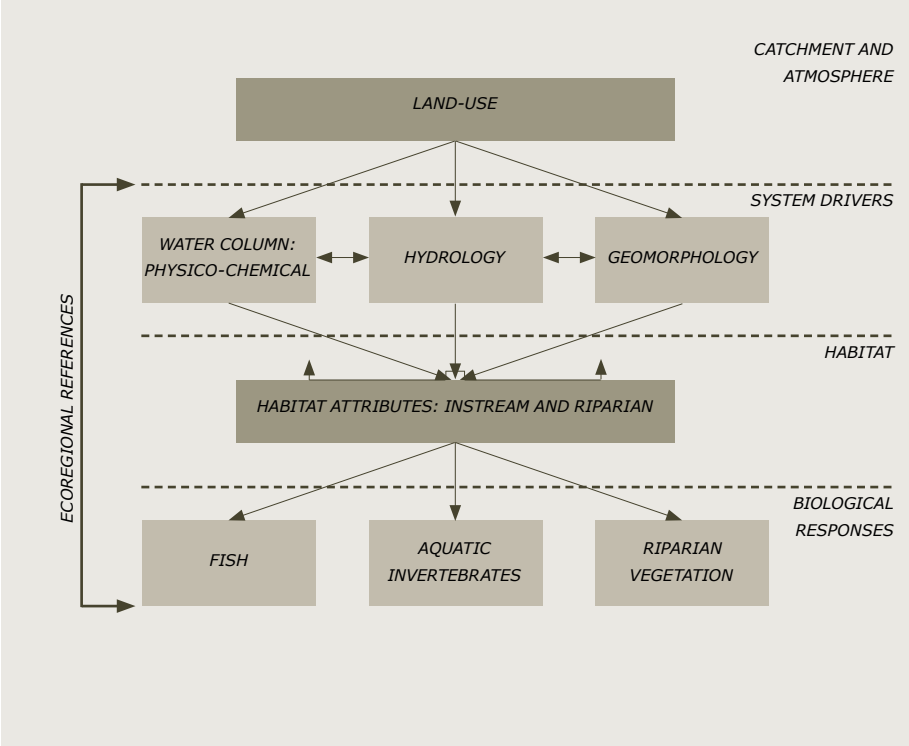
Ecostatus

- *Natural*
- *Good*
- Fair
- Poor
- Data unavailable *
- No official SoR reports produced

* Data unavailable in EcoStatus format and/or sites unsuitable for RHP assessments

No	CatchmentManagement Area
1	*Limpopo*
2	*Luvuvhu and Letaba*
3	*Crocodile(West)Marico*
4	*Olifants*
5	*Inkomati*
6	*Usutu to Mhlatuze*
7	*Thukela*
8	*Upper Vaal*
9	*Middle Vaal*
10	*Lower Vaal*
11	*Mvoti to Umzimkulu*
12	*Mzimvubu to Keiskamma*
13	*Upper Orange*
14	*Lower Orange*
15	*Fish to Tsitsikamma*
16	*Gouritz*
17	*Olifants/Doorn*
18	*Breede*
19	*Berg*

EcoStatus is interpreted through the integration of the Present Ecological State (PES) of the system drivers (geomorphology, hydrology and water quality), the resulting habitat integrity in terms of specific biological groups (fish, macro-invertebrates and riparian vegetation) and the responses of these biological groups. EcoStatus is thus an integrative measure that determines the response of the habitat to modifications. The response of the biota to the change in habitat determines the health of rivers. Since the RHP focusses on the assessment of biological responses of aquatic ecosystems, the EcoStatus appoach was adopted and applied as part of river health assessments.



The EcoStatus diagram explains the relationship between the system drivers, the resulting habitat integrity and the biological responses to habitat changes which determines the health of rivers.

River Health Categories

Once river health indices are measured, they need to be interpreted in such a way as to allow the health of monitoring sites to be compared, and also for comparison between river systems. For standardisation purposes, a river health categorisation is used where each of the river health categories (below) is associated with a level of ecosystem health. The present health (**Natural**, **Good**, **Fair** or **Poor**) is a measure of the present ecological state of a certain river reach at the time of the survey. Some rivers, for example canalised rivers, are changed to such an extent that they cannot be compared to ecologically functional rivers and are considered to be "artificial" rivers.

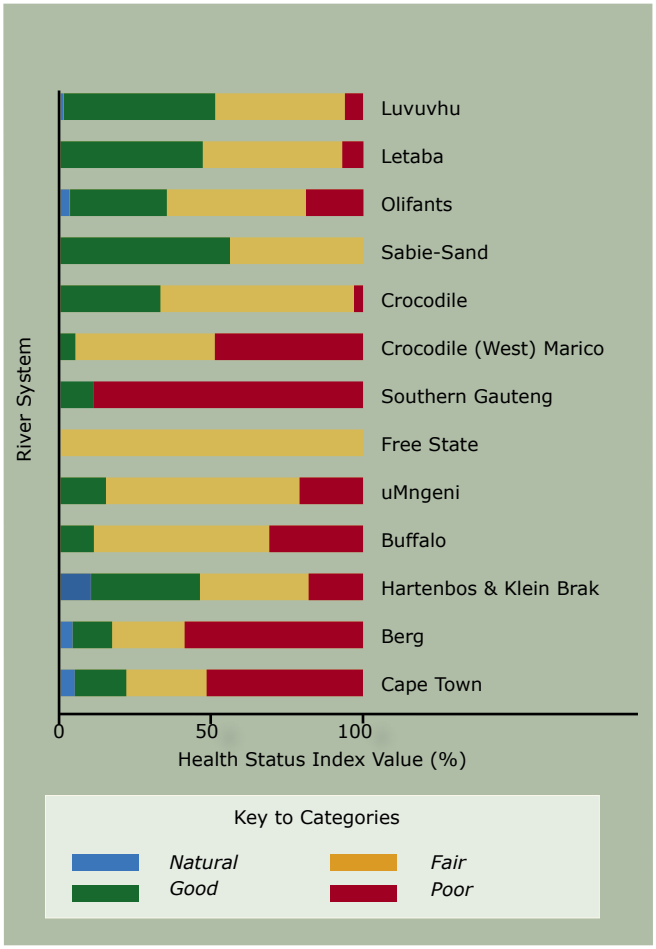
River Health Category	Ecological Perspective	Management Perspective
Natural (N)	No or negligible modification of in-stream and riparian habitats and biota.	Protected rivers; relatively untouched by human activities; no discharges or impoundments allowed.
Good (G)	Ecosystems essentially in good state; biodiversity largely intact.	Some human-related disturbance but mostly of low impact potential.
Fair (F)	A few sensitive species may be lost; lower diversity and abundances of biological populations are likely to occur, or sometimes, higher abundances of tolerant or opportunistic species occur.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation.
Poor (P)	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer reproduce or alien species have invaded the ecosystem).	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality.
Artificial	Transformed to such an extent that their habitat types, biological communities and ecosystem processes bears no or little resemblance to those that would occur under natural conditions.	Modified beyond rehabilitation to anything approaching a natural condition. Example: canalised rivers in urban environments.

State of River reports for South Africa

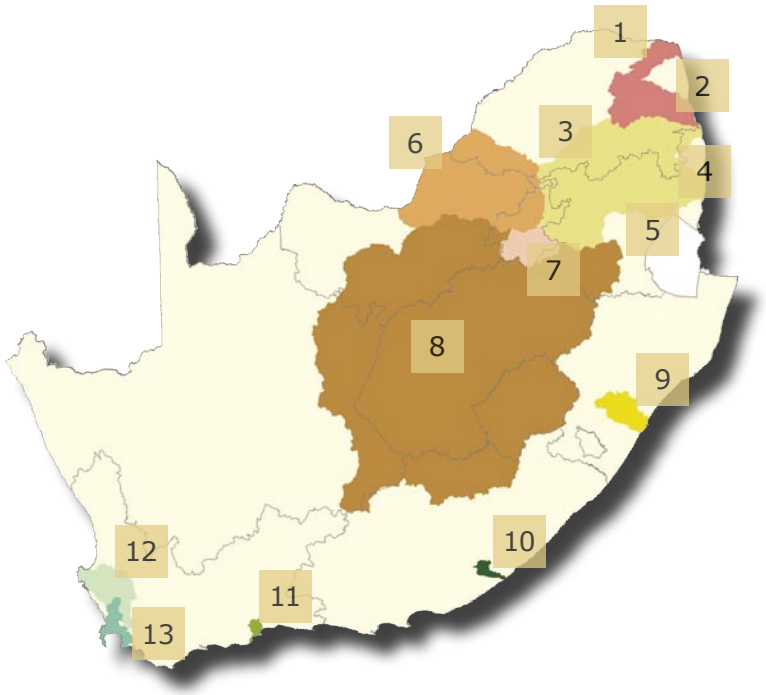
A Summary

The development and utilisation of water resources needs to take place on a sustainable basis. For this to be possible, we need to know the long-term availability of water of acceptable quality for future generations, what is the state of our rivers and what are the impacts on these river systems. This page summarises the health of those river systems assessed in State-of-Rivers reports since the initiation of the River Health Programme in 1994.

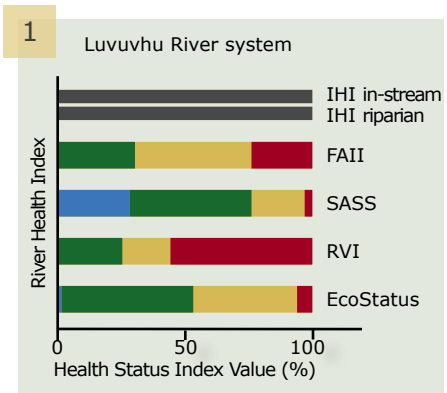
The graphs show a summary of the state of each river system where data are based on the sampled lengths of each river. The percentage of river length sampled is listed under each graph. Reasons why rivers were not sampled in full include tributaries being dry for most of the year, inaccessibility of river sections due to steep gorges, and unsafe access. Gaps in the data can be ascribed to budget limitations, lack of local expertise in a certain field and the unsuitability of particular sites. The EcoStatus data is expressed as a percentage of sampled river lengths only. For more detailed reporting of each system, please refer to pages 36-67 of this report.



EcoStatus of all river systems reported by the River Health Programme to date, arranged from north to south.

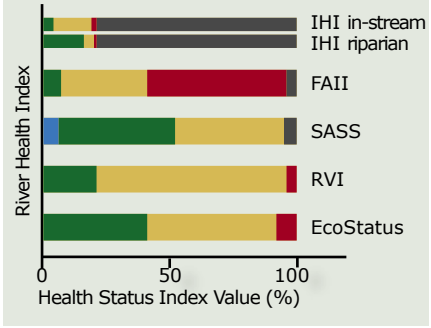


Map indicating the river systems reported on by the RHP between 1994 and 2004.



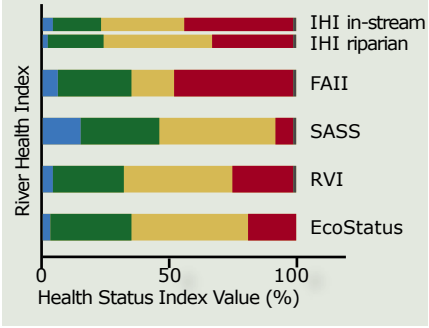
River length represented: *70%*
Perennial: *61%*

2 Letaba River system



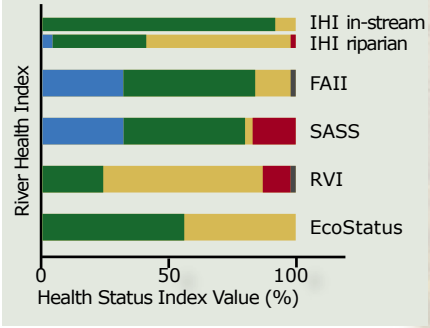
River length represented: 45%
Perennial: 74%

3 Olifants River system



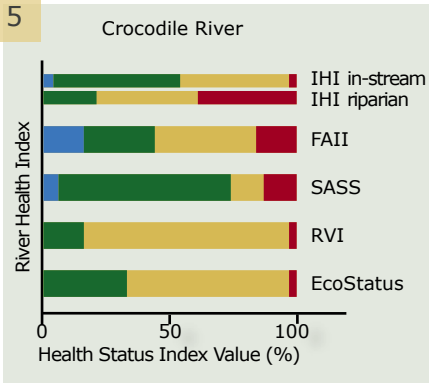
River length represented: 32%
Perennial: 73%

4 Sabie-Sand River system



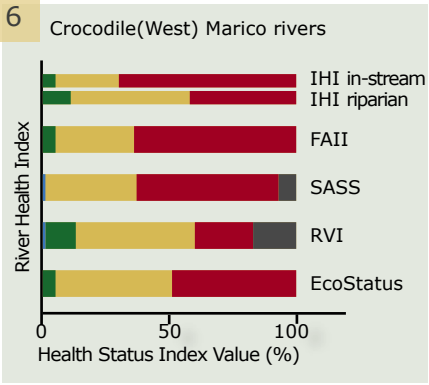
River length represented: 41%
Perennial: 77%

5 Crocodile River



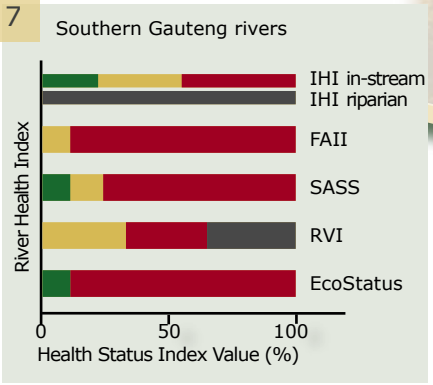
River length represented: 32%
Perennial: 83%

6 Crocodile(West) Marico rivers



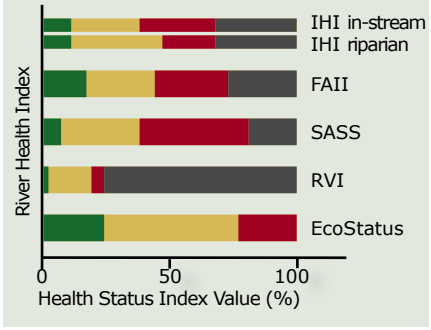
River length represented: 63%
Perennial: 56%

7 Southern Gauteng rivers



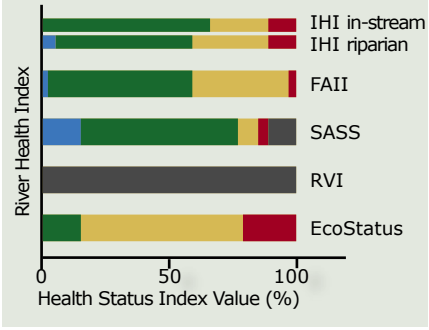
River length represented: 55%
Perennial: 54%

8 Free State Region rivers



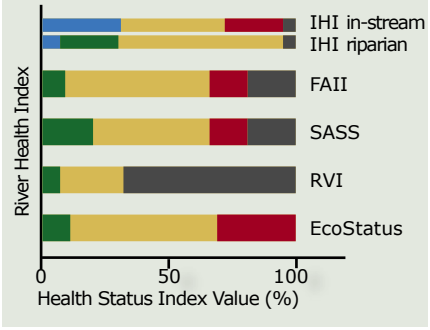
River length represented: 56%
Perennial: 92%

9 uMngeni River system



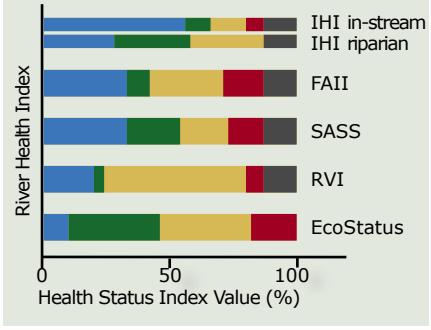
River length represented: 59%
Perennial: 93%

10 Buffalo River system



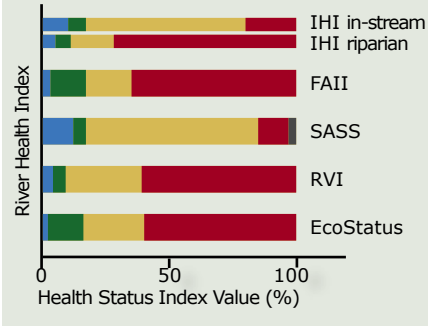
River length represented: 77%
Perennial: 82%

11 Hartenbos & Klein Brak rivers



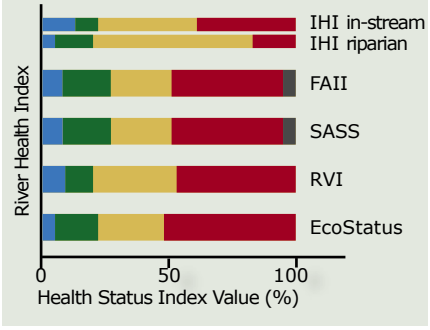
River length represented: 55%
Perennial: 67%

12 Berg River system



River length represented: 37%
Perennial: 37%

13 Cape Town rivers



River length represented: 85%
Perennial: 5%

Pressures and Management Actions

Impacts on River Health and how to Restore River Health

In South Africa, as in many arid parts of the world, population growth and urbanisation place increased pressure on limited water resources. Consequently, the challenge to balance water supply and water demands becomes greater than ever. Optimal water resource management is therefore imperative.

The information presented in this section is extracted from river health monitoring assessments that have been conducted over the past ten years. Some of the pressures on our river ecosystems are specific to a region, while others occur throughout South Africa. Following the DPSIR (Driving force-Pressure-State-Impact-Response) framework generally used in State of Environment reporting, the information presented in the table, to the right and on the following four pages, lists the driving forces, pressures and the impacts they have on our country's river ecosystems in a generic way, applicable to the whole country. The table also lists management actions and responsible organisations or departments which could help to mitigate these problems. Specific river attributes are discussed in more detail below to highlight their importance and value to society.

River Attributes

Aquatic ecosystems such as rivers and wetlands provide immeasurable benefits, either directly in the form of water for household use, agriculture, industry and recreation, or indirectly in the maintenance of vast ecosystems that underpin our very survival. Despite this, we are changing these water resources so dramatically that the health of many rivers and wetlands is precarious. The collapse of any of these systems would immediately threaten societal well-being. Our rapid development worldwide is placing an ever-growing demand on aquatic ecosystems. If we don't protect them, the benefits that we are reaping from them may diminish or disappear altogether.

What follows is a discussion of the components of aquatic ecosystems that provide goods and services to society, and the consequences to society if these components are damaged.

Driving Forces *The underlying social, political and economic activities that lead to environmental change*	**Pressures** *Pressures on the aquatic environment that result from the driving forces*
Urbanisation and Development Ever-increasing populations and high-density developments exert pressure on the natural and built environment	Building projects below the 1:100 year floodline in riparian zones. Overexploiting and modification of urban rivers and streams, including river and/or stream diversions
	Increased demand on sewage treatment works, water supplies and solid waste disposal sites
	Hardening of drainage basin surface
	Illegal dumping of solid waste; littering

Impacts on the aquatic environment *What damage does our behaviour inflict upon the aquatic environment?*	**Response** *What can we do in response to environmental change? How can we reduce environmental damage and encourage sustainable development?*
Clearing of riparian vegetation exposes the soil surface and increases erosion. This, in turn, causes instability of river banks and increased turbidity of water, degrading habitat for fish and other organisms. Uncontrolled removal of indigenous riparian plants, destruction of river beds and banks, canalisation, construction of gabions and levees, operation of heavy machinery: all cause poor water quality, increased siltation, modified flows and impaired flood retention. Disturbance may also result in invasion by shallow-rooted alien vegetation that is unable to withstand flooding. Alien trees often form a dense canopy which discourages undergrowth and further weakens river banks.	• Town planners and developers plan new developments in an environmentally acceptable manner • DWAF and local government implement and enforce the NWA and other regulations: strict enforcement and preventative measures, rehabilitation, Ecological Reserve (determination and implementation) • Communities living close to rivers become involved in protecting the resource • Provincial DEAT and local goverment implement and enforce NEMA and NEMBA (The National Environmental Management Biodiversity Act); EIA and scoping reports prepared before a new development is approved
Polluted water contaminates the surface and underground water, causing a human health risk and degrading aquatic habitats.	• Municipalities plan and manage treatment works and disposal sites to cope with population growth and development
Sealed surfaces exclude runoff from replenishing groundwater, and increase the magnitude of flooding.	• Municipalities plan open spaces where runoff can collect and infiltrate
Hazardous waste contaminates water resources and causes varying degrees of damage to different ecosystem components - often resulting in the disappearance of species and elimination of key ecological processes. Many hazardous materials are difficult to decompose; where these materials (such as plastics) accumulate, they often clog drainage systems. Unsightly litter discourages tourism and further contaminates water resources.	• DWAF and local goverment implement and enforce the NWA and other regulations

Gathering firewood

Eel catch in the Buffalo River

Washing activities

Environmental Flows

The natural flow regime in rivers, for example the cyclical rhythm of seasonal flow, is important in defining behaviour of plants and animals in and around rivers. Small floods trigger migrations by fish and invertebrates; major flood events sculpt in-stream habitats. Damming and water abstraction regulate river flows and suppress biological variation, restict ecosystem functioning and favour undesirable pests and pathogens.

We often see a river merely as an open channel with flowing water. But a river is much more than this: it is the visible part of a complex interaction between ground-water, surface water, sea and atmosphere. Reducing river flow often cuts off the replenishment of aquifers, with dire consequences for those who rely on them.

Other factors controlling the headlong downhill rush of water from source to sea are riparian zones, wetlands and intact indigenous landscapes. They take up water when it rains, releasing it gradually over weeks and months, and providing the services of flood prevention and water retention.

Large dams not only control natural flows, but also allow suspended sediments to settle, paradoxically reducing the dam's capacity to store water. Furthermore, the artificial release of large sediment-free floods increases scouring downstream, uproots riparian vegetation and interrupts the process of sediment deposition. The cost of these effects is reflected in the uneconomical expense of dredging silt from dams.

The cost of disrupting the natural flow processes in rivers is also seen when engineering solutions are required to regulate river flows in order to protect human lives that are threatened by flooding.

Driving Forces *The underlying social, political and economic activities that lead to environmental change*	**Pressures** *Pressures on the aquatic environment that result from the driving forces*
Infrastructure The growing social demand for better and increased services leads to the expansion of infrastructure such as weirs, dams, pipelines, roads and bridges.	Dams and weirs
	Water transfer schemes
	Roads, bridges and pipelines near, in or across rivers
Forestry Timber plantations mostly consist of trees that are not indigenous to South Africa.	Commercial forests Plantations of invasive plants are a source of infestation

The Hartenbos River has stopped flowing downstream of the Hartebeeskuil Dam due to the lack of water release mechanisms.

Impacts on the aquatic environment *What damage does our behaviour inflict upon the aquatic environment?*	**Response** *What can we do in response to environmental change? How can we reduce environmental damage and encourage sustainable development?*
• Modified river flow rates and flow patterns have adverse effects on the habitat and migration of many species, most notably fish. • River-adapted fish and other aquatic species cannot survive in reservoirs. • Water quality deterioration in and below dams. • Stocking of dams with alien fish for anglers poses a threat to indigenous fish and invertebrates.	• Engineers practise environmentally-sensitive planning and construction techniques • DWAF monitors and regulates construction, ensuring that new dams have appropriate release structures and, if necessary, fish ladders • DWAF assesses the aquatic environment • DWAF and local governments enforce and monitor measures to mitigate the impacts of developments on aquatic ecosystems, ensuring that environmental flow releases simulate natural flow patterns
• Water transfer schemes change river habitat and interfere with ecological processes by causing fluctuations in water temperature and flow regimes. • High flows scour recipient river beds and banks. • Inter-basin transfer of aquatic species causes disruption of aquatic communities, threatens biodiversity by polluting the gene pool of rare species and can contribute to the spread of disease.	• Transfer schemes are operated in a way that minimises the transfer of undesirable organisms
Clearing of vegetation, exposes the surface soil and causes increased erosion. This, in turn, causes instability of river banks and increased turbidity of water, degrading habitat for fish and other organisms.	• DWAF, DEAT and local goverment implement and enforce the NWA and other regulations pertaining to construction in rivers and wetlands.
Commercial forests extending into the riparian zone eliminate naturally occurring plants. Alien tree plantations have a higher water demand than indigenous vegetation and make an indirect demand upon rivers through the reduction of runoff. It is also a source of alien infestation. Plantation harvesting exposes bare soil. Inadequate riparian buffer zones, badly planned access roads, and incorrect timber harvesting activities, cause erosion and siltation.	• DWAF and DEAT implement and enforce the NWA and other regulations pertaining to preservation of riparian zones and correct harvesting practices. • DWAF and WRC encourage research on the cultivation of indigenous forests for commercial purposes.

Algae accumulates in a section of the river where there is almost no flow

Trampled river bank

Riparian Vegetation

The riparian zone is the area alongside a river that is inundated or flooded frequently enough to support vegetation that is distinct from surrounding areas. The riparian zone's functions in the river ecosystem include flow regulation, water quality amelioration, habitat provision, and corridor functions.

Removal of riparian vegetation is likely to trigger infestations by alien plants. These invaders often have shallow root systems that cannot maintain bank stability. Large floods then carry away vegetation and bank material, increasing the risk of loss of life, property and arable land.

Water Quality

Ecosystems regulate water quality. Often we utilise rivers to process and dilute our waste to the detriment of aquatic ecosystems. In a sparsely-populated catchment with plenty of clean water, this may be a logical approach: the riverine ecosystem dilutes toxins and processes organic matter, even dangerous pathogens. However, we often exhaust the capacity of aquatic ecosystems to dilute and process polutants.

Water pollution has a crippling economic effect on those who rely on the river water. Treatment costs are high for both domestic and industrial users, while agriculture can suffer large financial losses as a result of irrigation with poor quality water. Although the RHP does not measure human health directly, poor water quality poses a risk to recreational and domestic users.

Aquatic Habitats

Habitats are simply the places where plants and animals live. Many species are well adapted to a particular habitat, such as an estuary or a wetland, and can exist nowhere else. Intact habitats maintain biological and genetic diversity and the organisms that rely on these habitats assist in natural processes such as the breaking down of waste. Rivers provide a variety of habitat types, from mountain sponge wetlands, through torrents, rocky pools, broad reaches, riparian zones and finally estuaries, where the transition from river to marine environment occurs. The loss of any of these habitats implies the loss of an ecosystem service. For example, estuarine habitat provides a nursery for marine fish. Estuarine habitat destruction can have unexpected and expensive consequences for marine fisheries and all of the ecological processes that are linked to and support these fisheries. Similar consequences occur when riverine habitats are transformed or destroyed.

Driving Forces *The underlying social, political and economic activities that lead to environmental change*	**Pressures** *Pressures on the aquatic environment that result from the driving forces*
Mining and Industry	• Seepage from coal mines • Mine water runoff • Illegal effluent discharges • Unregulated solid waste disposal • Cooling water
	Small-scale mining of diamonds, stone, sand, or slasto
Agriculture Commercial and subsistence farming exert pressures on river ecosystems.	Poor commercial and subsistence farming practices include farming on river banks, excessive water abstraction, contaminated return flows, over-grazing and trampling of the riparian zone.

Eutrophication

The alien invasive water hyacinth

Impacts on the aquatic environment *What damage does our behaviour inflict upon the aquatic environment?*	**Response** *What can we do in response to environmental change? How can we reduce environmental damage and encourage sustainable development?*
Mining effluents often contain high concentrations of toxic chemical compounds, which disrupt river ecosystems. Acid mine drainage can cause irreversible damage to aquatic resources. Return flows from cooling processes can raise water temperatures, reduce oxygen levels, and disrupt riverine biota.	• DWAF and the Department of Minerals and Energy (DME) implement and enforce the NWA, the Minerals and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA) and other regulations.
Removal of sand and stone from wetlands, river beds and the riparian zone disrupts in-stream and riparian habitat. Stripping of vegetation results in erodible surfaces and siltation of rivers.	• DWAF, DEAT and DME implement and enforce the NWA and other regulations.
• Both commercial and subsistence farming include poor farming practices: farming on river banks; excessive water abstraction; contaminated return flows; over-grazing and trampling of the riparian zone. Stripping of natural vegetation destabilises river banks and results in erosion and the loss of topsoil. • Excessive abstraction decreases river flow, disrupts aquatic habitats and impacts life cycles and processes of aquatic organisms. • Alien plants and animals invade disturbed riparian zones.	• Farmers and other land owners refrain from disturbing land within riparian buffer zones. • DWAF and the Department of Agriculture (DoA) implement and enforce the NWA and other regulations.

Indigenous vegetation stabilises river banks

Letsitele River, tributary of the Great Letaba River

Challenges and Opportunities within the RHP

The modern era, with its improved health care, industrialisation and urbanisation, has accompanied a rapid increase in population numbers across the world. The same patterns hold true for South Africa and the growing exploitation of our freshwater resources has led to a steady decline in water resource quality. The challenge that we now face in South Africa is how to provide basic water supply and sanitation services to millions of deprived households, while ensuring sustainable use of our scarce resources and the same or better quality of services for future generations; in short, "**some for all, forever**".

Without proper implementation and enforcement of the NWA, DWAF will fail to protect South Africa's aquatic resources. Successful implementation of the NWA, amongst others, implies that:

- The classification system will be finalised and implemented
- The Reserve and resource quality objectives (RQOs) will be set and in-stream flow requirements will be implemented. This should be started in priority catchments and extended to all river systems in South Africa
- Monitoring will be continued to ensure compliance with control measures

Within the River Health Programme, there are several weaknesses and threats that hamper successful implementation of the programme. Nevertheless, some provinces have built on their strengths and have demonstrated several successes. The strengths, weaknessess and threats were explored and these are discussed as challenges and opportunities, below.

Clarify roles and responsibilities

DWAF, as the lead agent, need to **communicate regularly** with other departments and organisations that are involved in the implementation of the RHP on national and provincial levels. Individuals who are committed to the implementation of the RHP drive the process in the provinces. This is strengthened by **collaboration** between departments within which the RHP champions reside and other departments and organisations. Provinces where implementation of the RHP is successful have usually formed **partnerships** with other organisations to the mutual benefit of all parties. Through these partnerships, the workload and responsibility is shared. This is an ideal opportunity for other provinces to follow this successful implementation model.

River forums create the opportunity to discuss RHP implementation problems and issues. Awareness of the importance of aquatic ecosystem conservation and management leads to the acceptance of individual **responsibilities and duties** at all levels of government and within the public and private sectors. The RHP provides an opportunity to market and disseminate information about the aquatic environment to stakeholders and the general public: the RHP informs stakeholders of its objectives, plan of action and the value that it can add towards sustainable development and creating a better life for all in South Africa.

Each province has the opportunity to draw up an RHP implementation plan, in order to clarify roles and responsibilities of the different stakeholders and to prevent duplication. Government departments and other sectors can co-operate and share data. There are a number of initiatives and untapped capacity in the provinces that the RHP needs to link up with. We need to bring even more stakeholders on board to broaden the participants who have bought into the RHP. The opportunity exists for other government departments, tertiary institutions, consultants and local government to take part in the RHP and SoR reporting activities. Other sectors that need to contribute include industry, mining and forestry.

Western Cape Provincial Meeting - 2001

Some of the fish sampling equipment

Biomonitoring in the Crocodile River Catchment - 2000

Expand the capacity and expertise base.

Personnel turn-over rates in government departments are high, making it necessary to continuously train new people, because the implementation activities do not get the attention they deserve. While the increasing number of trained personnel is beneficial to the country as a whole, the workload placed on those staff members who remain within the national, provincial and local authorities, coupled with an increasing demand on financial resources, is a threat to the successful implementation of the RHP. Recruitment of scientists to assist with the implementation of the RHP at provincial level is slow. These are once again the results of inadequate planning for sustainable development, with the consequent under funding of regional activities.

The RHP benefits enormously when experts residing within the provincial and regional government are able to carry out the biomonitoring and other related RHP activities. There is also an opportunity for inexperienced RHP champions to tap the experience of other RHP champions and scientists, and get their **support, training and guidance**. There is a wealth of knowledge waiting to be transferred to keen newcomers to the programme through on-the-job training.

In the nine provinces, the implementation of the RHP is at varying levels of maturity. Despite these differences, the lessons that the implementers have learnt and can share are universal. By **sharing** their experience, the provincial teams can **assist** one another to overcome seemingly insurmountable problems.

Communicate and create awareness

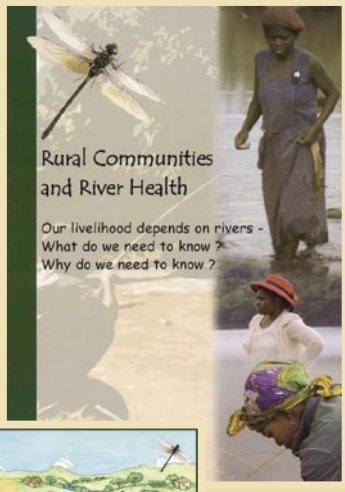
Through appropriate processes of communication and awareness creation, decision-makers in government should be convinced of the **value of the RHP**, the benefit of the RHP to **holistic river management,** and that management should **take action** in response to the RHP monitoring results. The understanding of ecosystem functioning and role of environmental services should be expanded and broadened. Where there are conflicting demands and responsibilities within local government, e.g. huge pressure for development, there is often a lack of co-operation. DWAF should not hesitate to apply the NWA where conflicts of interest occur.

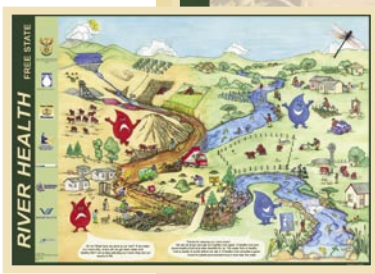
Improve managerial support

For implementation of the RHP to be successful, support is needed from all levels of management, from within DWAF as well as the partnering organisations. Where strong support is forthcoming from high-level management in DWAF Regions and the collaborating organisations, the necessary **resource allocation** is ensured. For example the RHP is written into business plans, so **budgets** cater for biomonitoring, reporting and related activities. The end result is committed and motivated implementation teams that are able to achieve much more.

Cover all major and important river systems in South Africa

The RHP must expand to include **more rivers** and become more broadly representative of South Africa. The National Coverage Phase addresses the selection of national sampling sites and the establishment of the programme at a national level.



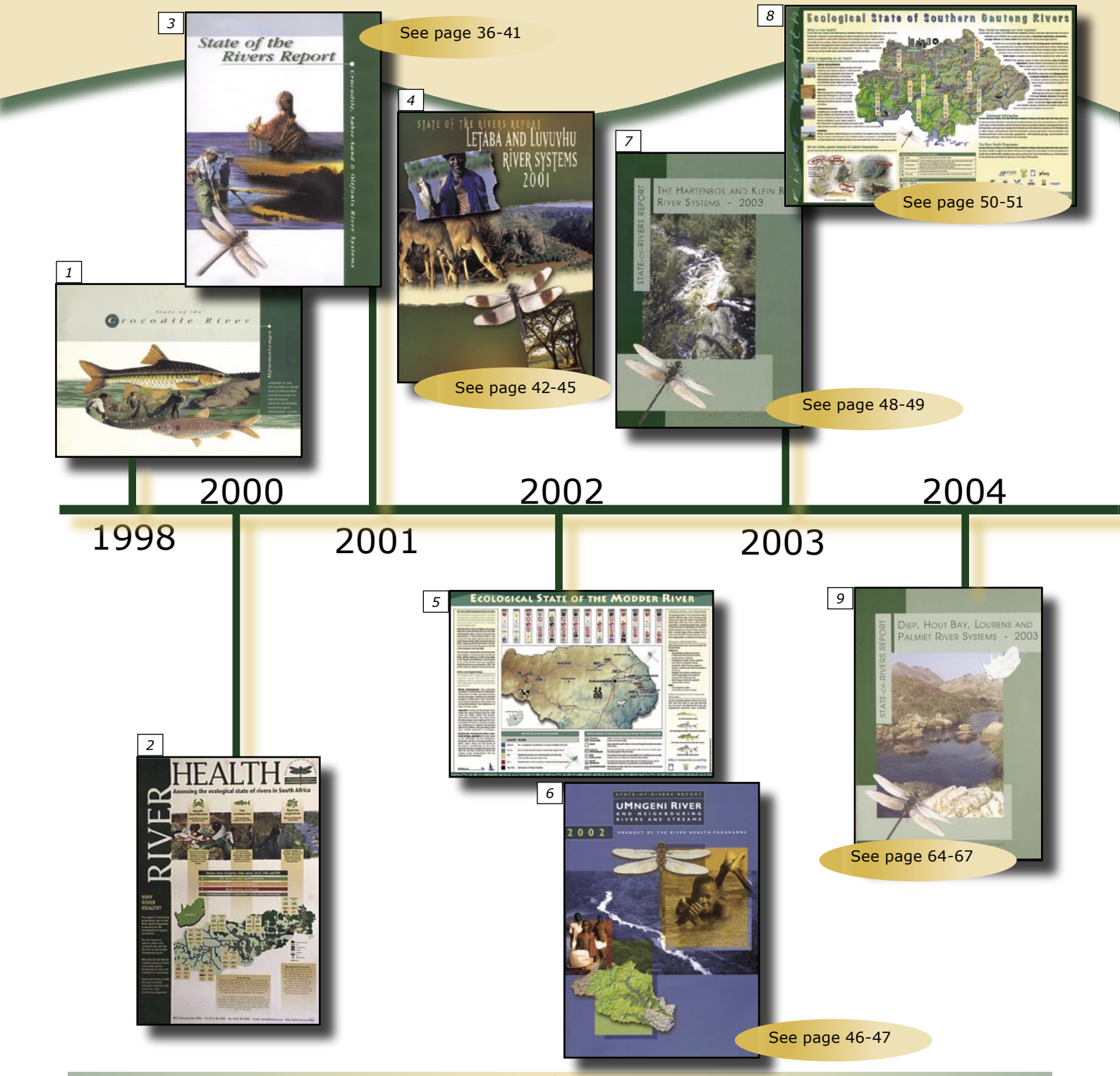


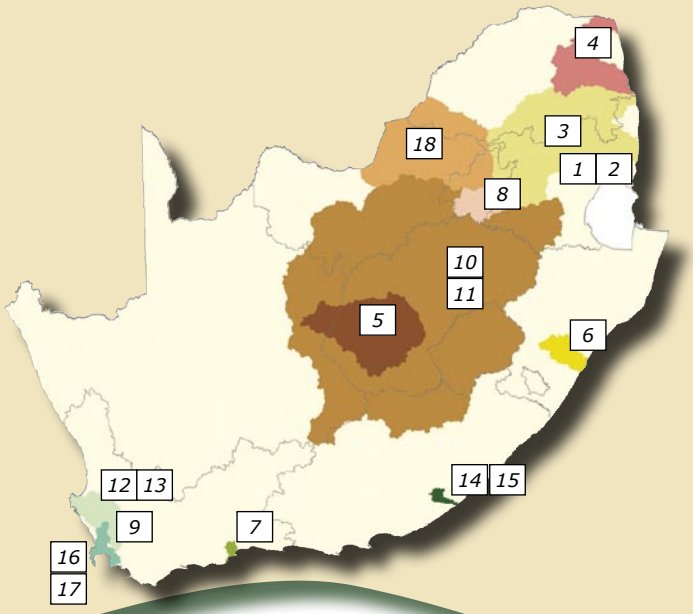
The River Health Programme gathers information related to the health of rivers. On its own, this information does not add any value towards ensuring sustainable development of our river systems. To gain maximum benefit from this river health information, it should be communicated in the right way to the right people. Target audiences include politicians, water resource managers and the general public.

State-of-Rivers Reporting in South Africa: A Timeline

The River Health Programme (RHP) gathers information related to the health of rivers. On its own, this information does not add any value towards ensuring sustainable development of our river systems. To gain maximum benefit from this river health information, it should be communicated in the right way to the right people. The target audiences of State-of-Rivers reports include politicians, water resource managers and the general public.

The first prototype publication appeared in 1998 and covered the Crocodile River in Mpumalanga where the pilot RHP studies took place. Soon thereafter, a generic River Health Poster appeared. Since the development of these pilot products, all nine of the South African provinces have become involved to varying degrees in the production of State-of-Rivers reports and posters. The SoR reporting series to date is shown below.





Note: The RHP has assessed and reported on only a small selection of South African rivers. While some rivers were selected merely because a wealth of information was available, others were chosen because of the potential benefit to the broader stakeholder group in the province. Selection was a provincial decision that was often driven by the stakeholder community requirements. In the end, the availability of biomonitoring information and the availability of human resources have defined the extent of RHP monitoring. Despite these restrictions, monitoring, assessment and reporting are continuing, with more rivers being added to the list each year. The remainder of the report discusses the present state of each river system separately. Detailed reports on these river systems are also available.

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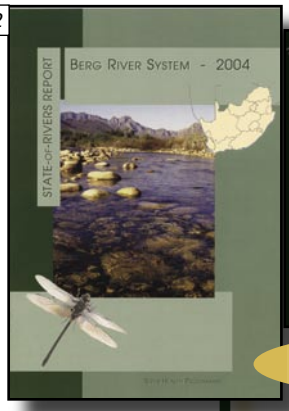

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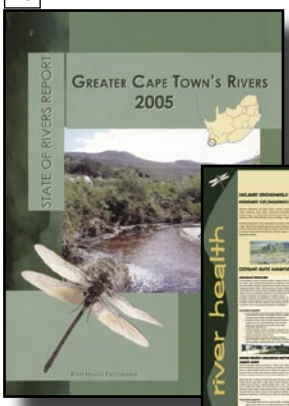

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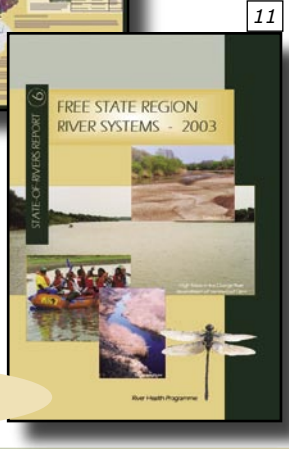

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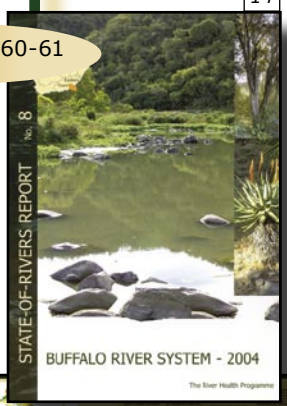

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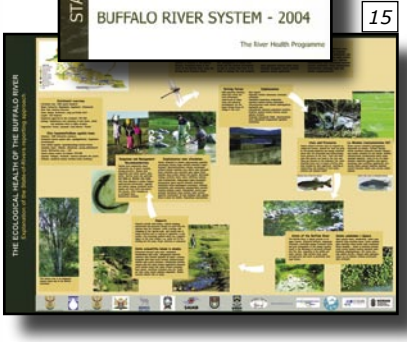

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Crocodile River System

Assessed: 1996
Area: 10 500 square kilometres
Mean annual runoff: 1200 million cubic metres

The Crocodile River is one of the major river systems of Mpumalanga. The upper tributaries of the Crocodile River drain high altitude grasslands and the sources of these streams are often within perennial wetlands, for example the internationally important Verlorenvlei Nature Reserve near Dullstroom, which is registered as a Ramsar wetland. The Kwena Dam is the largest dam in the catchment and controls 10% of the total runoff of the catchment.

A large proportion of the Crocodile River catchment has been modified or transformed from its natural condition. Urbanisation is rapid and Nelspruit is the largest town in this area. East of Nelspruit, the Crocodile River forms the southern border of the Kruger National Park. It joins the Incomati River close to the South African border with Mozambique near Komatipoort, and discharges into the Indian Ocean at Maputo Bay.

Overall State of the Crocodile River System

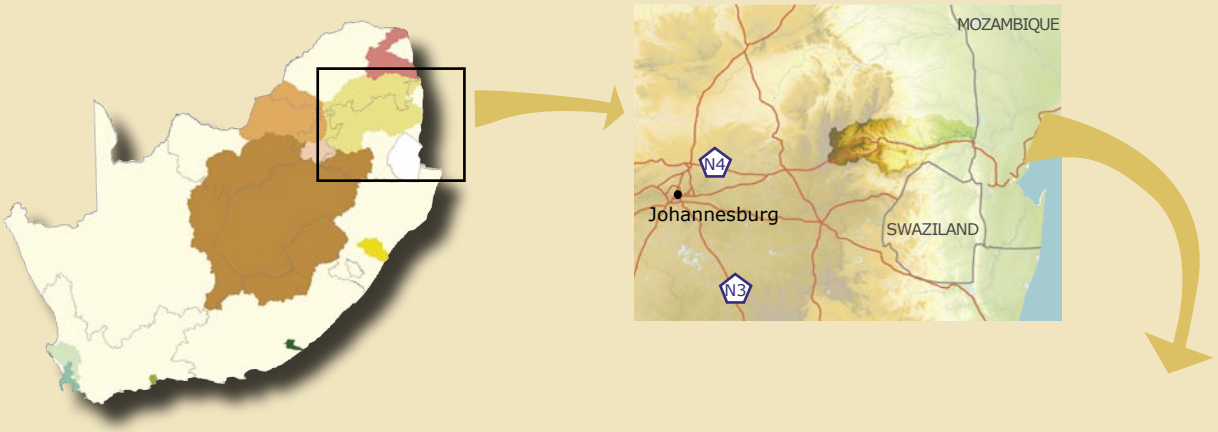
The main land use activities of the Crocodile River catchment are agriculture (irrigated and dryland cropping, cattle and sheep grazing), forestry, trout farming (in the upper reaches), as well as industrial and urban land uses.

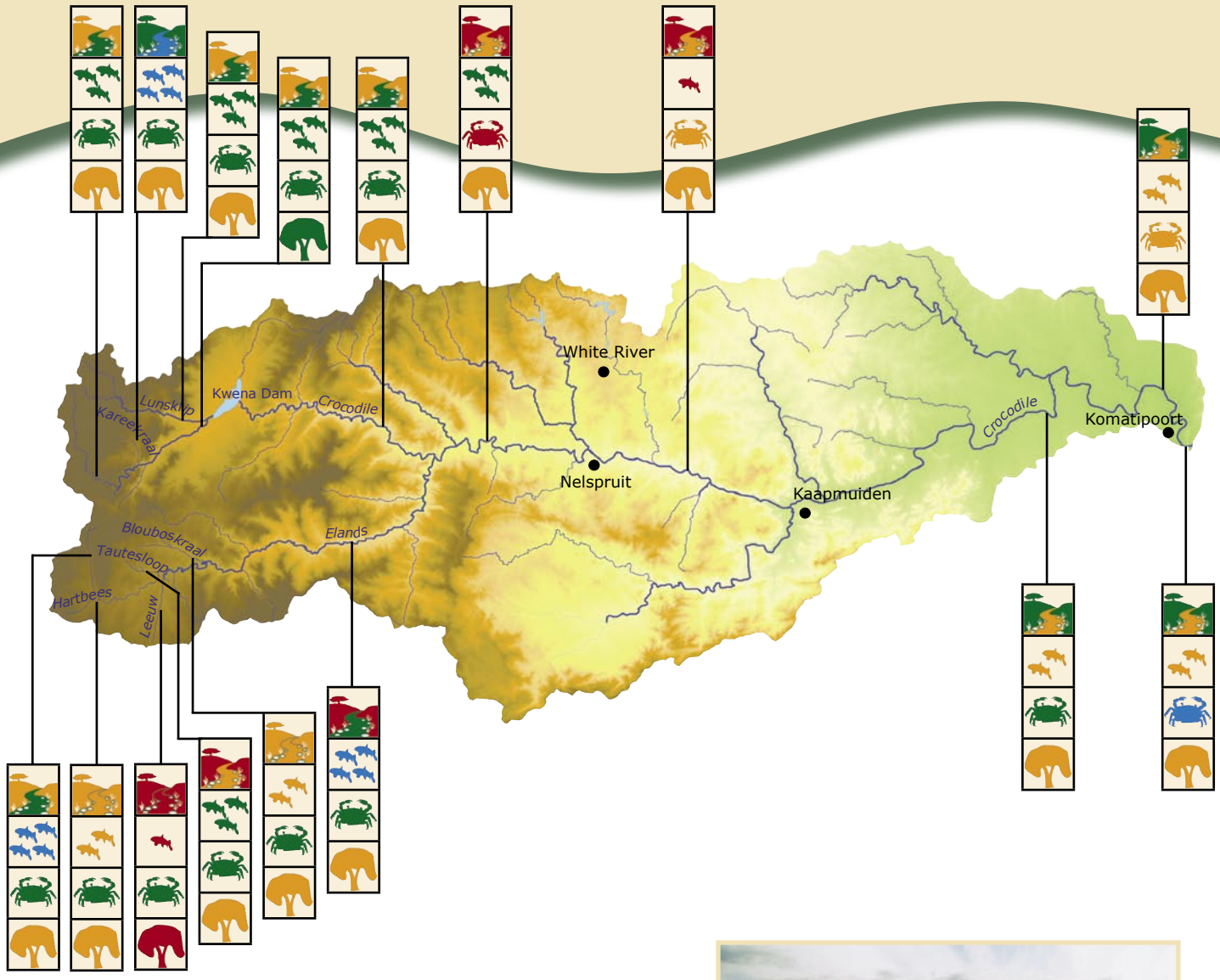
During 1996, when the Crocodile system was assessed, the overall condition of river ecosystems was good to fair. However, there was considerable variation in condition between the different components of river health. Infestations of alien vegetation and the clearing of ground cover have seriously damaged riparian habitats in some areas. Fish and invertebrate communities were generally in better health than the riparian vegetation, reflecting good water quality and in-stream habitat conditions. The main exception is in the Nelspruit area, where the river was in fair to poor health because of domestic runoff and urban and industrial waste water discharges from Nelspruit.

Biomonitoring team assess the area

SASS monitoring team

Top: Highveld grassland characterises the upper reaches of the Crocodile River catchment





Crocodile River in flood - Nelspruit Cascades - 2000

Sabie-Sand River System

Assessed: 1997
Size: 6 300 square kilometres
Mean annual runoff: 762 million cubic metres

This catchment, like the Crocodile River, forms part of the larger Incomati System which extends into Swaziland and Mozambique. The Sabie River has its source at 2 130 m above mean sea level in the Drakensberg Escarpment and drops into the lowveld where it joins the Sand River inside the Kruger National Park. Other tributaries to the Sabie River include the Marite and Mac Mac rivers. The dominant land uses in the upper catchment are agriculture (pasture, dryland or irrigated cultivation) and extensive forestry production. Some mining and industrial activities are also practised. Flows in the Sabie River peak in summer and are lowest at the end of the dry winter season.

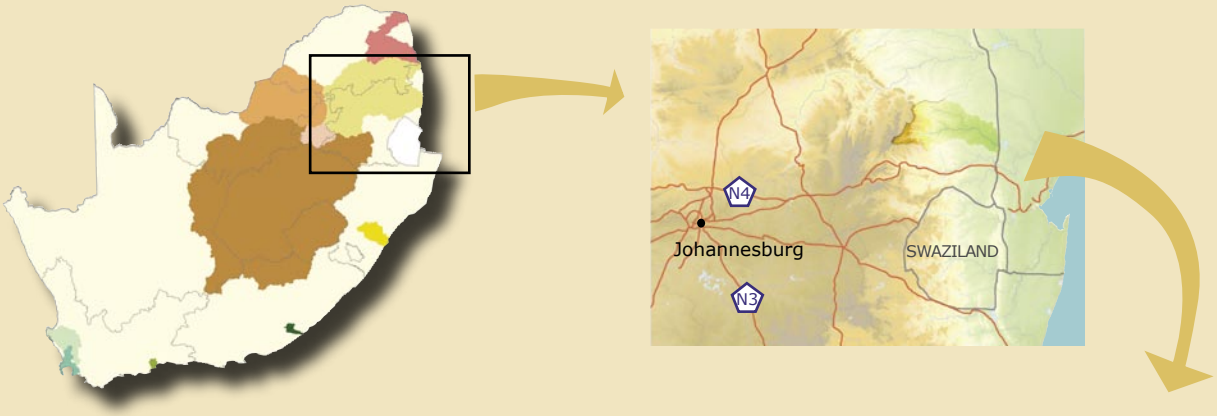
Overall State of the Sabie-Sand River System

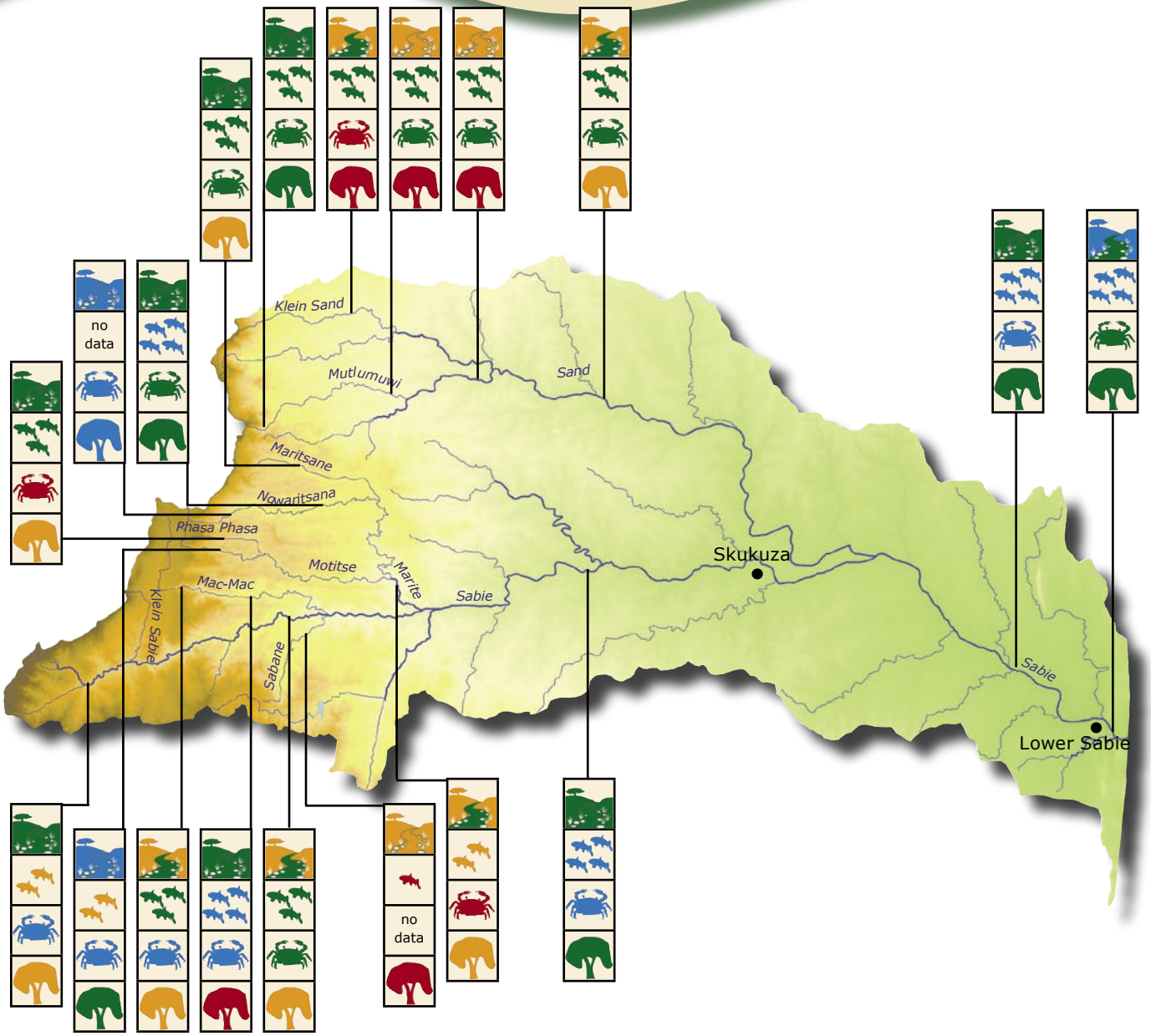
Land use is dominated by forestry with industry, agriculture and urban developments also having negative effects on ecosystem health.

Overall, the Sabie-Sand River system was in good condition during 1997. However, the invertebrate and riparian vegetation health in the Sabane and Klein Sand Rivers in particular, were poor and even unacceptable, as a result of clearing of riparian vegetation and a subsequent increase in erosion and the infestation of alien plants in the riparian zone.

Fish sampling by electro-shocking (middle) and netting (bottom)

Top: Lower Sabie River in the Kruger National Park


N4
Johannesburg
SWAZILAND
N3


no data
Klein Sand
Mutlumuwi
Sand
Maritsane
Nowaritsana
Phasa Phasa
Motitse
Marite
Mac-Mac
Sabie
Klein Sabie
Sabane
Skukuza
Sabie
Lower Sabie
no data

Olifants River System

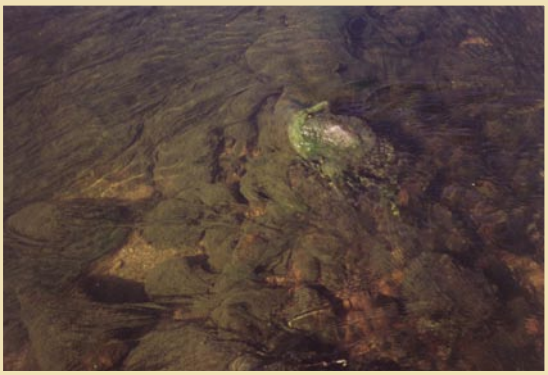
Assessed: 1998 – 1999
Area: 54 570 square kilometres
Mean annual runoff: 2400 million cubic metres

The Drakensberg Escarpment runs north to south, roughly through the centre of the Olifants Catchment. The Olifants River and some of its key tributaries, namely the Bronkhorstspruit, Wilge and Elands rivers, rise in the highveld grasslands of Gauteng while the Klein Olifants River rises in Mpumalanga. A large proportion of the catchment has been modified or transformed from its natural condition. The population is mainly rural but urbanisation is rapid. The upper reaches of the Olifants River catchment are characterised mainly by mining, agriculture and conservation activities. Over-grazing and highly erodible soils result in severe erosion in parts of the middle section of the Olifants Catchment. Thirty large dams together with many smaller dams impound a large proportion of the runoff. The Olifants River meanders past the foot of the Strydpoort Mountains and through the Drakensberg escarpment. The Mohlapitse, Steelpoort and Blyde tributaries join the Olifants River before it enters the Kruger National Park and neighbouring private game reserves. Just after entering Mozambique, the Olifants River flows into the Massingir Dam.

Olifants River in the Lowveld

Overall State of the Olifants River System

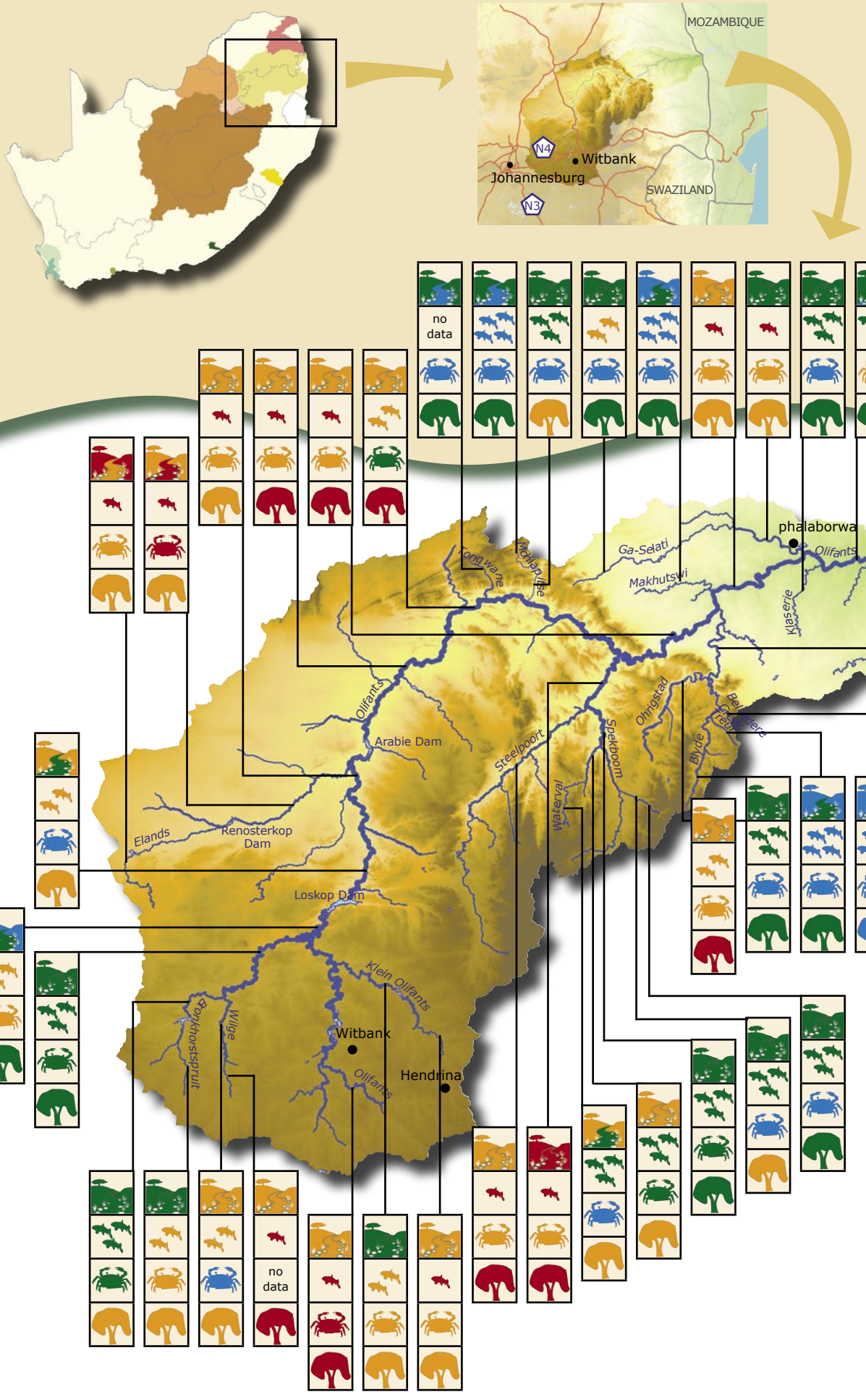
Extensive alien vegetation invasion and regulation of river flows by about 30 storage dams cause environmental degradation downstream, particularly in the middle and lower parts of the catchment. These impacts contribute to the sediment load, changing the habitat into a sand dominated river. Sediment laden water is responsible for periodical massive fish kills in the Kruger National Park and further downstream. The Olifants River catchment is dominated by mining activities, with some industries and large areas of agriculture.



Eutrofication

During the assessment period (1998 - 1999), the river ecosystems in the Olifants system were generally in a fair to poor condition, with a few exceptions such as the Tongwane and upper Mohlapitse and most of the Blyde, which were all in a natural state. In the upper part of the catchment, mining-related disturbances were the main causes of impairment of river health.

Top: Riffles in the upper Olifants River


MOZAMBIQUE
N4
Witbank
Johannesburg
SWAZILAND
N3
no data
phalaborwa
Olifants
Ga-Selati
Makhutswi
Klaserie
Olifants
Arabie Dam
Steelpoort
Spekboom
Ohrigstad
Blyde
Waterval
Elands
Renosterkop Dam
Loskop Dam
Klein Olifants
Witbank
Hendrina
Olifants
Wilge
Bronkhorstspruit
no data

Letaba River System

Assessed: 2000 – 2001
Area: 13 670 square kilometres
Mean annual runoff: 574 million cubic metres

The Groot Letaba River and some of its tributaries (Politsi, Debengeni, Thabina and Letsitele rivers) rise in the Northern Drakensberg Mountains between 1100 and 1 800 metres above sea level. The Letaba River flows eastwards and is joined by its major tributaries, including the Klein Letaba, Middle Letaba, Nsama and Molototsi rivers, before it flows through numerous private nature reserves and the Kruger National Park, joining the Olifants River close to the Mozambique border. Of the more than 20 major dams in the Groot Letaba Catchment, the Tzaneen and Middel Letaba dams are the two largest in the Limpopo Province. Other large dams include the Ebenezer, Magoebaskloof, Nsami and Modjadji.

The upper catchments of the Drakensberg mountains are dominated by forestry plantations, while the foothill zones contain tea estates. The Letaba catchment supports a wide range of agricultural activities, while further downstream the catchment is dominated by rural populations with cattle, goats and subsistence farming. The Tzaneen and Letsitele regions support citrus, mango and banana orchards. Gold mines occur along the Klein Letaba River and at the time of the survey numerous mining developments were under consideration in the Tzaneen area. Several natural areas of importance can also be found in these catchment areas, including the Wolkberg Wilderness area.

Magoebaskloof Dam

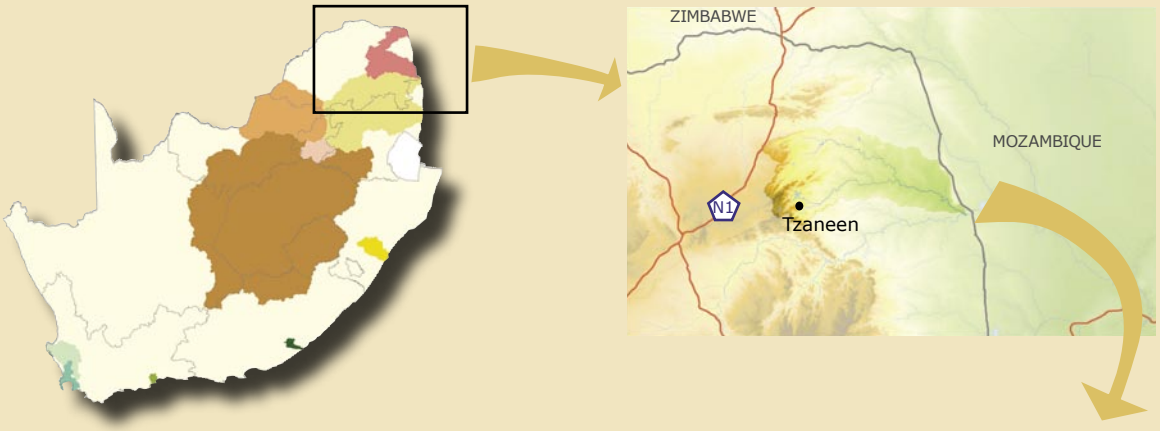
Overall state of the Letaba River System

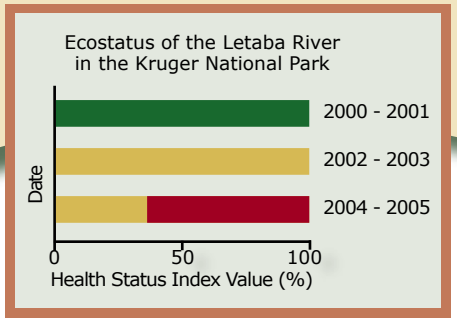
Land use is dominated by commercial forestry and agriculture (subsistence and commercial) in the upper and middle reaches of the catchment, while the lower reaches flow through the Kruger National Park.

During the assessment period (2000 - 2001), the overall ecological state of the Groot Letaba River varied from fair to poor, although the macro-invertebrate communities were generally in a natural to good state. The lower reaches of the Letaba, below the confluence of the Groot and Klein Letaba rivers and where the river flows into the Kruger National Park, were in a good state.

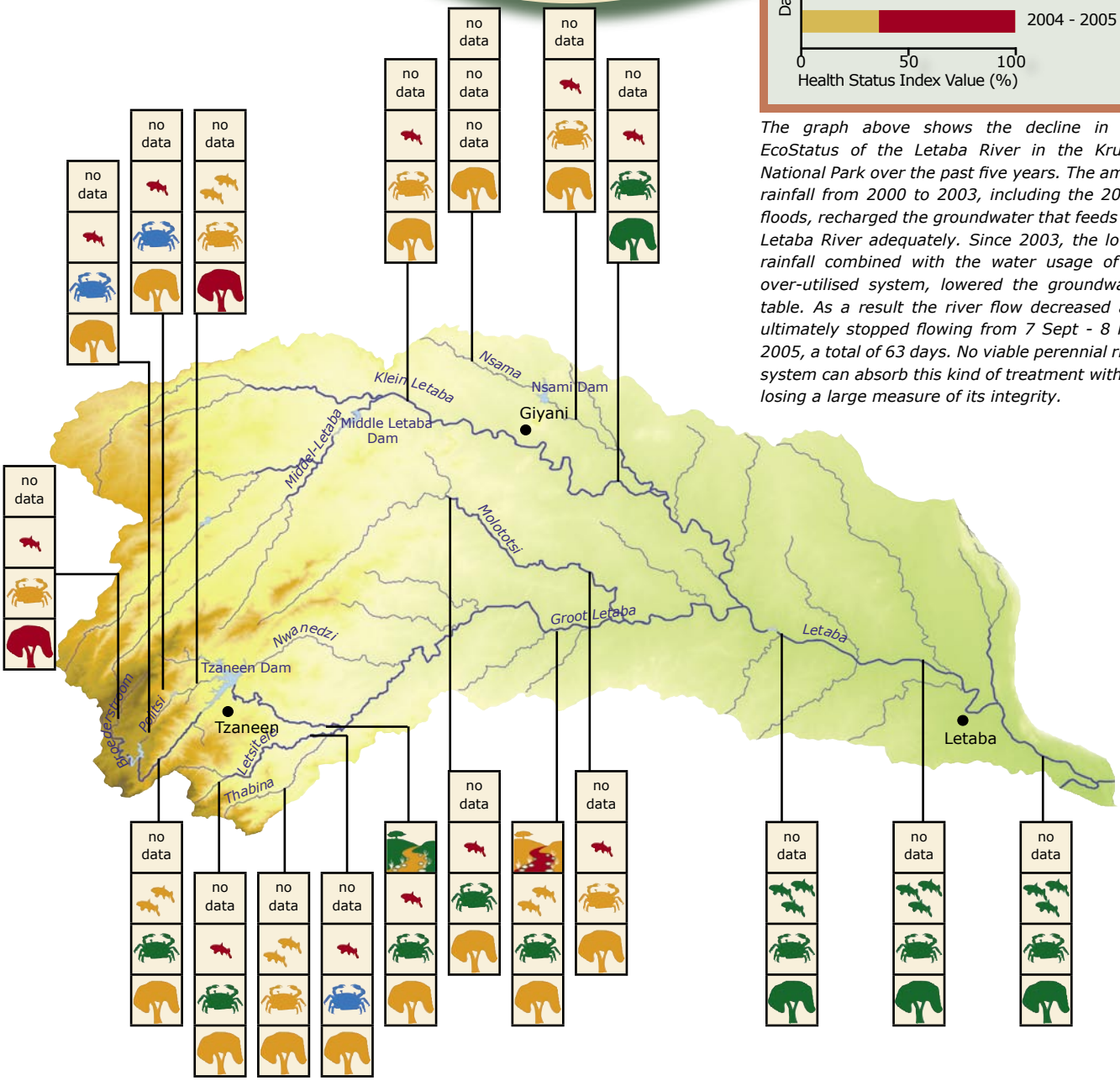
Alien vegetation in the Letaba River catchment

Top: The sandy riverbed and multiple channels of the Letaba River below the confluence of the Klein Letaba and Groot Letaba rivers





The graph above shows the decline in the EcoStatus of the Letaba River in the Kruger National Park over the past five years. The ample rainfall from 2000 to 2003, including the 2000-floods, recharged the groundwater that feeds the Letaba River adequately. Since 2003, the lower rainfall combined with the water usage of an over-utilised system, lowered the groundwater table. As a result the river flow decreased and ultimately stopped flowing from 7 Sept - 8 Nov 2005, a total of 63 days. No viable perennial river system can absorb this kind of treatment without losing a large measure of its integrity.



Luvuvhu River System

Assessed: 1999 – 2000
Area: 5 940 square kilometres
Mean annual runoff: 519 million cubic metres

The Luvuvhu River and Sterkstroom tributary rise between 1 000 and 1 400 metres above mean sea level on the southern side of the Soutpansberg Mountains. Other tributaries, the Dzindi, Mutshindudi and Mutale, originate in the mountain ranges east of the Entabeni and Vondo forestry areas. They join the Luvuvhu River before it traverses the Kruger National Park to join the Limpopo River near Pafuri on the Mozambique border.

Lake Fundudzi in the upper Mutale River is one of very few natural inland lakes in South Africa. Dams in the Luvuvhu River catchment include the Albasini and the smaller Mambedi, Tshakhuma, Damani, Vondo and Phiphidi dams. At the time of the survey the Nandoni Dam, downstream of the confluence of the Dzindi tributary was under construction in the Luvuvhu River. Indigenous forests in the upper Luvuvhu Catchment include Hangklip, Piesangkop, Entabeni, Thathe Vondo and the Vhutanda sacred forest. The Mphaphuli Cycad Reserve is near the confluence of the Luvuvhu and Mutshindudi rivers. The Pafuri floodplain has been proposed as a wetland of international importance (Ramsar site)

The upper catchment is mainly under forestry plantations, while the Mutshindudi and Mutale catchments are dominated by subsistence farming. A coal mine exists in the Luvuvhu catchment. The foothills of the Soutpansberg mountains are famous for their tea estates and other produce such as mangos, bananas and macadamias.

Forestry and tea plantations in the Luvuvhu Catchment

Overall state of the Luvuvhu River System

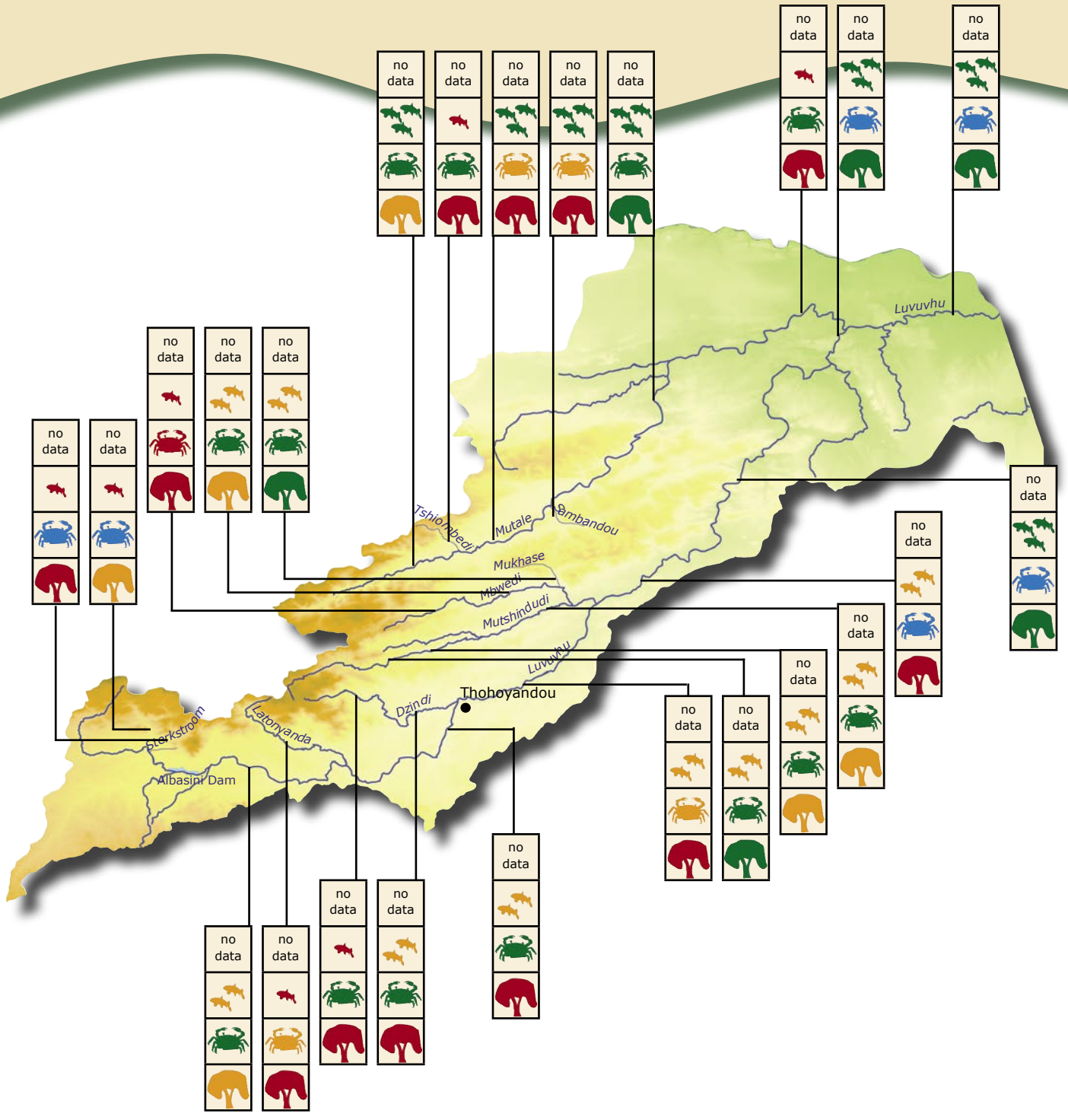
Main land uses are orchards, commercial forestry and agriculture (subsistence and commercial) in the upper and middle reaches of the catchment. The lower reaches flow through conservation areas, including the Makuya Provincial Reserve and the Kruger National Park.

The overall ecological state of the Luvuvhu River varied from good to poor during the assessment period. The lower reaches of the river, where it transects the Kruger National Park, were in natural to good state at the time. The macro-invertebrate communities were generally in a natural to good state. The riparian vegetation was mostly in a poor state, except for the conservation areas and upper reaches of the Mukhase and Mutshindudi rivers which varied from good to natural.

Washing day in the Muthindudi River

Top: Luvuvhu River in the Kruger National Park


ZIMBABWE
N1
MOZAMBIQUE
Tzaneen


no data
Luvuvhu
Tshiombedi
Mutale
Mukhase
Mbwedi
Mutshindudi
Luvuvhu
Dzindi
Thohoyandou
Latonyanda
Albasini Dam

uMngeni River and Neighbouring Rivers and Streams

Assessed: 1992 – 2002
Area: 4 420 square kilometre
Mean annual runoff: 877 million cubic metres

The uMngeni River originates in the uMngeni Vlei area, from where it flows in an easterly direction via Albert Falls Dam into Nagle Dam, downstream of which it is joined by the uMsunduze tributary. From here, it flows through the Valley of a Thousand Hills and then out to sea at Durban. The uMngeni and neighbouring catchments form a region of widely varying land uses, ranging from conserved natural areas to areas of intense urban and industrial development, forestry and agriculture. The region is one of major economic, cultural and ecological importance and careful planning is necessary if all the river-related activities are to be sustainable.

Overall State of the uMngeni River and Neighbouring Rivers and Streams

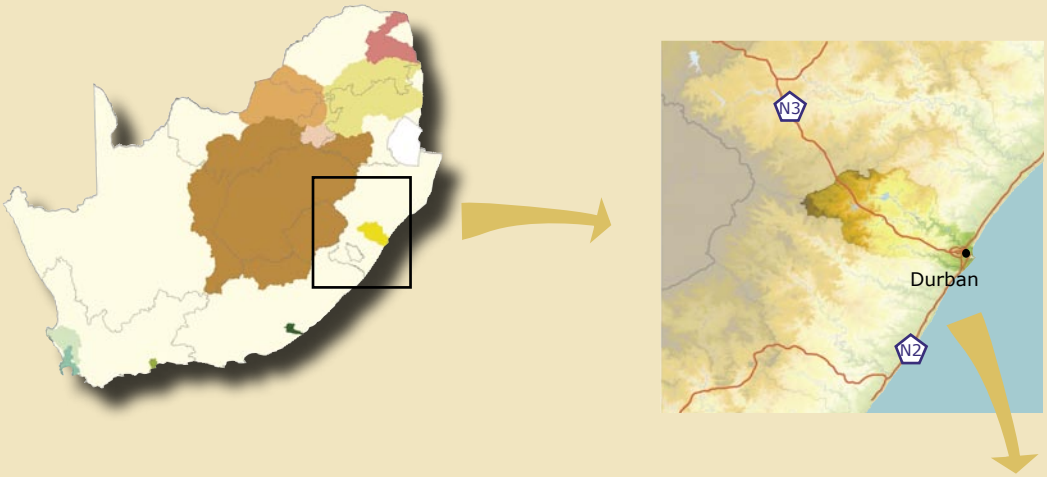
Despite effective water demand management in the uMngeni catchment area, an increased future demand of water is expected. Urbanisation in the lower reaches has led to increased contaminated runoff and faecal pollution. The rivers of the uMngeni and uMlazi catchments are also heavily regulated by dams, resulting in downstream river flow reduction, and the degradation of downstream water quality, habitat and biotic integrity.

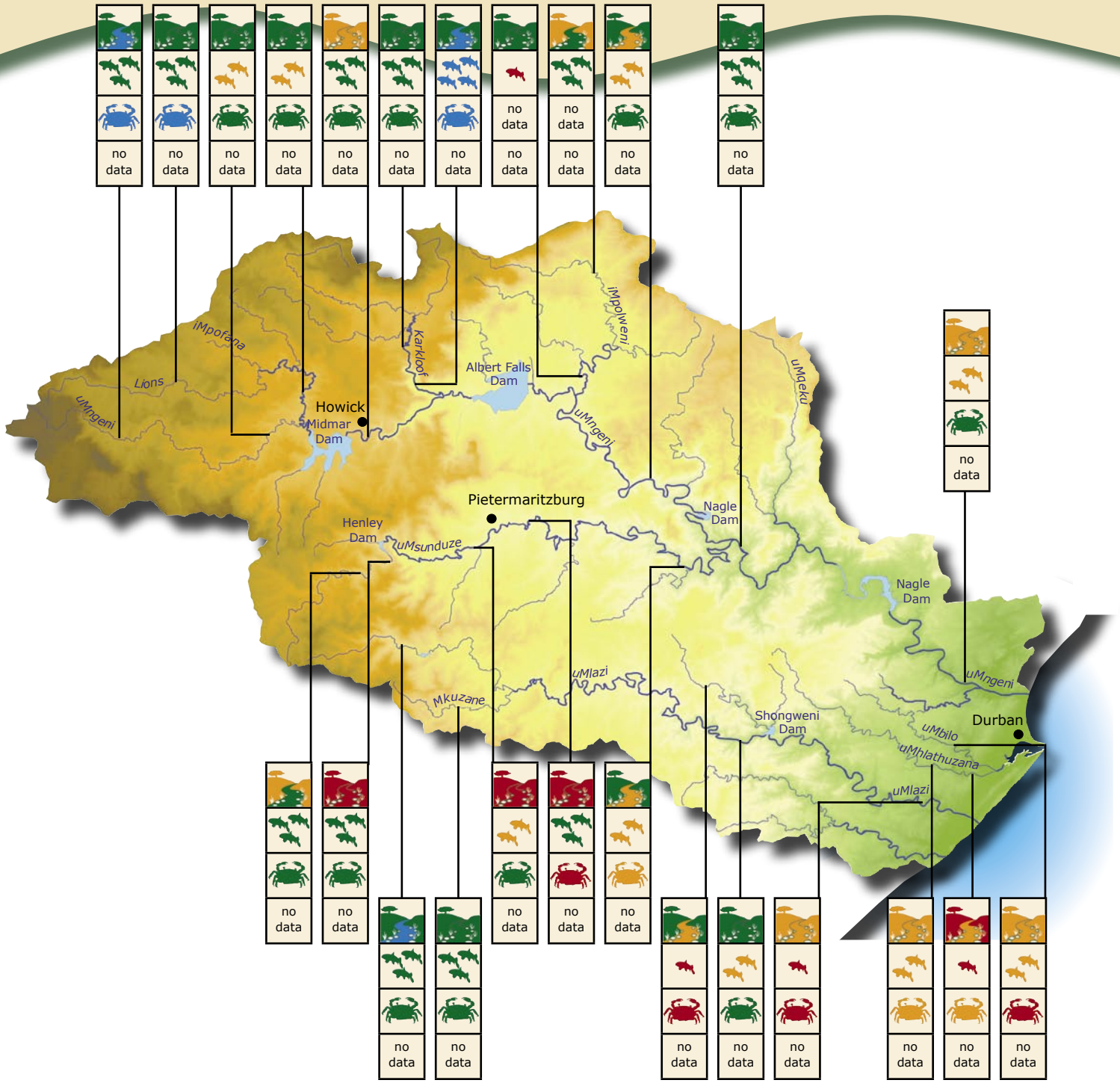
The upper and middle reaches of the uMngeni River was generally in a good ecological state at the time of assessment. The upper reaches of the uMsunduze River were in a good to fair state, while the lower reaches were predominantly in a poor state. Downstream of the confluence with the uMsunduzi River, the uMngeni was generally in a good to fair state.

The uMlazi River originates south west of Pietermaritzburg and flows out to sea near Durban through a concrete canal. Land use in the uMlazi Catchment ranges from forestry and agriculture to urban development. The overall ecological state of the uMlazi River varied from good in the upper reaches, to fair further downstream and poor near the sea.

The uMzunduze River in downstream Pietermaritzburg (above) and upstream of Henley Dam (top)

Washing in the uMngeni River


N3
Durban
N2


no data
iMpofana
Lions
uMngeni
Howick
Midmar Dam
Karkloof
Albert Falls Dam
iMpolweni
uMngeni
uMqeku
Pietermaritzburg
Henley Dam
uMsunduze
Nagle Dam
Nagle Dam
uMlazi
Mkuzane
Shongweni Dam
uMngeni
Durban
uMbilo
uMhlathuzana
uMlazi

Hartenbos and Klein Brak River Catchments

Assessed: 2001 – 2002
Area: 767 square kilometres
Mean annual runoff: 59 million cubic metres

The Hartenbos and Klein Brak rivers are situated on the Cape south coast and are typical coastal river systems draining the Table Mountain Sandstone (TMS) formations of the Cape Fold Mountains. The catchments are small and are characterised by high gradient streams that show a rapid response to rainfall events. Despite being peat-coloured due to the presence of dissolved material from decayed fynbos plants in the catchment, the water draining the TMS is of good quality and has a low conductivity, turbidity and pH. The land-use within the catchments comprises nature conservation, plantation forestry, grazing, limited agriculture, game farming and small rural settlements.

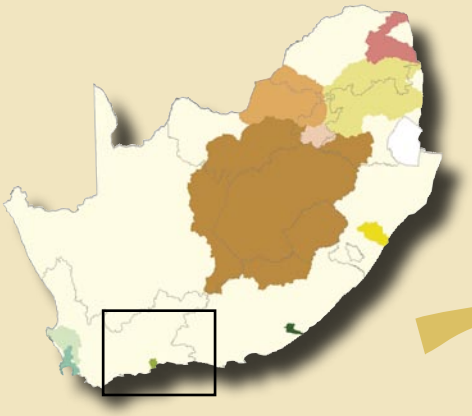
Overall state of the Hartenbos and Klein Brak rivers

The flow regime and habitat are severely altered in the Hartenbos River. This is mainly as a result of the Hartebeeskuil Dam which has no facility for flow releases. In addition, sand mining operations have resulted in a decrease in habitat diversity with a consequent loss of species diversity in the river. The overall ecological state of the Hartenbos River is fair to poor.

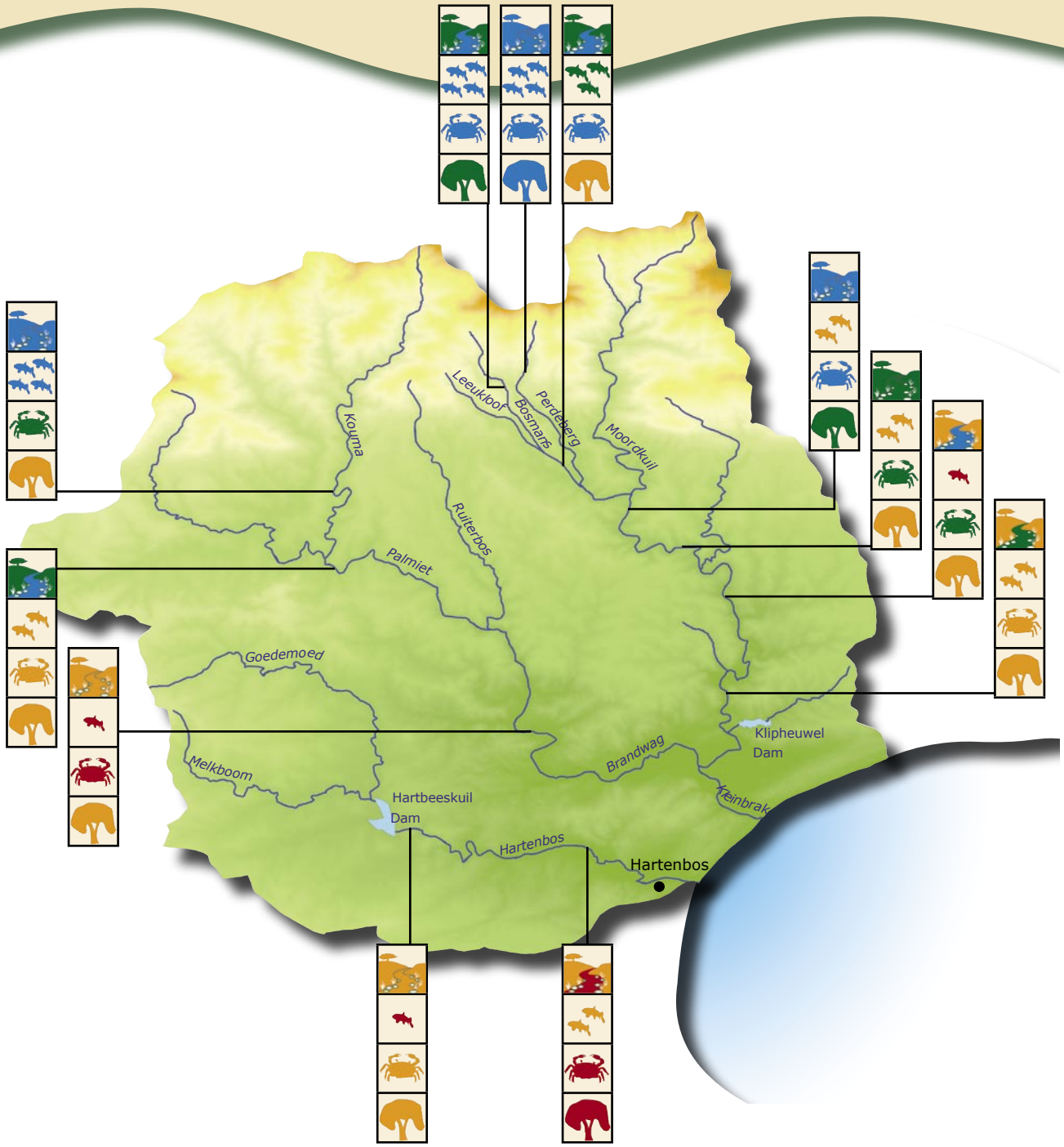
The major impacts on river health in the Klein Brak River are the presence of alien fish and alien vegetation within the riparian zone. Water quality and habitat integrity within the rivers deteriorates downstream of the Palmiet and Brandwag rivers as a result of agricultural and urban development. The overall ecological state of the Klein Brak River system ranges from fairly natural in the upper reaches to fair in the lower reaches.

Chemicals from crop spraying and fertilizers washes into the river

Alien plants is abundant in this study area, bordering an agricultural land in this photograph




N1
N2
Hartenbos
Mossel Bay


Leeukloof
Bosmans
Perdeberg
Moordkuil
Kouma
Ruiterbos
Palmiet
Goedemoed
Melkboom
Hartbeeskuil
Dam
Hartenbos
Brandwag
Klipheuwel
Dam
Hartenbos

Southern Gauteng River Systems

Assessed: 2000 – 2002
Area: 6950 square kilometres
Mean annual runoff: 236 million cubic metres

The southern Gauteng rivers drain the greater Johannesburg and Witwatersrand area of Gauteng Province. The major rivers of this study area are the Rietspruit, Natalspruit, Klipspruit, Suikerbosrand and Blesbokspruit (which flows through the Marievale Nature Reserve). For the most part, these rivers are severely modified by the urban environment that they drain.

Overall state of the Southern Gauteng Rivers

In general, the ecological state of the southern Gauteng Rivers is poor, with the exception of the upper Suikerbosrand which is in a fair overall ecological state. Major impacts on these river systems are caused by urban developments, extensive mining, industries and farming activities. Maize wheat and cattle farming occur mainly in the eastern areas.

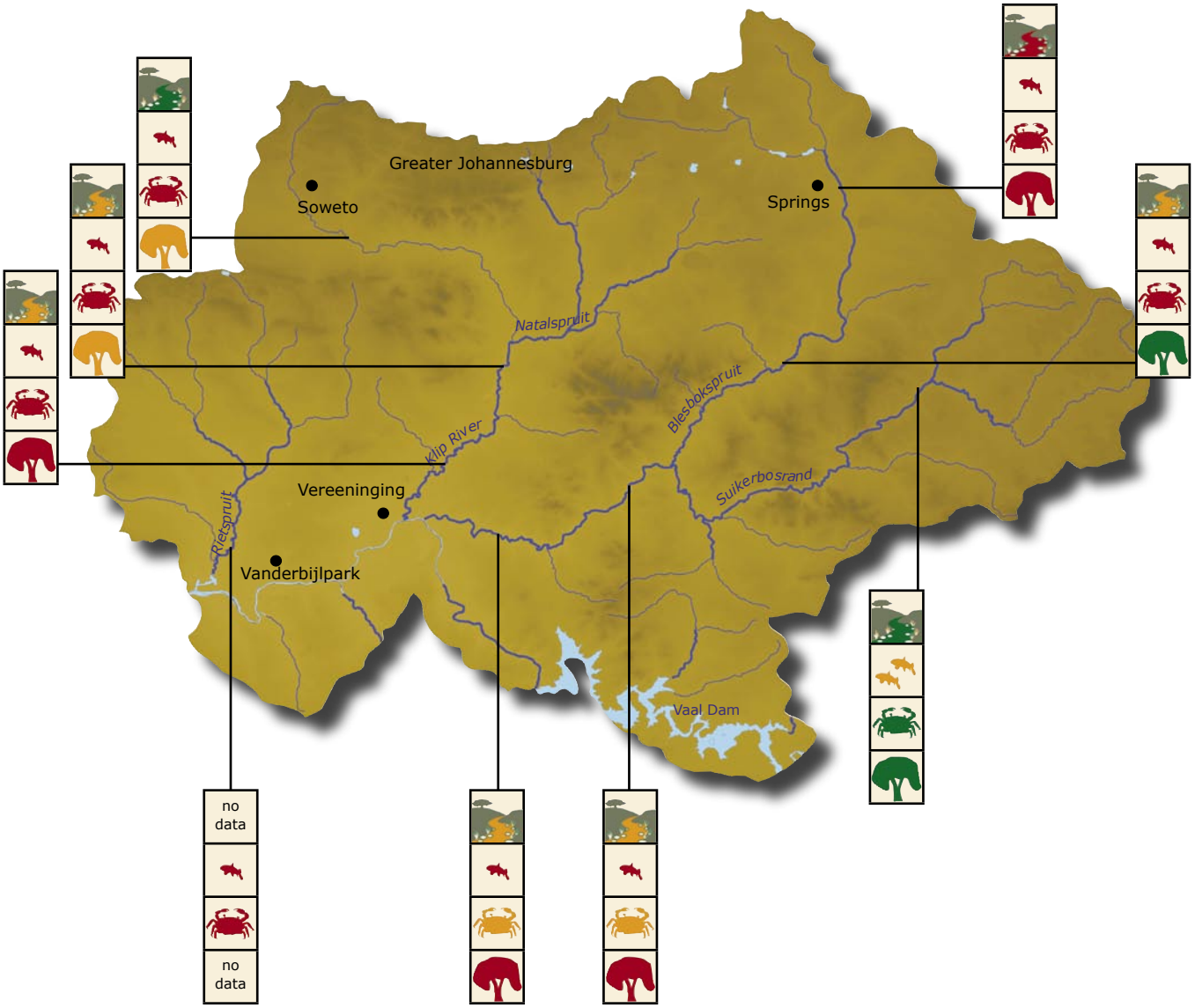
Formal and infromal housing, paving and road networks seal natural surfaces and prevent rainwater to filter into the ground naturally. It also causes unnatural high volumes of fast flowing stormwater runoff that erode river channels. These covered areas amount to a large proportion of the total southern Gauteng area. Canalised rivers and stormwater drains have replaced natural wetlands and streams and transport large volumes of polluted urban runoff to the rivers, causing severe degradation downstream. Loss of riparian vegetation causes erosion and scarring of river banks.

Mine water of poor quality has been released into the rivers for more than a century. Unregulated liquid and solid waste disposal from industries such as steel mills, paper mills, power stations and factories contribute to poor river health.

Untreated mine water that is released into rivers contributes to poor river health

Solid waste dumping worsens the already poor river health


Pretoria
Johannesburg
N4
N1
N3


Greater Johannesburg
Soweto
Springs
Natalspruit
Blesbokspruit
Klip River
Suikerbosrand
Vereeninging
Rietspruit
Vanderbijlpark
Vaal Dam
no data
no data

Free State Region River Systems

Assessed: 2000 – 2003
Area: 295 600 square kilometres
Mean annual runoff: 11 100 million cubic metres

The study area comprises the upper eastern one-third of the Orange-Vaal drainage basin, and includes the Free State Province and portions of Gauteng, Mpumalanga, North-West Province, the Northern Cape and the Eastern Cape. Although the landscape is mostly flat, many tributaries originate in the Drakensberg highlands. River flows in this region are strongly seasonal, with most runoff occurring during the summer rains.

The flat gradient encourages the formation of pools, meanders and pans. Small nature reserves, including private game reserves and conservancies are scattered throughout the study area, often close to or around major dams. Apart from a few coalmines, agriculture dominates the land-use in the Klip River catchment, to the detriment of the wetlands. In the western portion of the study area, the landscape becomes flatter and dryer, covered with grasslands and maize fields. Wheat and maize farming predominates in the central and northern regions of the study area, while sheep, cattle and game farming is popular in the southern and south-westerly regions.

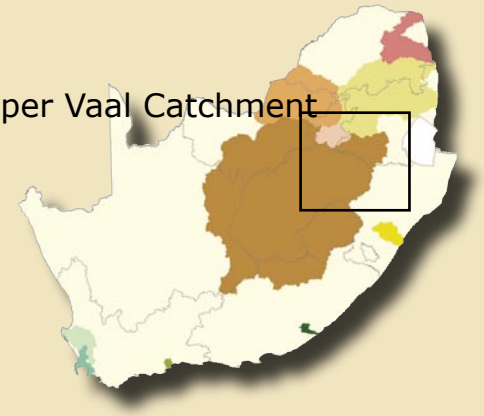
The Katse Dam (above) supply water to Gauteng via the As River (below), scouring river beds and river banks

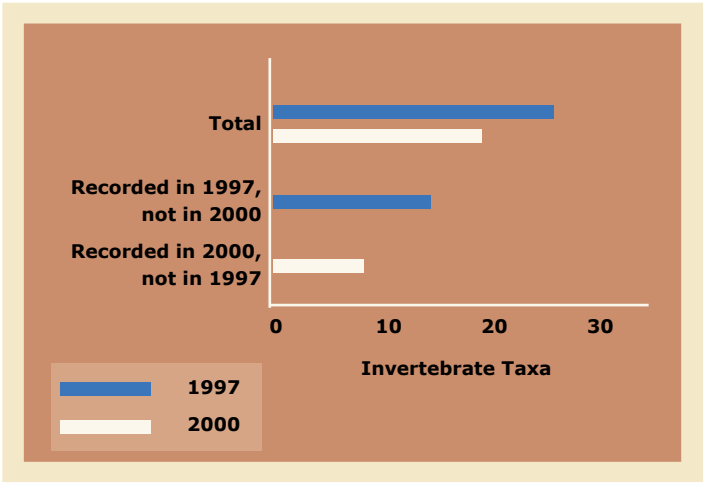
Top: Golden Gate Nature Reserve

Overall state of the Free State Region River Systems

Overall, the rivers in the Free State region catchments are in a fair to poor state of health. Most of the rivers in the study area have no natural flow during the dry winter months.

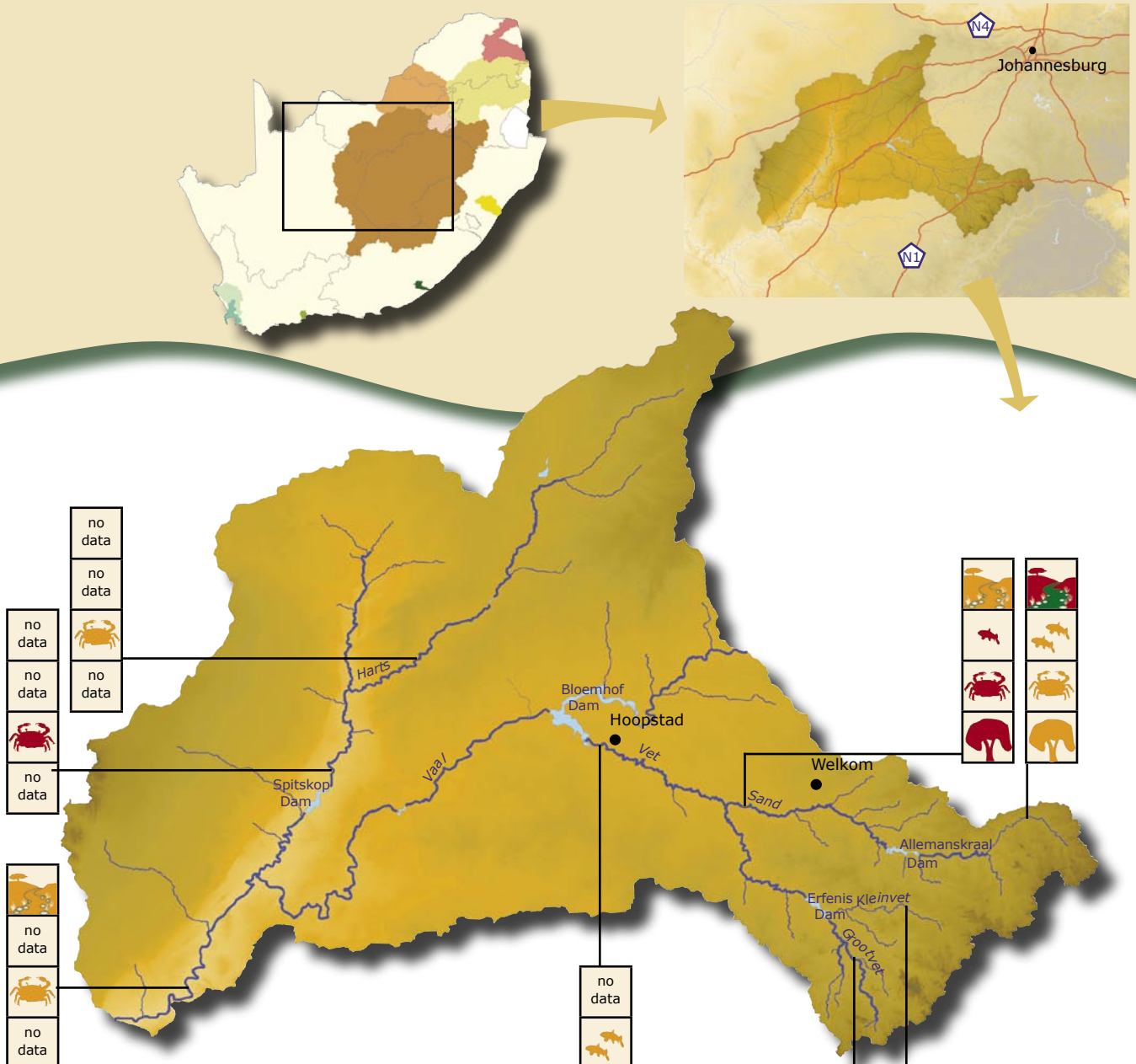
The overall ecological state of the upper Vaal catchment varies from good to fair, deteriorating to poor downstream due to large scale agricultural activities, urban and informal developments, industries, coal and gold mining and water transfer schemes. The health of the Klip River is good to fair and the Wilge River fair to poor, deteriorating downstream. The health of the Namahadi River headwaters are fair but deteriorates downstream. The Elands River has fair to poor health.





The number of taxa sampled in the As River declined between 1997 and 2000. During this period the water releases from Lesotho began. Opportunistic species now flourish and sensitive species are no longer found.

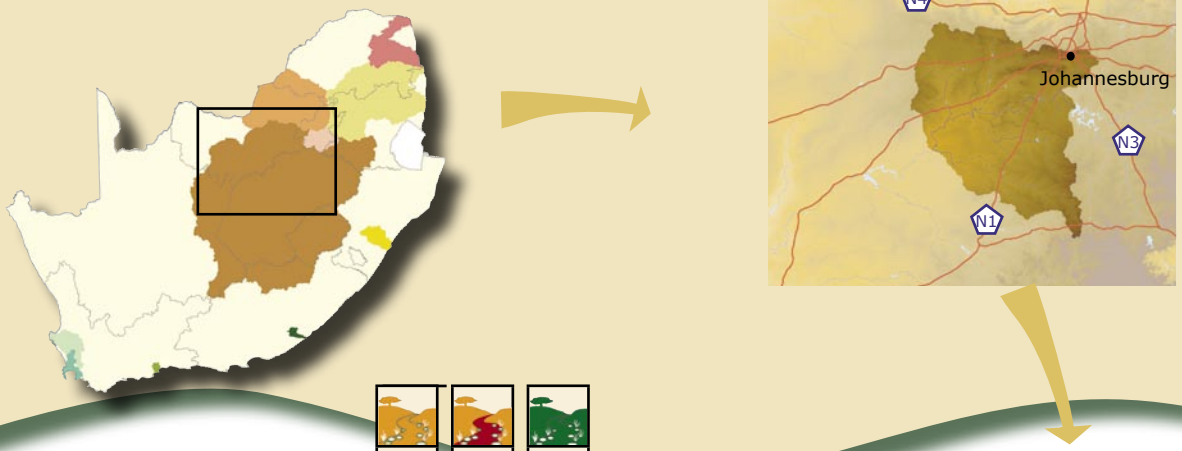
Vaal, Harts, Sand & Vet River Catchments

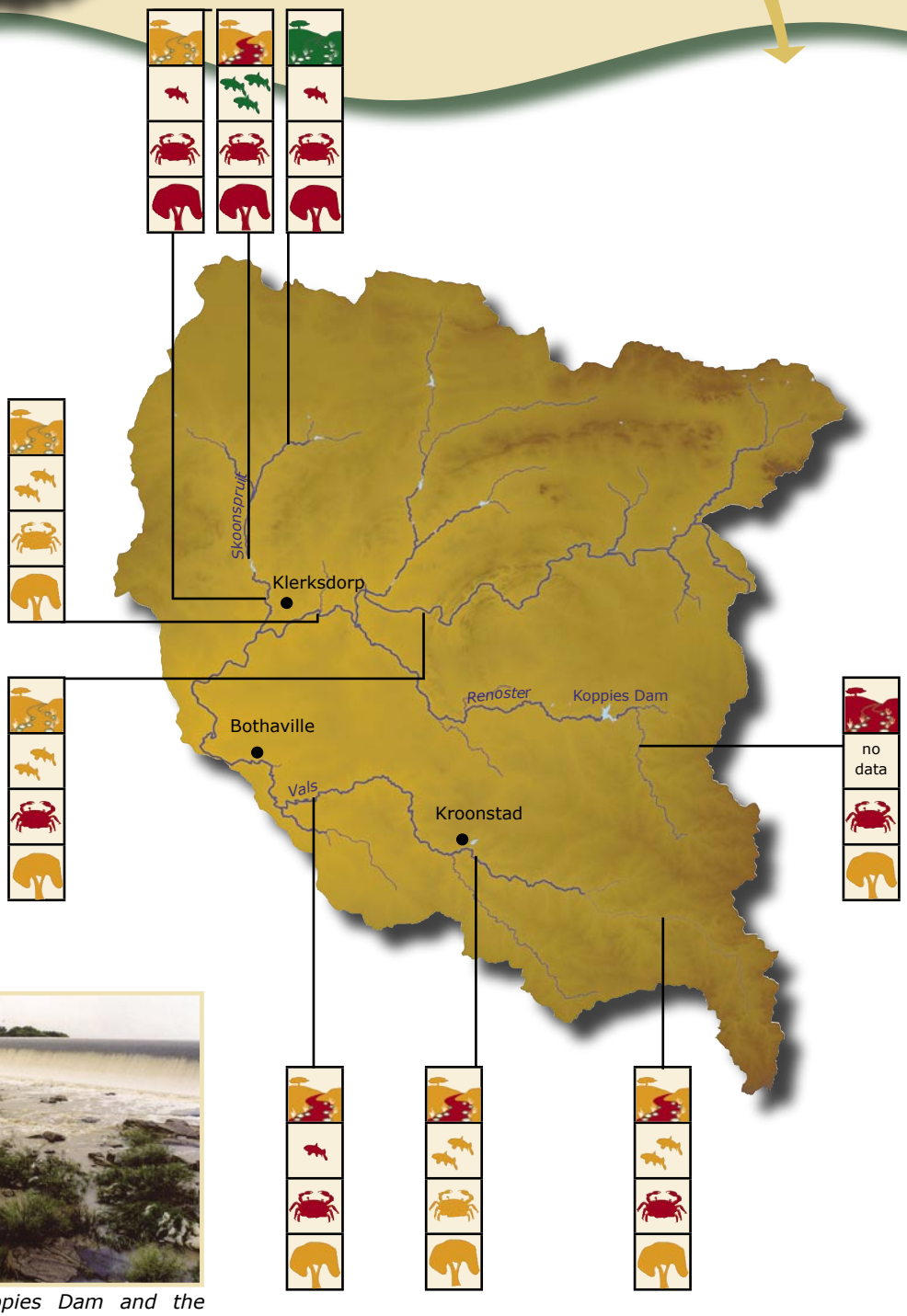


The overall health of the middle and lower Vaal River is fair to poor. Land use activities include urban and informal developments, diamond and gold mining operations as well as agriculture. The Sand-Vet River system is in a fair to poor ecological state. Activities in the catchment that affect this small river system include mining - there are extensive goldmining in the Welkom, Orkney and Klerksdorp areas - and irrigation return flows, agriculture and urban developments, sewage works and alien fish species. The overall ecological state of the Vals and Renoster catchments is poor (see on the right hand page). About 60% of the land-use in these catchments comprises natural grassland that is used for cattle grazing. These catchments are further degraded by urban developments and alien plants.

Harts River downstream of Taung Dam

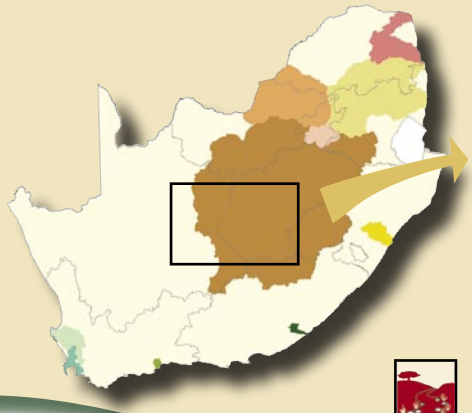
Skoonspruit, Vals & Renoster River Catchments

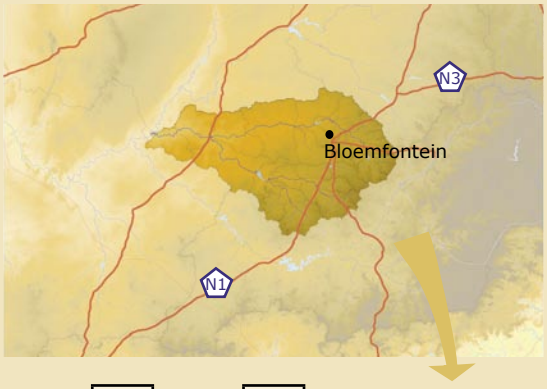


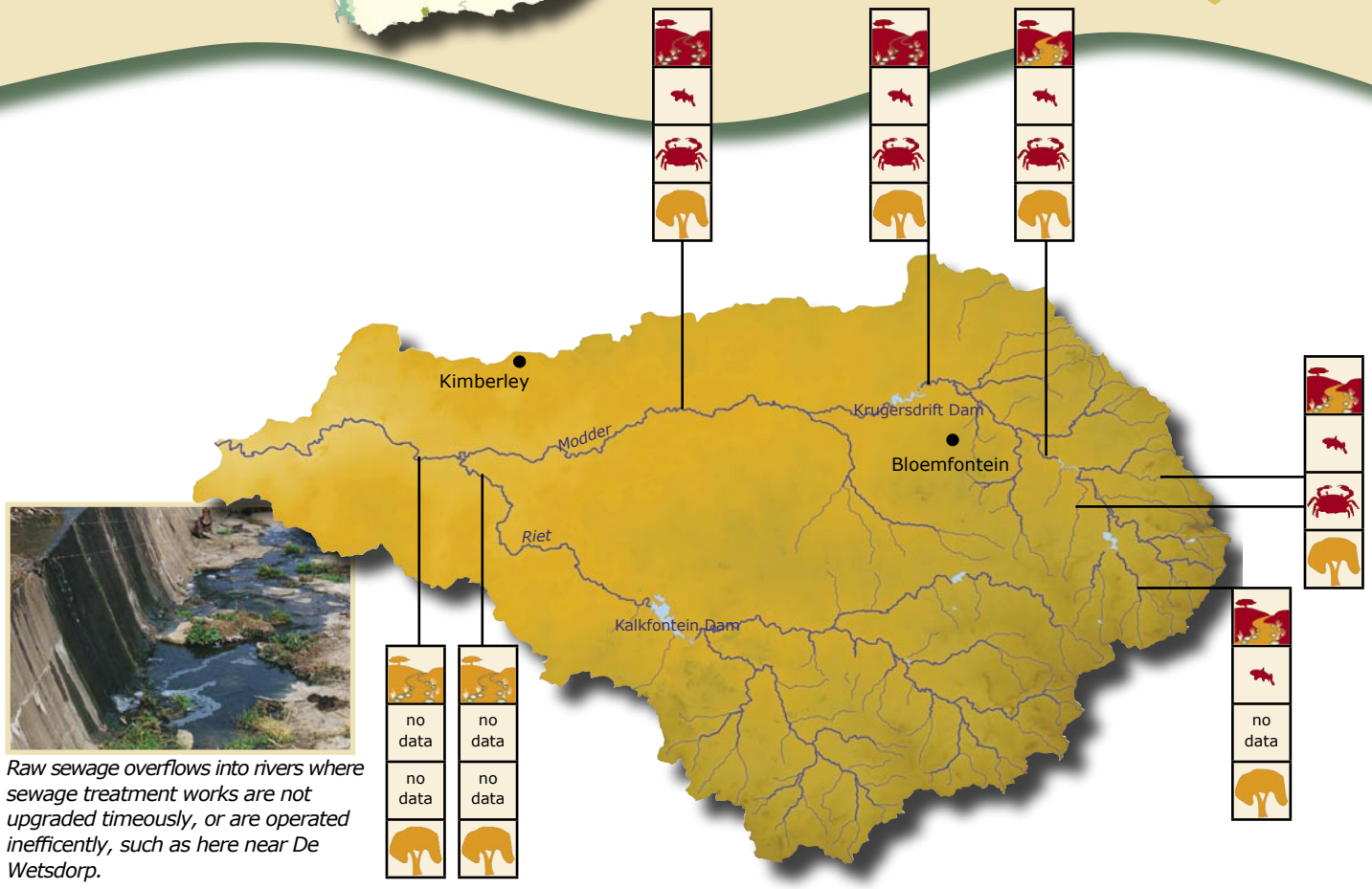


Water drawn from Koppies Dam and the Renoster River is used mainly for irrigation

Modder & Riet River Catchments

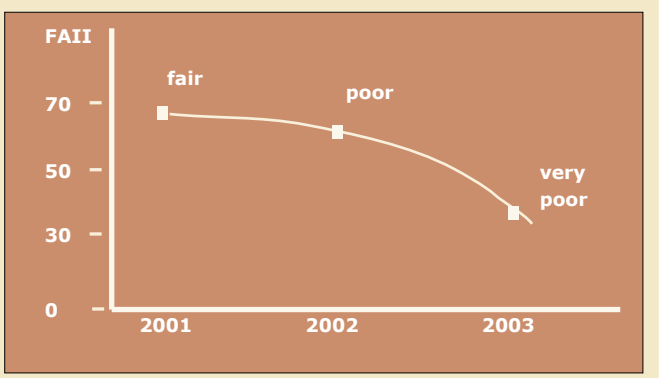






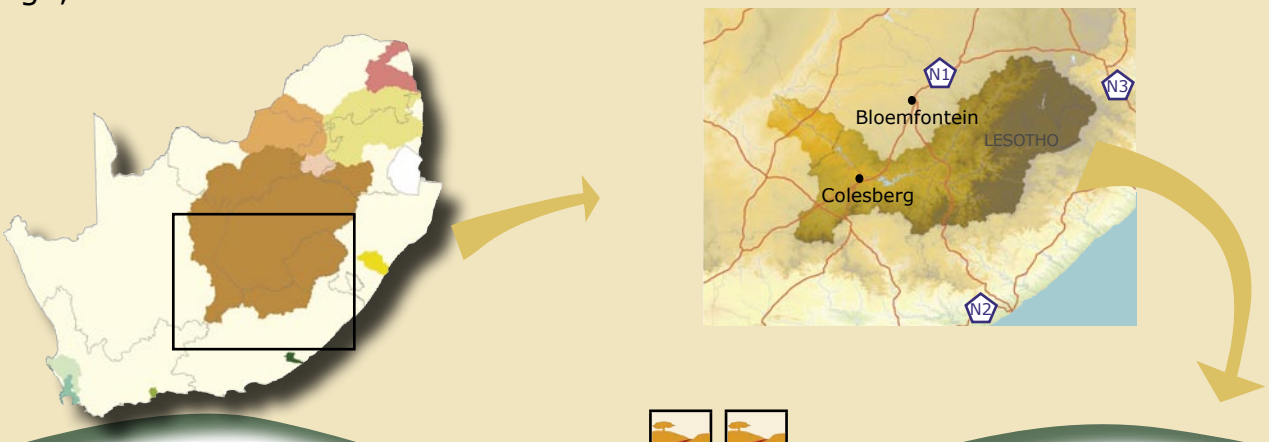
Raw sewage overflows into rivers where sewage treatment works are not upgraded timeously, or are operated inefficently, such as here near De Wetsdorp.

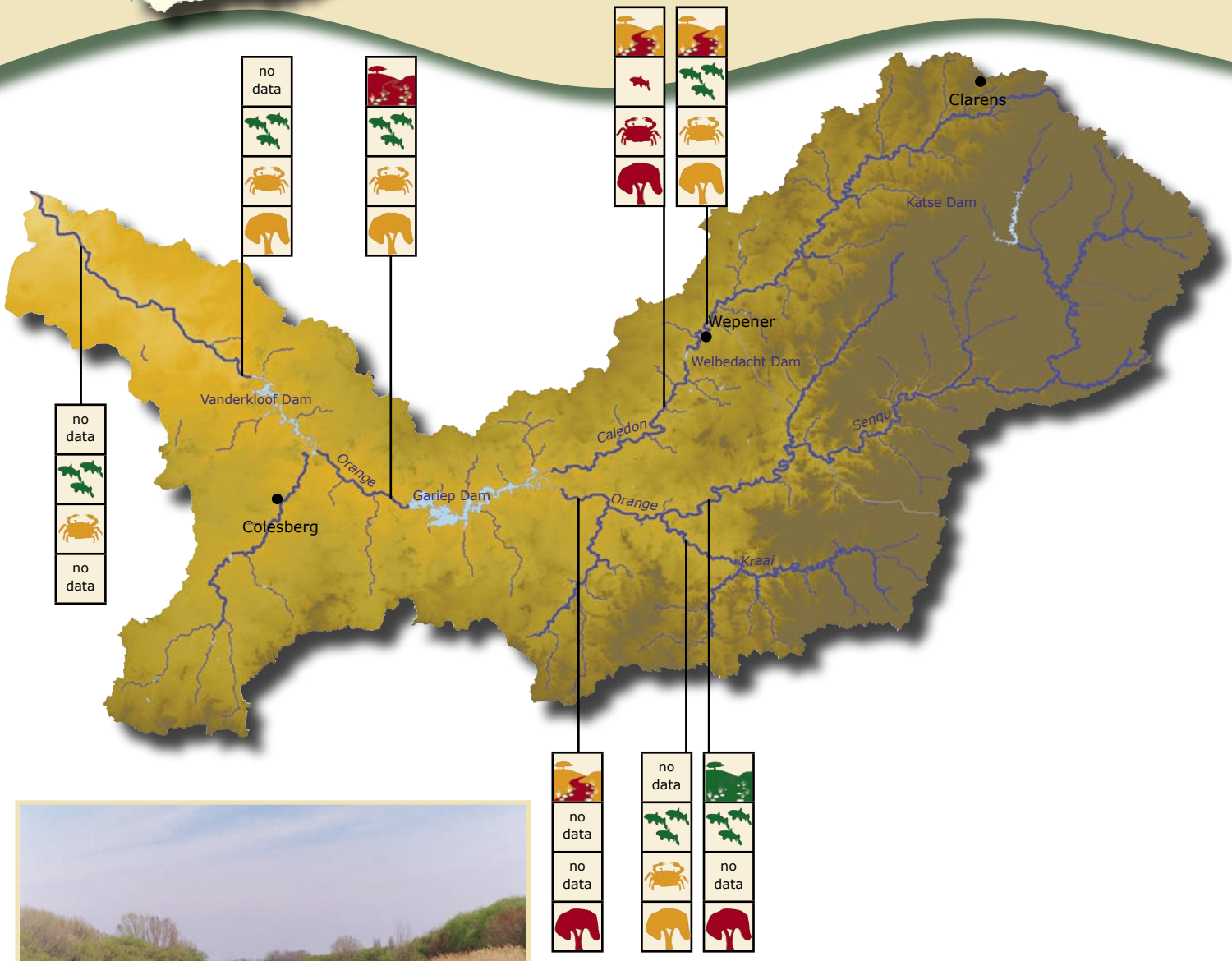
The overall ecological health of the Modder and Riet rivers is poor. This is caused by extensive agriculture, artificial structures such as roads, bridges and weirs, urban development, sand mining and diamond diggings. The Caledon River upstream of Welbedacht Dam is influenced by silt from the catchment, Wepener's sewage treatment plant and dyes from clothing factories upstream. The Caledon River is in a fair to poor state. The upper Orange and upper Kraai river are in a good and near natural ecological state, respectively. The ecological health of the Orange River varies from fair to poor. The unnatural flow regime (due to various large dams), agriculture, urban developments, and alien fish species are the main factors that influence ecosystem health.



According to fish monitoring data, the fish population has showed an alarming deterioration in the upper Modder River since 2001.

Orange, Caledon and Kraai River Catchments



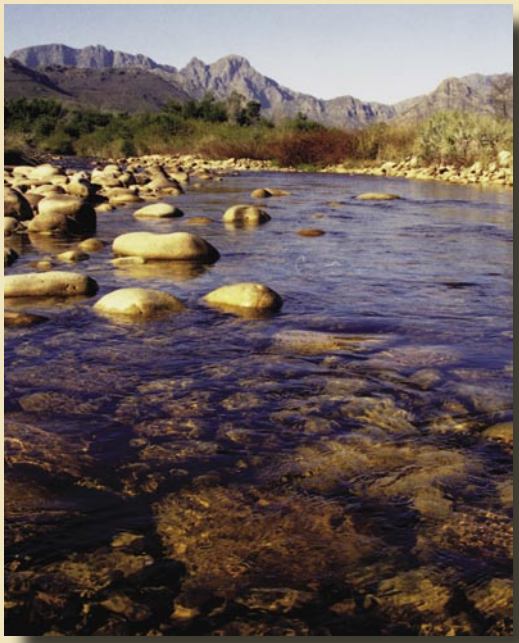


Caledon River near Reddersburg

Berg River System

Assessed: 2003
Area: 8912 square kilometres
Mean annual runoff: 915 million cubic metres

The Berg River rises in the Franschhoek and Drakenstein mountains north-east of Cape Town in the south-western Cape. It flows in a north-westerly direction towards the west coast, entering the sea at St. Helena Bay. The major industries in the Berg River catchment are linked to agricultural activities. The cultivation of grapes and deciduous fruit is the backbone of the economy of this catchment. North of Wellington, dry-land grain farming and sheep farming predominate. Commercial pine forests occur near the headwaters around Franschhoek. The growing water demand from the City of Cape Town has prompted the Department of Water Affairs and Forestry to implement the Berg Water Project. The Berg River Dam is being built on the Berg River west of Franschhoek, and is currently the largest water project being undertaken in southern Africa.



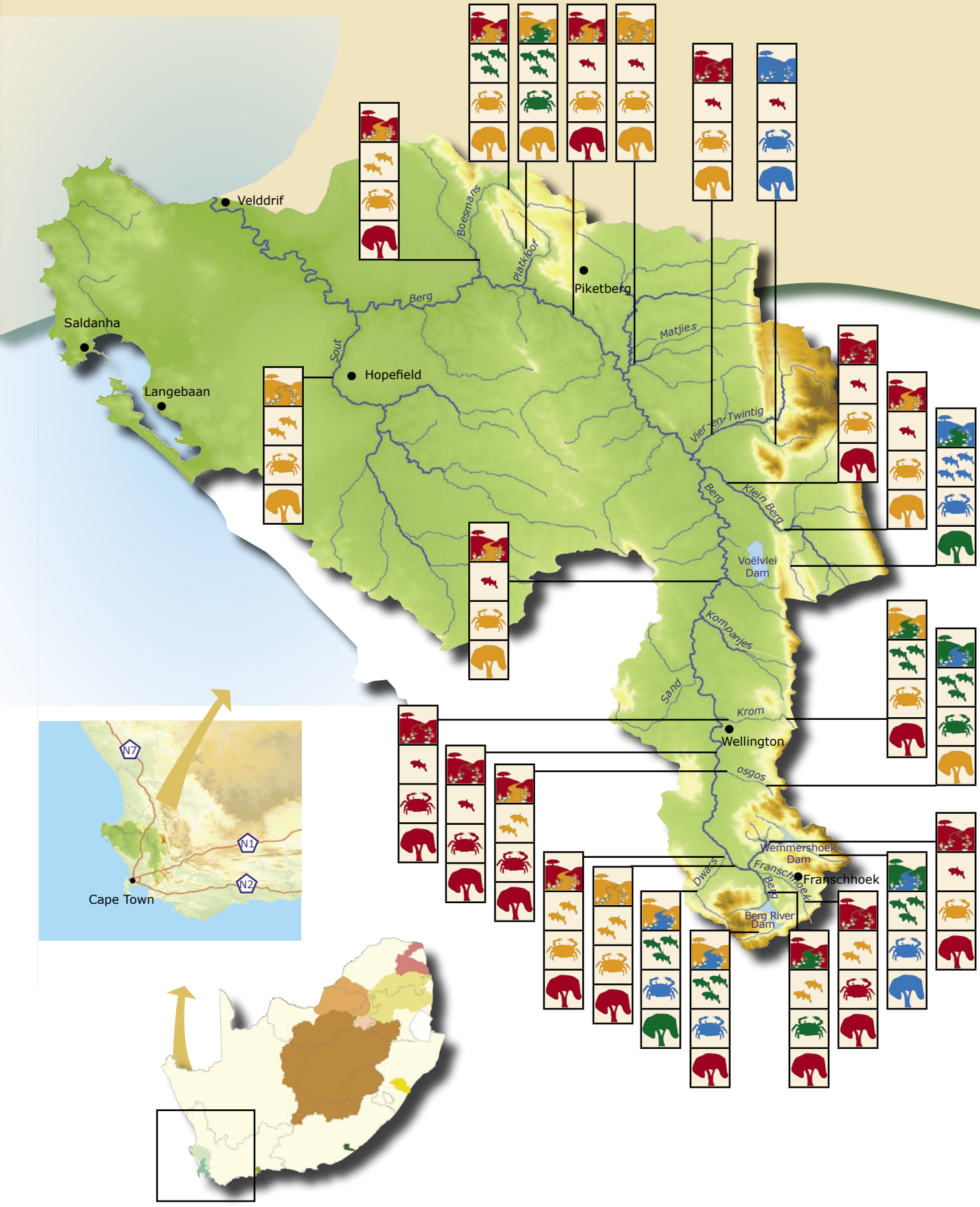
Overall State of the Berg River System

The overall river health of the Berg River decreases rapidly from its source to its middle reaches and remains poor all the way to its mouth. This is as a result of alien vegetation and fish infestation as well as agricultural and urban development. The interbasin transfer of water in the upper Berg River, and diversion weirs and dams throughout the catchment alter the flow regime, water quality and habitat of the river. The uppermost reaches of the Berg River and some of its tributaries are generally in a good ecological state. The upper Klein Berg and Vier-en-Twintig rivers are in a near natural state. Further downstream the Berg and the tributaries deteriorate to an overall ecological state of fair and poor. This can largely be ascribed to urban and agricultural development, alien vegetation infestation and alien fish species such as bass and banded tilapia that have caused the large scale disappearance of indigenous fish.

Water hyacinth infestation

Alien plants invade when natural vegetation in the riparian zone is disturbed. This results in habitat loss as well as loss of refuge areas for biota

Top: Upper Berg River


Velddrif
Saldanha
Langebaan
Hopefield
Piketberg
Wellington
Franschhoek
Voëlvlei Dam
Wemmershoek Dam
Berg River Dam
Boesmans
Platkbor
Berg
Sout
Matjies
Vier-en-Twintig
Klein Berg
Berg
Kompanjies
Sand
Krom
osgos
Dwars
Franschhoek
Berg
N7
N1
N2
Cape Town

Buffalo River System

Assessed: 2002 – 2003
Area: 1287 square kilometres
Mean annual runoff: 109 million cubic metres

The Buffalo River has its source in the forested Amatola Mountains of the Eastern Cape and flows eastwards across the coastal plateau before entering the Indian Ocean at the East London harbour. Agriculture is widespread in the middle reaches of the catchment. Although subsistence farming predominates, local areas of intensive irrigation (less than 1% of the catchment area) provide fresh produce and other crops such as lucerne. Dryland cultivation covers about 8% of the total catchment area. The lower reaches of the catchment comprise coastal forest and the East London harbour is situated in the estuary. About 560 ha of natural forest are conserved in the Umtiza Coastal Nature Reserve. The coastal zone is commercially important, particularly for tourism and fishing. The value of tourism in the Buffalo City Municipal area is estimated at more than R300 million per year.

High-density rural area north of Bhisho

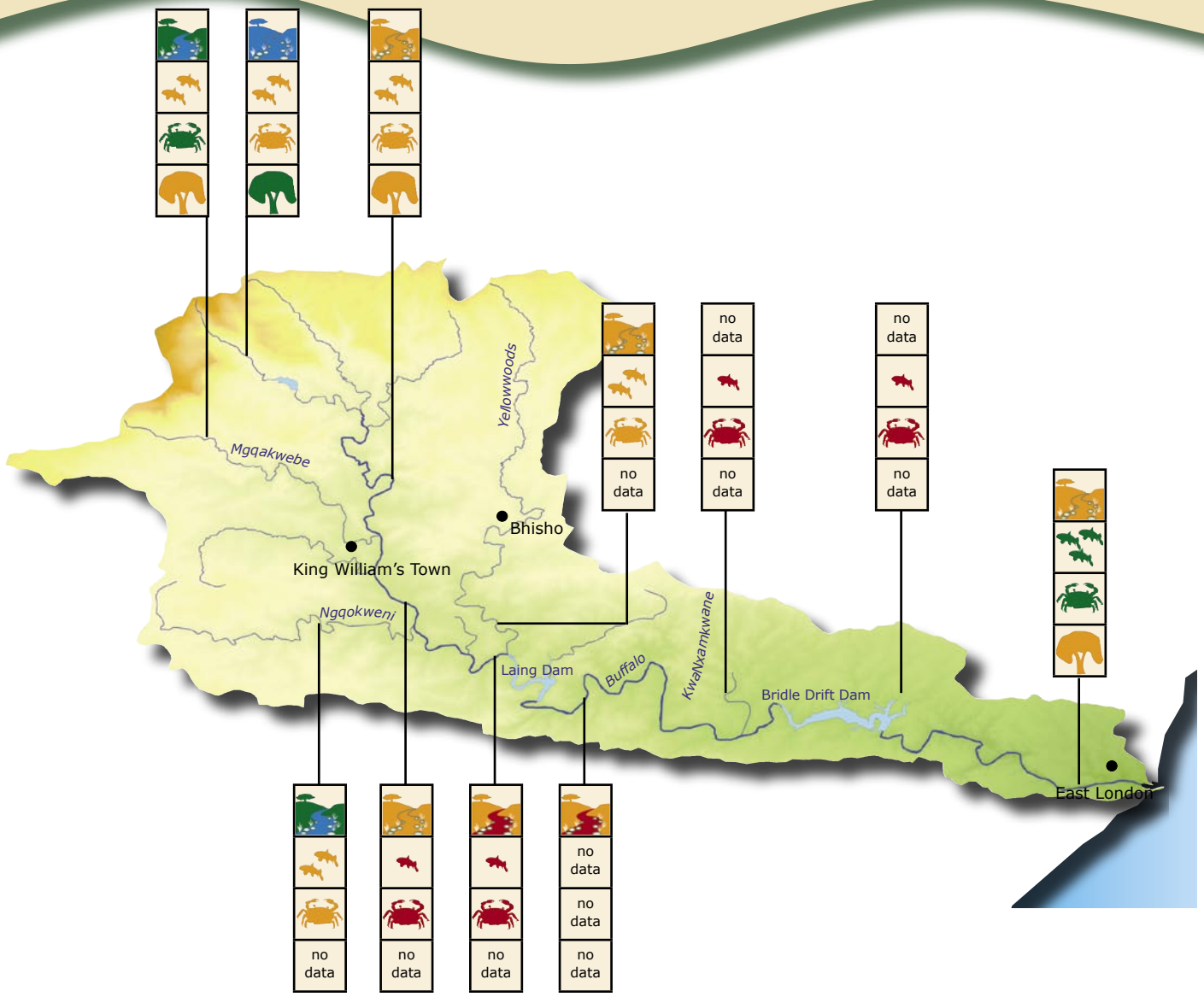
Overall state of the Buffalo River system

Although the Buffalo River is in an almost natural state at its source, alien plant infestation in the riparian zone downstream causes undercutting of the riverbanks and timber plantations reduce runoff and river flows. Flows are also modified by the dams in the system, which only release water when they overtop their walls. The overall ecological state of the headwaters is in an overall fair ecological state. In the upper reaches of the Buffalo River subsistence farming is the dominant land-use activity and together with high population densities, has adverse impacts on the river in this area. The overall ecological state of the main tributaries in this area varies from a good to a fair ecological state. The Buffalo River catchment upstream of Laing Dam is densely populated. Various associated problems, such as blockage in the sewerage systems, inadequate effluent treatment capacity and poor management, result in the discharge of partially treated and untreated sewage into the river and dams. The overall ecological state for this section of river is poor. Similarly, the Buffalo River on the coastal plain is also in a poor ecological state, mainly because of the adverse effects of high population pressure. In the lower Buffalo River, despite industrial development and the pollution output of industries, the overall ecological state is fair.

Harbour in the Buffalo Estuary at East London

Top: The Buffalo River north of King William's Town


East London
N2


Yellowwoods
Mgqakwebe
Bhisho
King William's Town
Ngqokweni
Laing Dam
Buffalo
KwaNtamkwane
Bridle Drift Dam
East London
no data

Crocodile (West) Marico Water Management Area.

Assessed: 2004
Area: 47 500 square kilometres
Mean annual runoff: 855 million cubic metres

The Crocodile (West) Marico Water Management Area (WMA) lies primarily within the North West Province, with parts of it located in the northern region of Gauteng and the south-western corner of the Limpopo province. To the north-west, the WMA borders on Botswana. The Crocodile and Marico rivers are the two main rivers in this WMA, which has the second highest population of South Africa's nineteen water management areas. Urban areas are the dominant land-use of the south-eastern parts of the WMA, and include the northern suburbs of Johannesburg. Extensive irrigation takes place along the Crocodile River and dryland crops are grown in the south and south-western parts of the WMA. Extensive mining activities in the vicinity of Rustenburg focus primarily on the platinum group of metals. About 25% of the Gross Domestic Product of South Africa originates from the Crocodile (West) Marico WMA, which constitutes the largest single contribution to the national wealth from any of the WMAs. The following sub-management areas were assessed as part of the study area: Marico, Lower Crocodile, Apies/Pienaars, Elands and upper Molopo.

Canalised river in Johannesburg

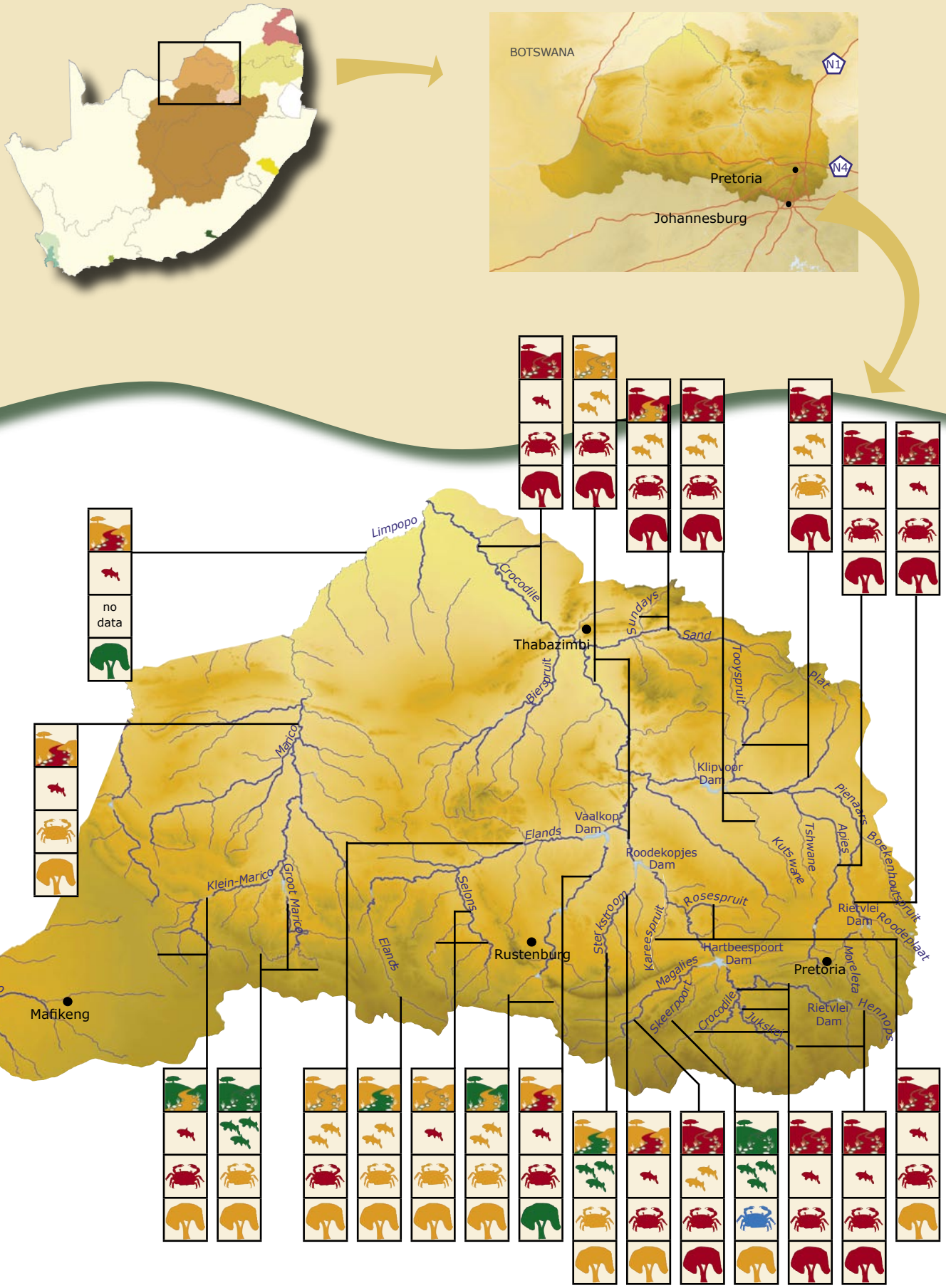
A water management area (WMA) is an area established as a management unit in the national water resource strategy, within which a catchment management agency will conduct the protection, use, development, conservation, management and control of water resources.

Dolomitic spring in the Molopo catchment

Top: Johannesburg skyline

Overall state of the Crocodile (West) Marico Water Management Area

The overall EcoStatus of the Apies/Pienaars sub-management area is poor mainly because of the effects of impoundments, extensive urbanisation and the resultant effluent discharges, agriculture, and alien vegetation. In the Upper Crocodile, the overall EcoStatus is poor, except for the Skeerpoort River which is largely natural with little farming activity taking place in the catchment and the upper Sterkstroom River which has an EcoStatus of good to fair. Impacts on this sub-management area vary from mining operations, industries, and agricultural return flows, to urban developments and informal settlements. The overall EcoStatus of the Elands sub-management area is largely fair, except for the Lower Hex River which is in a poor state. The rivers in the Elands sub-management area are infested with alien vegetation and disrupted by impoundments, irrigation, mining operations and road construction. The EcoStatus of the Lower Crocodile sub-management area varies between fair and poor. This sub-management area is mainly influenced by invasive alien vegetation, and has many dams and weirs that alter natural flow patterns. The Marico sub-management area has an overall EcoStatus of good to fair in the Groot Marico ecological study unit, changing to fair and fair-poor downstream towards the lower Marico River. Impacts in this sub-management area include dams and weirs, shale and slasto mining, agriculture, presence of alien fish species and a demand for water that exceeds the available supply.


BOTSWANA
N1
N4
Pretoria
Johannesburg
no data
Limpopo
Crocodile
Sundays
Sand
Thabazimbi
Biespruit
Marico
Klipvoor Dam
Vaalkop Dam
Elands
Roodekopjes Dam
Klein-Marico
Groot Marico
Selons
Elands
Rustenburg
Sterkstroom
Kareespruit
Rosespruit
Hartbeespoort Dam
Magalies
Skeerpoort
Crocodile
Julukskei
Rietvlei Dam
Pretoria
Moreleta
Hennops
Rietvlei Dam
Roodeplaat
Boekenhoutspruit
Pienaars
Apies
Tshwane
Kutswane
Tooyspruit
Molopo
Mafikeng

Greater Cape Town's Rivers

Assessed: 2002 – 2005
Area: 4000 square kilometres
Mean annual runoff: 445 million cubic metres

The Steenbras, Sir Lowry's Pass, Lourens, Eerste/Kuils, Sand, Zeekoe, Schusters, Else, Hout Bay, Salt, Diep, Sout and Silvermine rivers fall within the greater Cape Town area. These rivers rise in the high mountain ranges of the Hottentots Holland Mountains in the east and Table Mountain and Cape Peninsula Mountains in the south west. Urban development is the predominant land-use in the low-lying areas, with the Cape Flats being the most densely populated. Other major land-use activities are conservation (Table Mountain National Park) in the south, irrigated agriculture (vineyards) to the east and dry-land agriculture (wheat) in the north.

Overall State of Cape Town's rivers

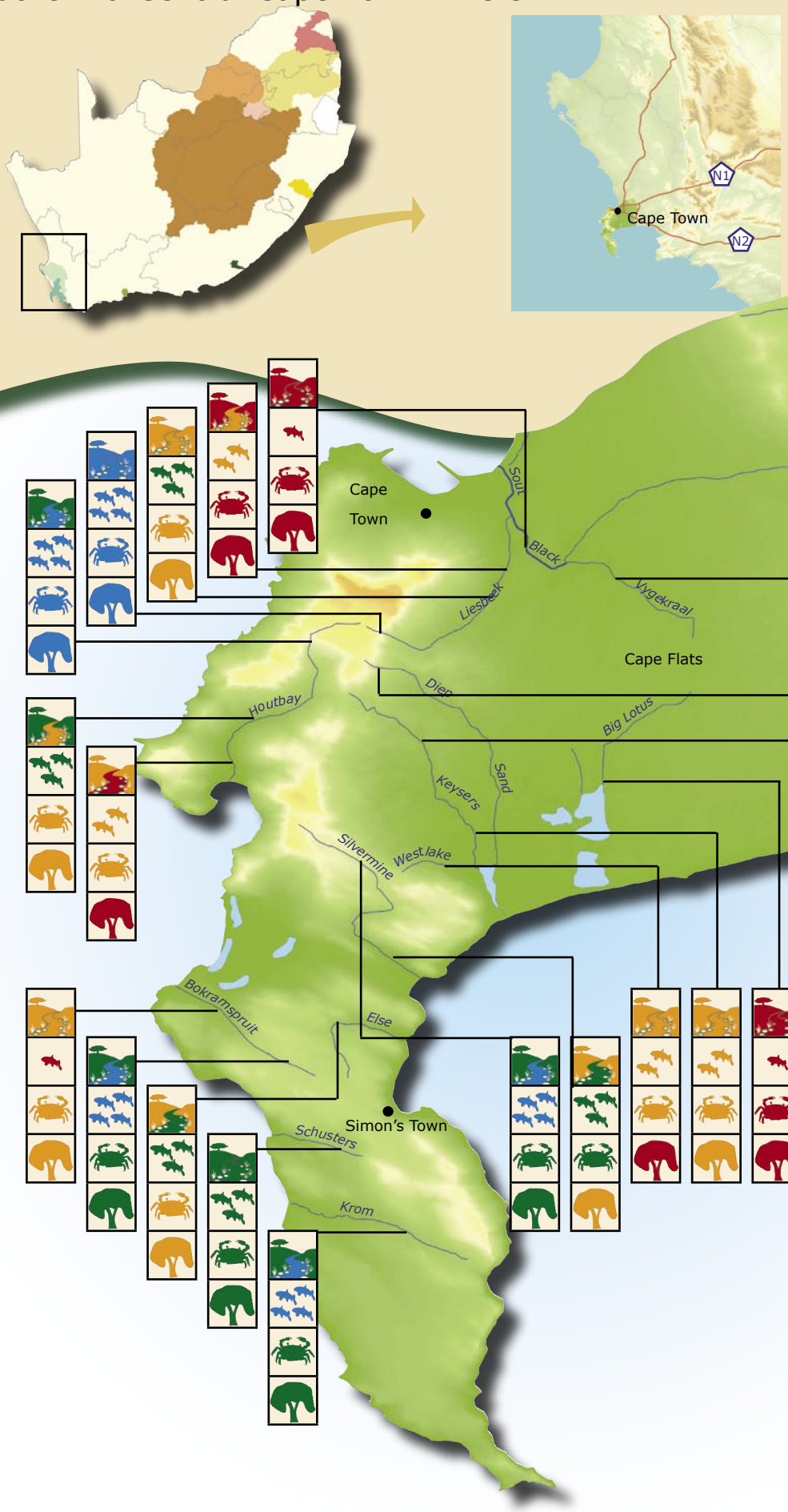
Generally, only a few short stretches of the upper reaches of the rivers in the greater Cape Town area are still in a natural or good ecological state. Development in the lowland areas has extensively modified the rivers, resulting in their poor ecological state. Long stretches of most rivers are canalised, have poor water quality, modified flows and abundant alien fish and plant life. The ecological functioning and delivery of goods and services by these rivers have been severely reduced. Many rivers require rehabilitation.

Palmiet River

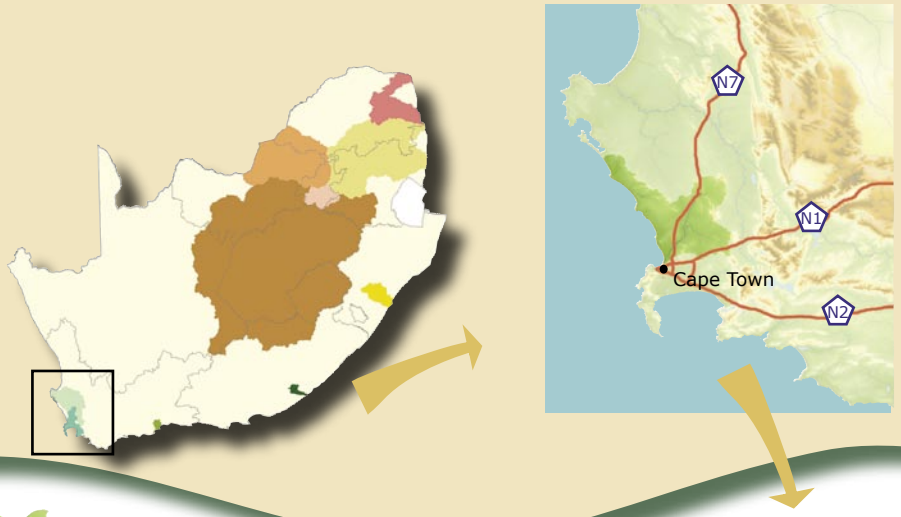
Agricultural activities within the riparian zone along the Diep River

Top: Aerial view of Cape Town

Southern & Central Cape Town Rivers

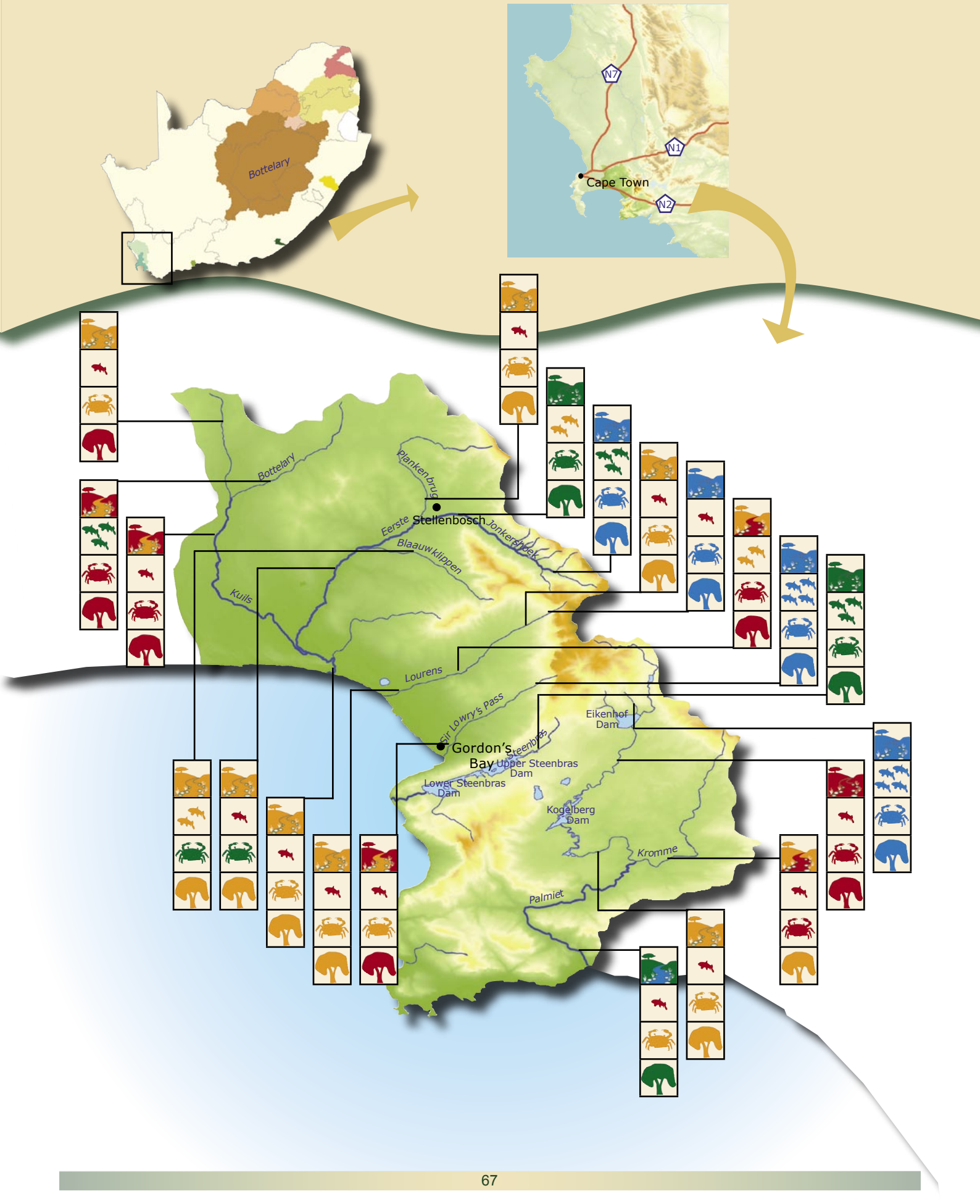


Northern Cape Town Rivers



Sedimentation in the Diep River

Eastern Cape Town Rivers



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