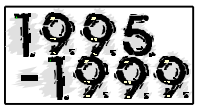
EXECUTIVE SUMMARY

The progress of the River Health Programme (RHP) overall is generally regarded as having been a success story. However, implementation in some provinces still faces considerable challenges. Insight Modelling Services was approached by the National Coordinating Committee to produce a single concise document which Provincial Champions could use for basic guidance. The document should capture the essence of strategies that have proved successful in other provinces. Accordingly, this document summarises various aspects of the River Health Programme while referring the reader to specific individuals and publications for more details.

SECTION ONE: BACKGROUND



The design phase of the National Aquatic Ecosystem Biomonitoring Programme (NAEBP), later simplified to RHP, was commissioned by the Institute for Water Quality Studies (IWQS), DWAF in January 1995. In the following two years workshops and meetings were held resulting in a series of foundation reports. These included a design framework [Hohls, 1995], a classification of South Africa into bioregions [Brown *et al.*, 1996], a protocol for selecting reference and monitoring sites [Eekhout *et al.*, 1996]and a good review of ecological indicators [Uys *et al.*, 1996]. A consultation planning meeting was held in September 1996. Unanimous agreement was reached concerning the applicability and usefulness of the RHP [DWAF, 1996]. Implementation guidelines were also produced [Roux, 1997].

A document currently being prepared that examines the strategies adopted by the RHP over the years is strongly recommended [Roux, 1999]. It gives more detailed insights into the evolution of the RHP.

Of fundamental importance to biomonitoring (and the RHP in particular) is the concept of ecological integrity. All indices should be a measure of this ability of the ecosystem to function in a way comparable to its natural state (that is, without any anthropogenic impacts).

SECTION TWO: THE STATUS QUO

The National Government through the Department of Environment Affairs and Tourism (DEAT) is the custodian of the nation's natural resources. The Department of Water Affairs and Forestry (DWAF) is the public trustee of South Africa's water resources. The National Water Act (No. 36 of 1998) is a radical departure from the previous act. It is now soundly based on good ecological principles (like that of establishing a reserve) and explicitly requires monitoring. The RHP is particularly well suited to this Act and will inevitably play a significant role in its implementation.

Catchment Management Agencies (CMAs) and other water-related organisations (like water

user associations and water boards) all have important roles to play in implementation of the RHP. CMAs in particular are currently being closely examined. Initiatives are in place that aim at creating local committees (under the Act) that will have sufficient status to play a significant role in local monitoring.

A number of indices exist in South African biomonitoring circles. Each reflects the ecological integrity (though to differing degrees) of different ecosystem components. The biological components are fish, invertebrates, riparian vegetation. Non-biological components include habitat, hydrology, water quality and geomorphology.

The indices are at greatly varying levels of development. The SASS4 index for invertebrates is by far the most advanced. This involves *in situ* observations of the presence of invertebrate taxa. With due consideration given to weighting their respective tolerances to polluted waters, this results in two indices, namely, SASS4 and ASPT (Average Score Per Taxon). The SASS4 score depends primarily on water quality and habitat availability. An Invertebrate habitat Assessment System (IHAS) is in the early stage of development and testing. It aims at adjusting the SASS4 score in such a way that it becomes independent of habitat availability.

A Fish Assemblage Integrity Index (FAII) is being developed and has been tested. An Index of Habitat Integrity (IHI), involving both instream and riparian habitats, is also available. A Geomorphological Index (GI) has recently been published. However, this requires further testing.

Site selection is an issue of fundamental importance to any monitoring programme. Work is underway to characterise all rivers in a way that takes account of natural variations in climate, geology, geomorphology and so on. Reference conditions for a river type will be defined as those typical of the least impacted sites where that type occurs. Although many indices have built-in reference states, this work will help establish these reference states more objectively. Monitoring sites (as opposed to references sites) should primarily be chosen to satisfy the national objective of State of Environment (SoE) reporting. That is, they should be randomly selected and should represent all river types. However, local objectives, such as assessment of impacts, require that the changes due to the impacts be adequately reflected at the site.

Sampling frequency is typically much less than, for example, chemical monitoring. Frequency needs to be of the order of the life-span of the organisms being measured or that of the natural or anthropogenic changes occurring in the system. Frequencies can therefore vary from 2-3 times per year for invertebrates (SASS4) to every 3-5 years for fish (FAII) and habitat (IHI) indices.

Database management is not at all standardised at present. A “Rivers Database” is being developed which should contribute considerably to this pressing problem.

Training capabilities are widespread throughout South Africa at many institutions. However, it remains somewhat uncoordinated though work is underway to address this.

SECTION THREE: VISION 2005

The RHP is primarily a national monitoring initiative. That is, monitoring for State of Environment reporting is the typical level required. However, some indices are suited to local use. A conflict between local, regional and national objectives will necessarily lead to difference in implementation of biomonitoring. (For example, site selection and sampling frequency will be different.) Given limited national funding, local and regional involvement is essential for attainment of national objectives. Accordingly, a model is presented which acknowledges different objectives at national, regional and local levels. However, it stresses the need to find win-win situations in which national objectives are also addressed. For example, by judicious choice of sampling sites and frequency and transferring only selected data from local databases, national objectives could also be met simultaneously with local and regional. Nevertheless, this issue of simultaneously meeting national and local objectives remains ill-defined and should be examined in more detail.

The year 2005 should see biomonitoring in South Africa as a commodity market. There should be suppliers of biomonitoring expertise that can sell their wares anywhere in South Africa. Methods should also be highly standardised. Ultimate users of the information should regard it being a competitive necessity (not a competitive advantage).

SECTION FOUR: THE ROAD AHEAD

A wide variety of problems exist in the various provinces that impede implementation of the RHP. These involve primarily a perceived lack of accountability, resource constraints and a lack of concerned parties perceiving a real need for the RHP. However, it should be emphatically stated that these problems are not pervasive. In a few provinces these problems occur to a much lesser extent that others.

The objectives of the River Health Programme are typically stated as follows [Roux, 1997]:

1. **To measure, assess and report on the ecological state of aquatic ecosystems;**
2. **To detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems; and**
3. **To identify and report on emerging problems regarding the ecological state of aquatic ecosystems in South Africa.**

The implication of these objectives is that the RHP objectives are attained once reports have been produced. However, monitoring programmes should be characterised by producing good information. That is, it must be accurate, complete, economical, reliable, relevant, simple, timely and verifiable [Stair, 1992]. Accordingly, it is proposed that the following fourth objective be included henceforth when stating the objectives of the RHP:

4. **To ensure that all reports provide scientifically and managerially relevant information for national aquatic ecosystem management.**

By “scientifically relevant” is meant that the scientists are confident that the right things have been measured in the right way. By “managerially relevant” is meant that the information provided by the scientists is used in a meaningful and rational way for management of riverine ecosystems.

This new objective now rationalises the existing initiatives to (1) produce ecosystem management models for optimal use of RHP reports and (2) development of grassroots awareness and education in respect of aquatic ecosystems. Both of these provide essential tools for those managers ultimately having to act upon information provided by the RHP.

The way forward will require a compatible combination of both a top-down and a bottom-up strategy. The top-down approach can be enhanced by creating greater statutory legitimacy for the RHP. The bottom-up approach (for which greater emphasis should be given) will involve developing optimum ways of communicating the advantages of the RHP to local and regional players so that their buy-in is created and sustained. Data transfer protocols that ensure a win-win situation for local, regional and national players need to be developed. This aspect will be critical to the ultimate success of the programme.

The national issues facing the National Coordinating Committee (NCC) have been examined briefly and presented in a simplified systems model diagram. It is evident from this that variability is a fundamental issue that drives many of the NCC’s activities. This variability occurs in the ecosystems being monitored, the methods being applied, the people who apply them and in the ultimate user requirements. All vary both spatially and temporally throughout South Africa. (The complexity of this situation is evident when one compares this to the monitoring of a simple chemical variable, say pH, in surface waters which uses a tried and tested standard method.) This variability drives a need for standardisation (and hence quality control) and focussed R&D (and hence huge resource demands). Good communication is a crosscutting issue which remains essential in many contexts.

Although the NCC seems to analyse problems and plan solutions extremely well, a flaw is that the solutions are often not implemented. This is likely to be because the members of the NCC are already significantly overworked and any extra NCC-related workload is not easily accommodated. To address this the appointment of a national coordinator is proposed. This person should be funded for at least six months per annum. The person should be an aquatic ecologist with management experience and good people and communication skills. The primary responsibility will be to execute the tasks identified by the NCC as important. That is, this person is not a delegator. In this way, the national coordinator can reduce the extra load on NCC members to that required to access an individual’s expertise as required for the specific task at hand.

The national coordinator should also chair the NCC and ExCo meetings. The NCC should consist of the following executive portfolios: national coordinator, secretariate, three custodians, provincial champions and R&D officer. *Ad hoc* scientific specialists and special members (for example of other national programmes) can be included in advisory capacities as and when specific needs arise.

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CONTENTS

LIST OF ABBREVIATIONS

ASPT	Average Score Per Taxon (Invertebrates)
BP1-5	Biomonitoring Protocol 1 to 5
CCI	Channel Classification Index
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EMAP	Environmental Monitoring and Assessment Programme (USA)
EXCO	Executive Committee
FAII	Fish Assemblage Integrity Index
FHAI	Fish Health Assessment Index
FCI	Fish Community Index
GI	Geomorphological Index
HAM	Habitat Assessment Matrix
HBDI	Hydraulic Biotope Diversity Index
HQI	Habitat Quality Index
HI	Hydrological Index
I&AP	Interested and Affected Party
IBI	Index of Biotic Integrity (USA)
IHAS	Invertebrate Habitat Assessment System
IHI	Index of Habitat Integrity
IWQS	Institute for Water Quality Studies
IWR	Institute for Water Research (Rhodes University)
KNPRRP	Kruger National Park Rivers Research Programme
MEC	Member of the Executive Committee
NCC	National Coordinating Committee
NAEBP	National Aquatic Ecosystem Biomonitoring Programme
PIT	Provincial Implementation Team
R&D	Research and Development
RBA	Rapid Biological Assessment
RVI	Riparian Vegetation Index
SASS4	South African Scoring System version 4
SoE	State of the Environment
RIVPACS	River Invertebrate Prediction and Classification System (British biomonitoring procedure)
WQI	Water Quality Index
WRC	Water Research Commission

GLOSSARY

***Aquaculture*.** The production of protein for human consumption in an aquatic environment under controlled or semi-controlled conditions. It includes the production of fish, shell-fish, crustaceans and plants.

Aquatic ecosystems. Ecosystems which provide a medium for habitation by aquatic organisms and sustain aquatic ecological processes.

Anthropogenic. Resulting from the presence or activities of humans.

Assessment Endpoint. An explicit expression of the environmental value that bears directly on the management of ecological resources. An assessment endpoint includes both an ecological component and specific attributes of that entity. For example, fish are a valued ecological component; reproduction and population maintenance of fish form an assessment endpoint.

Backwater. An hydraulically "detached" alcove, of variable depth, where there is no through-flow of water, and water tends to enter and leave using the same route. Velocity tends to be very low and often zero.

Benthic. Living on the bottom of a body substrata (sediments, debris, logs, cobbles, etc.) of aquatic biotopes.

Biological River Segment. A portion of a river in which the fish community remains generally homogenous due to the relatively uniform nature of the physical habitat.

Biomonitoring. The gathering of biological information in both the laboratory and the field for the purpose of making an assessment or decision or in determining whether quality objectives are being met.

Biodiversity. Biodiversity comprises composition, structure, and function. Composition is the identity and variety of elements in a collection, and includes species lists and measures of species diversity and genetic diversity. Structure is the physical organization or pattern of a system, from habitat complexity as measured within communities to the pattern of patches and other elements at a landscape scale. Function involves ecological and evolutionary processes, including gene flow, disturbances, and nutrient cycling.

Bioregions. Geographical regions delineated by South African river scientists as the first level of an hierarchical classification of the rivers of the country. The rivers within each bioregion were considered, on the basis of expert opinion, to be similar in terms of physical and biotic characteristics.

Biota. Animal and plant life characteristic of a given region.

Biotic Integrity. The ability to support and maintain a balanced, integrated, adaptive community of organisms having a full range of elements (genes, species and assemblages) and processes (mutation, demography, biotic interactions, nutrient and energy dynamics and metapopulation processes) expected in the natural habitat of the region.

Biotope. A homogeneous environment that satisfies the habitat requirements of a biotic community (e.g. riffle, pool or sandbank).

***Catchment*.** The area from which any rainfall will drain into a watercourse through surface flow.

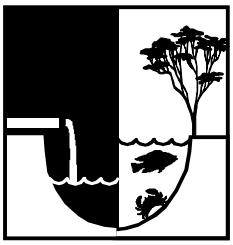
***Catchment Management Agency*.** A statutory body established by the Minister of Water Affairs to delegate water resource management to a local level and to involve local communities. They may be established for specific geographical areas, after public consultation, on the initiative of the community and stakeholders concerned.

***Diffuse-source Pollution*.** Pollution that comes from a wide area, such as fertilisers draining off farmlands or pollutants in the runoff from urban areas.

Ecological Indicator. Measurable attribute of a

high-level ecosystem component (biological, chemical or physical). A high-level biological component would typically be either fish, invertebrates or riparian vegetation. (For example, one measurable attribute of fish is frequency of occurrence at a series of sites.) A high-level non-biological component might be either habitat, water quality or geomorphology. (One measurable attribute of geomorphology is bank stability.)

Ecological Index. A single quantitative value that incorporates the information contained in a number of related ecological indicators. It is based on field data that are simple to collect and it provides a meaningful and accurate representation of the river condition for a high-level ecosystem component. The purpose is to simplify the interpretation of the indicators and hence make them more understandable to non-specialists such as resource managers, conservationists and the general public.



Ecological Integrity. The ability of an ecosystem to support and maintain a balanced, integrated composition of physico-chemical habitat characteristics, as well as biotic components, on a temporal and spatial scale, that are comparable to the natural (*i.e.* unimpaired) characteristics of such an ecosystem. (High ecological integrity implies that the structure and functioning of an ecosystem are unimpaired by anthropogenic stresses.)

Ecoregions. Geographic regions grouped together on the basis of shared similar characteristics, such as geology, rainfall, vegetation and altitude.

Ecosystem. Any unit that includes all of the organisms (*i.e.* the community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biodiversity and material cycles (*i.e.* exchange of material between living and non-living parts) within the system.

Ecosystem Health. A value judgement of the overall condition (*i.e.* health) of an ecosystem, based on the social well-being, economic development and ecological integrity within that system.

Geomorphology. The study of the origin of secondary topographic features which are carved by erosion in the primary elements and built up of the erosional debris.

Groundwater. Water found underground, typically supplying wells, boreholes, and springs.

Habitat Integrity. The maintenance of a balanced, integrated composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region.

Hydraulics. The branch of science and technology concerned with the mechanics of fluids, especially liquids.

Hydrology. The science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

Infrastructure. The basic structure of an organisation, system, etc.

Integrated Environmental Management. A code of practice ensuring that environmental considerations are fully integrated into the management of all activities in order to achieve a desirable balance between conservation and development.

Invertebrate. An animal lacking a backbone and internal skeleton.

Macroinvertebrates. Invertebrates retained by mesh size $\geq$ 200 µm.

Measurement Endpoint. See ***Ecological Indicator***.

Monitoring Site. For problem-area monitoring, a monitoring site is one identified as important in assessing the condition (*i.e.* available habitat, water quality and biological parameters) of a river or reach, relative to a reference site. For State-of-Environment reporting, monitoring sites are randomly selected impacted or unimpacted sites that will reveal the range of conditions in rivers of a certain kind.

Morphology. The form and structure.

Multivariate Methods. Statistical methods characterised by the fact that they base their comparisons of two or more samples on the extent to which these samples share particular attributes. Either implicitly or explicitly, all multivariate techniques are founded on similarity coefficients calculated between every pair of samples being tested.

***Point-source Pollution*.** Pollution that comes from a single source, such as a pipe.

Pool. A feature with slow through-flow of water (low or zero velocity), generally deep relative to river size.

Reference Condition. A benchmark of the best attainable ecological conditions for a specific type of river.

Reference Site. A site that has been exposed to relatively little or no anthropogenic impact that can be used to define the best physical habitat, water quality and biological parameters for a particular kind of river. These sites represent the best condition that can be achieved in a particular kind of river, against which the conditions found at the monitoring sites in the same kind of river can be assessed.

Riffle. A shallow, fast-flowing reach of a river with turbulent flow and broken water.

Riparian. Living or located on the banks of streams or rivers.

Run. An area of transition between a pool/rapid and riffle. Depth is variable and velocity is generally moderate.

***Runoff*.** Water that does not filter into soil but flows over the surface and into natural surface waters.

***Site-specific*.** Unique or specific to a certain locality.

Stressor. Any physical, chemical or biological entity or process that can induce adverse effects on individuals, populations, communities or ecosystems.

***Surface Water*.** Water above the ground surface in lakes, dams, rivers and so on.

***Suspended Solids*.** Inorganic or organic matter, such as clay, minerals, decay products and living organisms, that remains in suspension in water. In surface waters it is usually associated with erosion or runoff after rainfall events.

Sustainable Development. Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

***Turbidity*.** A measure of the light-scattering ability of water. It indicates the concentration of suspended solids in the water.

Water Board. An organ of state established or regarded as having been established in terms of the Water Services Act (No 108 of 1997) to perform, as its primary activity, a public function. This includes a "water services provider" who provides water services to consumers or to another water services institution, but does not include a water services intermediary. The National Water Act (No 36 of 1998) provides for the restructuring of water boards as water user associations.

***Watercourse*.** A river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows.

Water Management Institution. A catchment management agency, a water user association, a body responsible for international water management or any person who fulfils the functions of a water management institution in terms of the National Water Act (No 36 of 1998).

Water Resource. An ecosystem which includes the physical or structural aquatic habitats (both instream and riparian), the water, the aquatic biota, and the physical, chemical and ecological processes which link habitats, water and biota.

Water User Association. Co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit. They operate at a restricted local level.