

# Adaptive assessment and management of riverine ecosystems: The Crocodile/Elands River case study

DJ Roux<sup>1\*</sup>, CJ Kleynhans<sup>2</sup>, C Thirion<sup>2</sup>, L Hill<sup>2</sup>, JS Engelbrecht<sup>3</sup>, AR Deacon<sup>4</sup> and NP Kemper<sup>5</sup>

<sup>1</sup> CSIR Environmentek, PO Box 395, Pretoria 0001, South Africa

<sup>2</sup> Institute for Water Quality Studies, Private Bag X313, Pretoria 0001, South Africa

<sup>3</sup> Mpumalanga Parks Board, Private Bag X1088, Lydenburg 1120, South Africa

<sup>4</sup> Scientific Services, Private Bag X402, Skukuza 1350, South Africa

<sup>5</sup> IWR Environmental, PO Box 890, Ifafi 0260, South Africa

## Abstract

The River Health Programme (RHP) is being designed to generate information regarding the ecological state of riverine ecosystems in South Africa. An adaptive assessment and management procedure is suggested as a means of linking the monitoring outcomes of the RHP with water resource management decisions. The potential of such a procedure is demonstrated, using data that have been collected, through the pilot application of the RHP, on the Crocodile and Elands Rivers, Mpumalanga.

In order to assess the collected data relative to a reference state, homogeneous river segments were identified. Each segment was classified in terms of its relative ecological integrity, based on three biological indicators (fish, benthic invertebrates, riparian vegetation). These assessments of current integrity were compared with management goals and quality objectives for the respective river segments. Finally, river segments were ranked in terms of priority for receiving management attention, and an example is given of formulating appropriate management actions for addressing a high priority need.

The systematic following of the step-wise procedure would facilitate and formalise the linking of data collection and assessment, the setting of management goals and quantifiable objectives, the selection of management options, and the monitoring of responses to chosen management actions.

## Introduction

A national monitoring programme, that focuses on measuring and assessing the ecological state of riverine ecosystems, is being designed for South Africa. This programme, the River Health Programme (RHP), is developed with the overall goal of expanding the ecological basis of information on aquatic resources, in order to support the rational management of these systems (Roux, 1997).

For the RHP to become truly operational as a management information system, a step-wise procedure must be in place for linking the collected data and derived information with management actions. Therefore, in addition and parallel to protocols for site selection and indices with which to measure ecological condition, mechanisms must be developed for assessing the monitoring results in the context of management objectives, as well as for deciding on appropriate management activities.

To facilitate these parallel and interdependent initiatives, prototypes of both the monitoring methods and the step-wise procedure need to be tested in pilot exercises. By generating real data through pilot applications, a high degree of alignment and synergy between technical programme components can be encouraged. Such data are also essential for the construction of a systematic procedure for linking monitoring, assessment and management outputs.

Considerable attention has and is being given to the conceptual development and practical testing of the technical components of the RHP. Examples include the development of a protocol for the selection of monitoring sites (Eekhout et al., 1996), indices for assessing the condition of communities of fish (Kleynhans, 1999)

and riparian vegetation (Kemper, 1998), as well as for establishing natural baseline conditions for aquatic invertebrates (Dallas, 1999). However, no formal procedure has been suggested for linking the information output of the programme with management decisions.

Note that the word procedure, as used in this paper, refers to a set of steps that needs to be performed in order to achieve a certain outcome. The outcome is to establish a closed loop between the monitoring, assessment and management of the ecological state of riverine ecosystems. Each step may consist of one or more protocols or methods.

This paper proposes a procedure which enables managers to respond to the results of the RHP. The procedure is demonstrated by applying existing data, obtained through pilot application of the RHP on the Crocodile and Elands Rivers (Mpumalanga). Emphasis is on the links between the different steps and the continuity provided by the overall procedure, rather than on the detail of protocols used within each step. Prototype outcomes of each step are, however, used for demonstrative purposes.

## Background

### The river health programme (RHP)

#### *Design of the programme*

The formal design of the RHP was initiated in 1994 by the Department of Water Affairs and Forestry (DWAF). The main purpose was for the programme to serve as a source of information regarding the overall ecological status of riverine ecosystems in South Africa. For this reason, the RHP essentially makes use of in-stream biological response monitoring (effects monitoring), in order to characterise the response of the aquatic environment to multiple disturbances. The rationale is that the integrity of the biota inhabiting the river provides a direct, holistic and integrated

\* To whom all correspondence should be addressed.

☎ (012) 841-2695; fax (012) 841-2506; e-mail: droux@csir.co.za

Received 17 February 1999; accepted in revised form 21 June 1999.