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BIOLOGICAL MONITORING AND ASSESSMENT OF RIVERS AS A BASIS FOR IDENTIFYING AND PRIORITISING RIVER MANAGEMENT OPTIONS

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ABSTRACT

The output of monitoring programmes such as the National Aquatic Ecosystem Biomonitoring Programme must be used in the management of aquatic ecosystems. To achieve this, collected data must, through a systematic framework, be linked to measurable management objectives. This paper demonstrates how the results obtained with biological indices and system-specific knowledge, are combined to derive semi-quantitative assessments of ecosystem condition. These assessments provide the basis for responding to the results of a river monitoring programme.

KEYWORDS

Biological integrity; biomonitoring of rivers; fish community assessment; invertebrate community assessment; resource quality objectives.

INTRODUCTION

A National Aquatic Ecosystem Biomonitoring Programme (NAEBP) is currently being designed to extend and broaden the ecological basis of existing water monitoring activities in South Africa. The first phase of this programme deals specifically with river monitoring and focuses on several biotic (e.g. fish, invertebrates, riparian vegetation) and abiotic (e.g. geomorphology, habitat, hydrology, water quality) indicators of river condition. For some of these indicators, indices have been developed and applied in South Africa. For the majority of the indicators, however, indices are in the early phases of conceptualisation and still need practical development and testing (Roux, 1997).

The NAEBP is intended primarily as a management information system, where the information must support the rational management of water resources. Therefore, the programme design must address all the underlying technologies associated with the end product of effective resource management. In addition to protocols for site selection and indices with which to measure ecological condition, these technologies include the management of data, developing reporting formats, creating capacity and negotiating institutional responsibilities and arrangements. Also, before a monitoring programme can be truly operational and ongoing, mechanisms must be in place for linking the collected data and derived information with a structured resource management framework.

An approach of applying the latest developmental prototypes of the above technologies, in the context of case studies, is being followed. By doing so, a high degree of alignment and synergy between programme components can be encouraged. This also applies to a systematic and adaptive procedure for linking monitoring, assessment and management outputs. This paper demonstrates a prototype framework for linking biological response data, as generated by the NAEBP, through a systematic approach to river management. The relevant concepts are broadly demonstrated with the aid of a case study.

STUDY AREA AND BIOLOGICAL SURVEY

The results of fish and invertebrate sampling on the Elands River, Mpumalanga, were assessed by means of a prototype Fish Assemblage Integrity Index (FAII) (Kleynhans, 1998) and the fourth version of the South African Scoring System (SASS4) (Chutter, 1998), respectively. The sampling surveys took place during the second half of 1996.

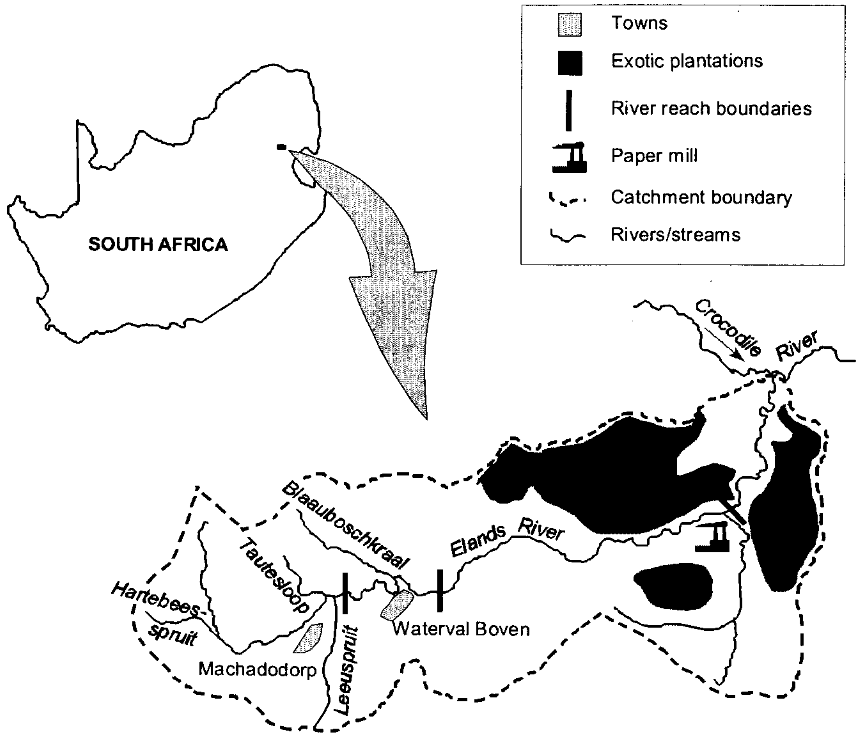

Figure 1. Location and characteristics of the study area.

The Elands River (Figure 1) was divided into reaches, based on physical characteristics which determine habitat suitability for fish. These reaches were refined by checking them against historical fish distribution patterns. In other words, each reach represents a segment of the river in which the fish community would, under unimpaired conditions, remain generally homogenous due to the relative uniform nature of the physical habitat (Kleynhans, 1998). Each fish-based reach was assumed also to support a homogenous community of benthic invertebrates. Based on site suitability, accessibility and representativeness, surveys were conducted at between three and five sampling sites per reach.

A BIOLOGICAL MONITORING AND ASSESSMENT FRAMEWORK

Monitoring results were assessed by comparing the collected data against reference conditions derived for each reach. These reference conditions approximate the best attainable biological condition for a reach, in the absence of impact from human activities. A combination of historical data and expert opinion for fish, and relatively unimpaired reference sites and expert opinion for invertebrates, was used to define the reference conditions.

To provide a management perspective in the assessment of the monitoring data, a provisional River Integrity Classification Scheme (RICS), shown in Table 1, was followed.

Table 1. The provisional River Integrity Classification Scheme (RICS)

River Integrity Class	Biological community characteristics (FAII and SASS4)	% of reference index score
Class A: Unmodified	Community characteristics approximate natural conditions.	>85%
Class B: Moderately Modified	Moderate change to community characteristics (lower abundances and possible loss of some intolerant species); basic ecosystem functions remain predominantly unchanged.	61-85%
Class C: Considerably Modified	Considerable modification of community characteristics and basic ecosystem functions have occurred; several intolerant species have been lost or occur only in low numbers.	40-60%
Class D: Severely Modified	Community characteristics have been seriously modified with an extensive loss of basic ecosystem functions; tendency towards domination by a few tolerant species.	<40%

Table 2 indicates the outcome when the results of the biological survey were applied to the RICS.

Table 2. The current biological integrity classes for each river reach, according to assessment of fish and invertebrate communities

River reach (altitude in m)	River/Stream	Biological condition class	
		FAII	SASS4
E1 (>1500)	Tautesloop	A	A
	Hartbeesspruit	B	A
	Leeuspruit	D	A
E2 (1200-1500)	Elands River	A	B
	Blaauboschkraal	B	A
E3 (900-1200)	Elands River	A	A
E4 (800-900)	Elands River	A	A

RESOURCE QUALITY OBJECTIVES AND MANAGEMENT ACTION

The availability of quantitative information on the reference biological integrity as well as the current biological integrity of a river will contribute towards setting realistic and ecologically sound resource management goals. A third critical condition in goal setting is the future condition that the various stakeholders desire for the river; this would typically include an assessment of the social-cultural, economic and ecological importance of the resource. Once consensus is reached on a management goal for a particular river, and if this goal can be expressed in terms of a specific integrity class (Table 1), then measurable Resource Quality Objectives (RQOs) can be allocated per ecological indicator group. In other words, the range of index scores coinciding with the desired integrity class, for each biological indicator group, becomes measurable and auditable RQOs.

An exercise involving stakeholders to set management goals for the Elands River has not yet been undertaken. However, to take this exercise further, we assume the following hypothetical desired conditions: a) No indicator group should deteriorate from its current integrity class and b) the whole of the Elands River should at least be maintained at Integrity Class B - given the social (e.g. recreational trout angling in upper reaches) and economic (e.g. trout aquaculture and forestry) importance of the Elands River catchment, a goal of Class A for the entire river may be unrealistic and impossible to achieve. According to the above rules for goal setting, it is only the Leeuspruit in reach E1 for which the fish community needs to improve from Integrity Class D to Integrity Class B. The current low integrity class according to the FAII is associated with the presence of exotic black bass in the Leeuspruit.

The RICS will provide the range of index values for the FAII in order to comply with a goal of Class B. Based on expert and system-specific knowledge, management options could be suggested for improving the fish community characteristics accordingly. An example of a management option for the Leeuspruit is the removal of exotic black bass and/or trout and the reintroduction of the appropriate indigenous fish species. Various management options could be rated on the basis of their political and technical feasibility and perceived efficacy (e.g. Haney and Power, 1996), in order to prioritise and guide management action.

CONCLUSIONS

A systematic process which involves the collection and assessment of biological data, setting goals and quantifiable objectives for managing the biological integrity of rivers, predicting how various management options will affect components of the ecosystem, and monitoring responses to the chosen management actions, will close the loop between monitoring, assessment and management. By following this iterative cycle and improving the individual components, the balance between water resource protection and utilisation can be optimised.

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