

Regional Scale Risk Assessment of threats to the yellowfish (*Labeobarbus spp.*) and the ecosystem services they provide in the in the Vaal River, South Africa's hardest working river.

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1. Introduction

The Vaal River is South Africa's most economically valuable aquatic ecosystems, and one of Africa's hardest working rivers [1]. Although a wide range of ecosystem services are provided by the Vaal River, the provision of water to and removal of waterborne wastes from Gauteng, Africa's most economically valuable urban centre, is the most important [2]. Additional ecosystem services include the provision of natural products including a unique yellowfish dependent angling industry in the Vaal River [3]. As a result of the excessive use of ecological services of the Vaal River, negative impacts to the structure and function of the river occur [4]. This includes impacts to the local yellowfish populations which have been declining in abundance and distribution from early as the 1960s [5]. The impact to the yellowfish in the Vaal River is threatening the local yellowfish dependent angling industry.

The yellowfishes that occur within the Vaal River include the Orange-Vaal largemouth yellowfish *Labeobarbus kimberleyensis* (Gilchrist and Thompson, 1913), and the Orange-Vaal smallmouth yellowfish *L. aeneus* (Burchell, 1822). The Orange-Vaal largemouth yellowfish is an endangered species with vulnerable status locally and near threatened status internationally [6; 7].

To date, the nature and extent of threats by stressors to the yellowfishes in the Vaal River is unknown, and the current social and economic value of the yellowfish dependent angling industry in the Vaal River has not been documented. Without this information, managers of the Vaal River are reluctant to establish tradeoffs from one ecosystem service user such as Gauteng, to another such as the anglers who target yellowfish. The aim of this study is to carry out a regional scale risk assessment of threats to the sustainability of the yellowfishes in the Vaal River and characterise the social and economic value of the yellowfish dependent angling industry in the system. This paper presents the approaches adopted and the findings of the application of the relative risk model to assess threats to yellowfish populations in nine established risk regions in the Vaal River catchment and the socio-economic assessment methods used to characterise the value of yellowfish dependent angling in the Vaal River.

2. Materials and methods

The approach adopted in the study is based on the relative risk model (RRM) approach presented by [8]. The fundamentals of this approach include the evaluation of risks of sources, stressors or combinations of these to defined endpoints for a particular study [8]. Four endpoints were selected for this study including; (1) maintain healthy populations of the endangered Orange-Vaal Largemouth yellowfish, (2) ensure healthy, regular recruitment of yellowfish individuals into populations, (3) maintain physiologically healthy yellowfish individuals and (4) ensure sustainability of the yellowfish dependent angling industry. The RRM includes the ranking of identified source and stressor combinations and habitats for subareas of the study area (Figure 1) named risk regions (RRs). The study evaluates the potential for ecological impacts to occur or risks to (1) each risk region, (2) by stressors, (3) to habitats defined habitats. Risks were based on the analysed interactions between identified sources, calculated stressors and chosen habitats. A series of risk scenarios were also provided based on a series of management options for stakeholders of the Vaal River. The uncertainty and sensitivity of the risk assessment which included the RRM was carried out using a range of univariate and multivariate statistical procedures. Finally a series of hypotheses for validation experiments were established for further validation of the risk outcomes.

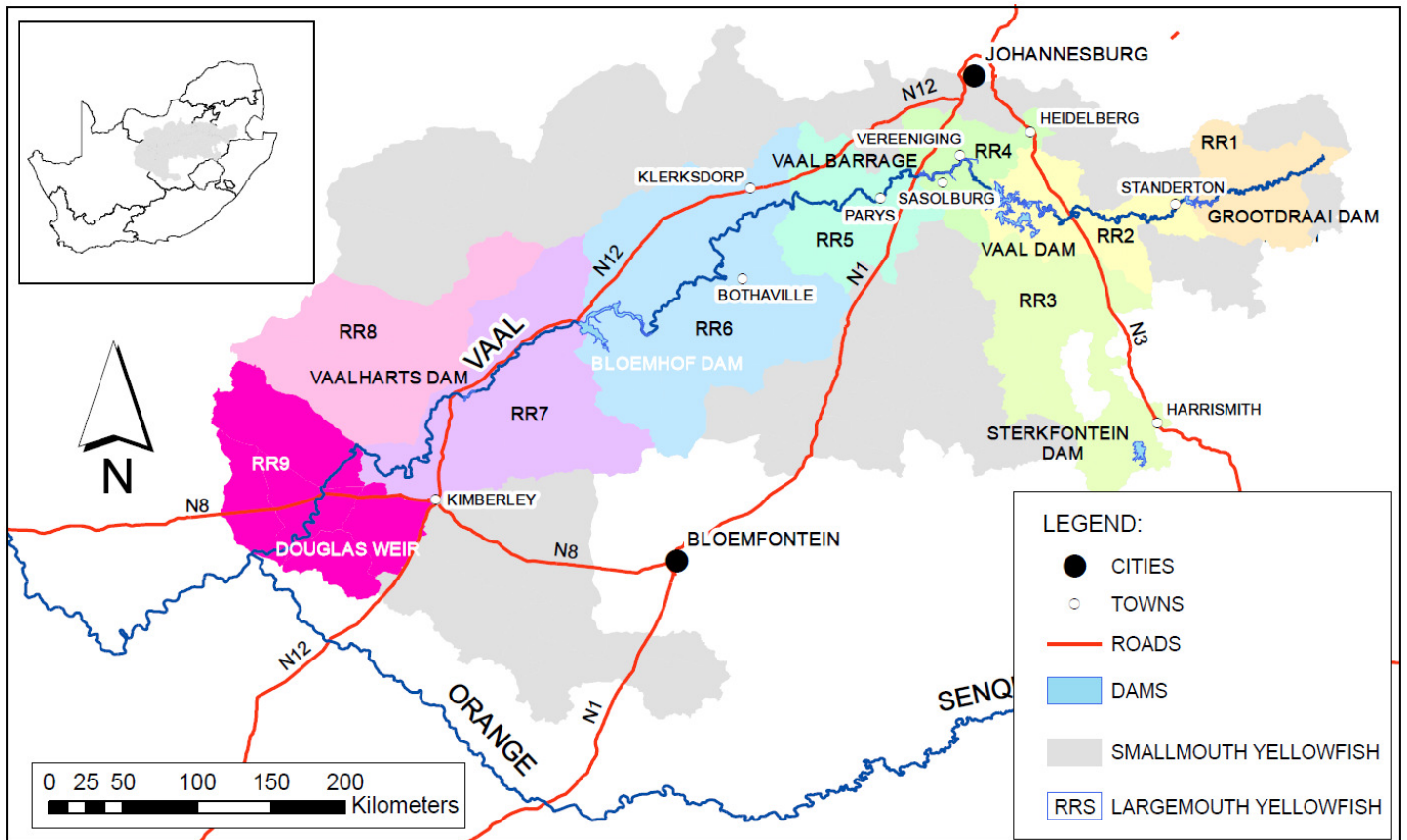


Figure 1: The portions of the Vaal River catchment considered in this relative risk assessment. Established risk regions (1-9) are portions of the distribution of the yellowfish in the catchment.

A questionnaire based survey approach with additional interviews was adopted to evaluate the economic value of the yellowfish dependent angling industry in the Vaal River [9]. The social assessment involved a desktop review of yellowfish and the associated fisheries industry, and a field survey into the risk assessment study area (Figure 1), where selected interviews with yellowfish and the Vaal River stakeholders were held.

3. Results and discussion

The risk assessment showed that the threat of chemical pollution, flow alterations, habitat alterations and disturbance to wildlife stressors exists in the Vaal River. These stressors are currently impacting negatively on the recruitment of yellowfish into the Vaal River primarily, followed by the sustainability of Orange-Vaal Largemouth yellowfish populations and health of yellowfish in the system. Habitats or ecosystem components that are threatened include yellowfish spawning areas and conditions primarily, followed by feeding and maintenance areas and refugia areas. A summary of the regional risk scenarios in the study area is presented graphically in Figure 2. Results for present day conditions (Figure 2A) show that low risks to yellowfish only occur in the upper part of the Vaal catchment (RR1 - RR3) and the Harts River catchment (RR8). Risks to the yellowfish in the rest Vaal River from the Vaal Dam to its confluence with the Orange River are moderate to high. Risks to RR4 which is in close proximity to Gauteng is exceptionally high. Other scenario assessments show that in the 1920s prior to the augmentation of the Vaal River and major industrial development in Gauteng, the risks was generally zero to low (Figure 2B). In consideration of future management options; if existing legislated environmental management requirements [10], are implemented the risk should reduce to sustainable low to moderate levels (Figure 2C) and if the current status quo is maintained the risk levels will increase, particularly in the upper reaches (Figure 2D).

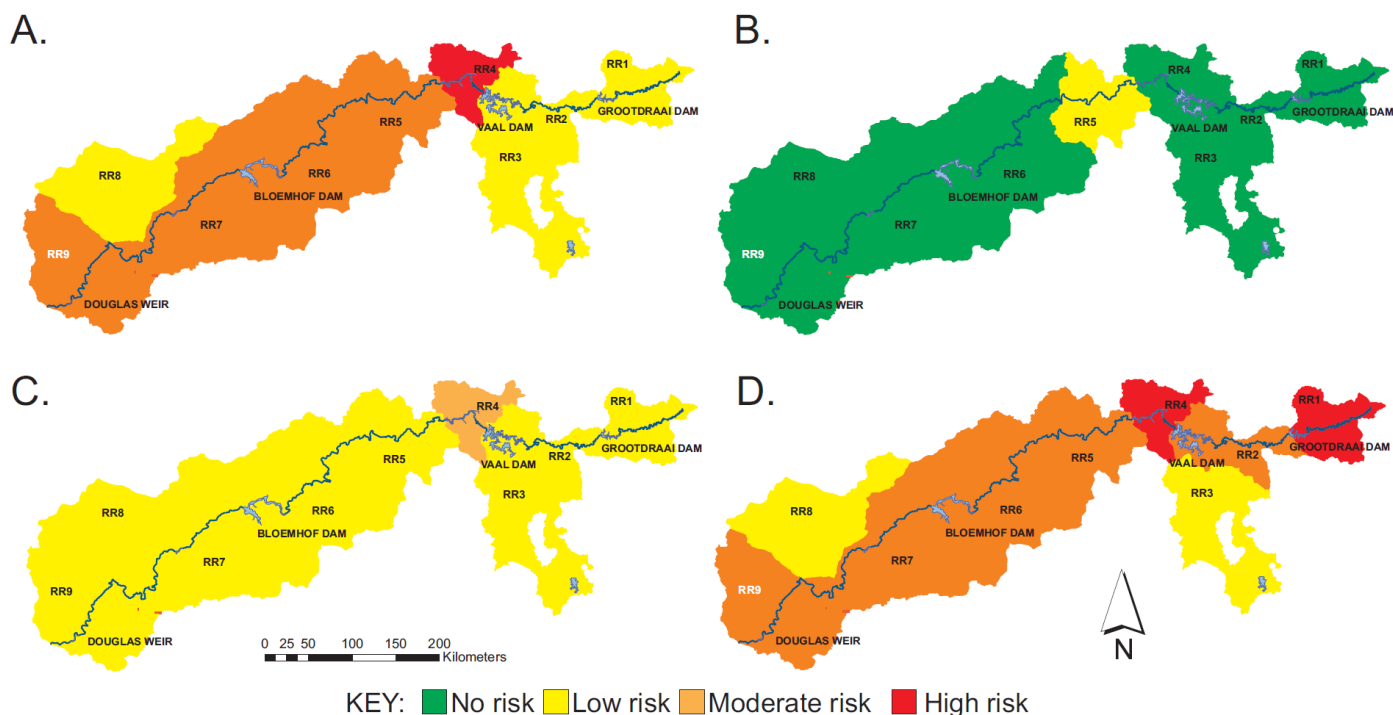


Figure 2: Spatial representation of the total risks to each risk region considered in the study. Maps of current risks (A), historical risks prior to the development of the Vaal River (B), possible attainable risks if sound management plans are adopted (C) and realistic future risks (D) if the development of the system continues without management intervention, to each risk region considered.

The findings of the yellowfish economic assessment shows that the current estimated value of the yellowfish dependant angling industry which includes approximately 5000 anglers per season is just over US\$16.7 million. In 2009, this equalled 17% of the value of the agriculture industry which the water in the Vaal River maintains. Of this US\$16.7, the equipment sector is worth US\$1.8 million, the amount spent on travel is US\$5.2 million, accommodation costs total US\$9.4 million, other costs carried out while undertaking angling trips totalled R0.3 million per season. Findings of the social assessment showed that by harvesting yellowfish for food, promoting yellowfish in regional ecotourism endeavours, and using yellowfish as a flagship, indicator species in the management and conservation of the Vaal River, numerous social benefits that yellowfish provide to communities were characterised. This includes yellowfish as an important source of protein to local communities who also benefit directly from improvements in health of the river when yellowfish are successfully used as ecological indicators. Furthermore yellowfish conservation promotes social cohesion, recreational activities and provides revenue to local communities. Finally, through local stewardship programmes, community upliftment and engagement programmes for yellowfish use and conservation, the quality of life of many South Africans are improved. This shows that the yellowfish dependant angling industry and other ecological services of the Vaal River, directly related to yellowfish conservation and use are of great economic and social value to South Africans.

4. Conclusions

The study shows that yellowfish in the Vaal River are not only of ecological importance as a part of the biodiversity of South Africa, but of social and economic value to South Africans as well. Thereafter, the study shows that due to the excessive use of the ecological services in the Vaal River, this value of yellowfish is at risk of being impacted on by chemical pollution, flow alterations, habitat alterations and disturbance to wildlife stressors. Although currently conditions may be acceptable, trends show that if increasing use of the ecological services of the Vaal River continue the likelihood that the biodiversity of our country would be threatened and that many South Africans would suffer social and economic losses. To avoid these losses and possibly enhance the value of yellowfish as an ecosystem service in the Vaal River existing environmental management regulations should be implemented.

5. References

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NOTE: The authors are still finalising this risk assessment and wish to know about problem areas in the Vaal