Food web and integrated biomonitoring

OVERVIEW

This programme was developed to quantify the collective improvements in the Hartbeespoort Dam's ecological functioning after the implementation of the *Harties metse a me* remediation programme. Of particular interest, in this instance, is the ecological response to the food web restructuring initiative. The integrated monitoring programme consists of two components, namely (1) Biomonitoring (monitoring of biotic components) and (2) Integrated Water Quality Monitoring. Monitoring is conducted on a monthly basis at six representative localities in the Hartbeespoort Dam.

In biomonitoring, biotic components are monitored to determine the increased taxa (species diversity), changes in the population size and composition, and changes in species succession. The following components are covered:

- **Fish ecological** studies are conducted to determine certain aspects of the fish population: species composition; species dominance; fishing gear efficacy, selectivity and selection for use in a fishery; biomass estimates and sustainable yield; presence of undesirable species and their contribution to the biomass; fishery potential of certain fish species (undesirable and desirable); fishery potential of certain sites on the Hartbeespoort Dam; structure of the fish population (population health and length frequencies); progress of the fishery (to determine shifts in the fish population after fish removal).
- **Open water phytoplankton** monitoring is a good indicator of any improvements in the dam. The algae composition and succession shifts in the population towards desirable species are determined. A trend towards reduced algae biomass, reduction in microcystis biomass (decrease in dominance during certain periods), and increased clear water state have been found since 2009.
- **Open water and floating wetlands zooplankton** monitoring. The zooplanton is part of the food chain that can show changes and responses within the system, and monitoring has been done since 2008. The floating wetlands create a habitat that is similar to the littoral zone (close to the shore), as many plant roots grow and hang beneath the floating wetlands. The floating wetlands create additional habitat to that found in the limnetic zone.
- **Macro-invertebrate** assessment aims to determine whether changes occur in the macro-invertebrate community structure, including manipulation of the fish population, lake shore habitat rehabilitation, the introduction of floating wetlands, as well as potential water quality changes. Sampling is conducted in three different habitat zones, namely that of the littoral zone, benthic zone and floating wetlands.
- **Vegetation succession** monitoring around the dam to identify the movement towards more desirable species.
- **Fisheries monitoring** determines whether targets are met and whether the fishery is on track. Data is used to make recommendations to management regarding the use of correct and prescribed gear, the fishing effort, fishery plan, continuous development of a fishery protocol, and fishing areas.
- **The fish health assessment and suitability for human consumption** programme focuses on the edible parts of the fish (muscle). Toxin and microbiological analyses of fish are done.
- **Aquatic health** of the dam, which is divided broadly into three categories: (1) macroscopic health assessment, (2) histological evaluation and (3) the edibility of fish. Since catfish and carp have been removed to shift the fish community structure to favour desirable fish species they have been used for the fish health and edibility part of the Resource Management Plan for the Hartbeespoort Dam.

In Integrated Water Quality Monitoring, data is used to analyse and explain certain trends or changes in the dam with reference to the biotic components and overall aquatic health.

OUTCOMES, RESULTS AND ACHIEVEMENTS

A baseline data set for the Integrated Biomonitoring has been recorded and a three-year data set for comparison now exists. The data sets of the two components of the Integrated Biomonitoring (biotic and water quality) will complement each other, and with comparison and statistical analysis, will verify improvement in the aquatic health of the Hartbeespoort Dam. The Integrated Biomonitoring Programme is a first for dams in South Africa and it is being developed for extension to other dams.

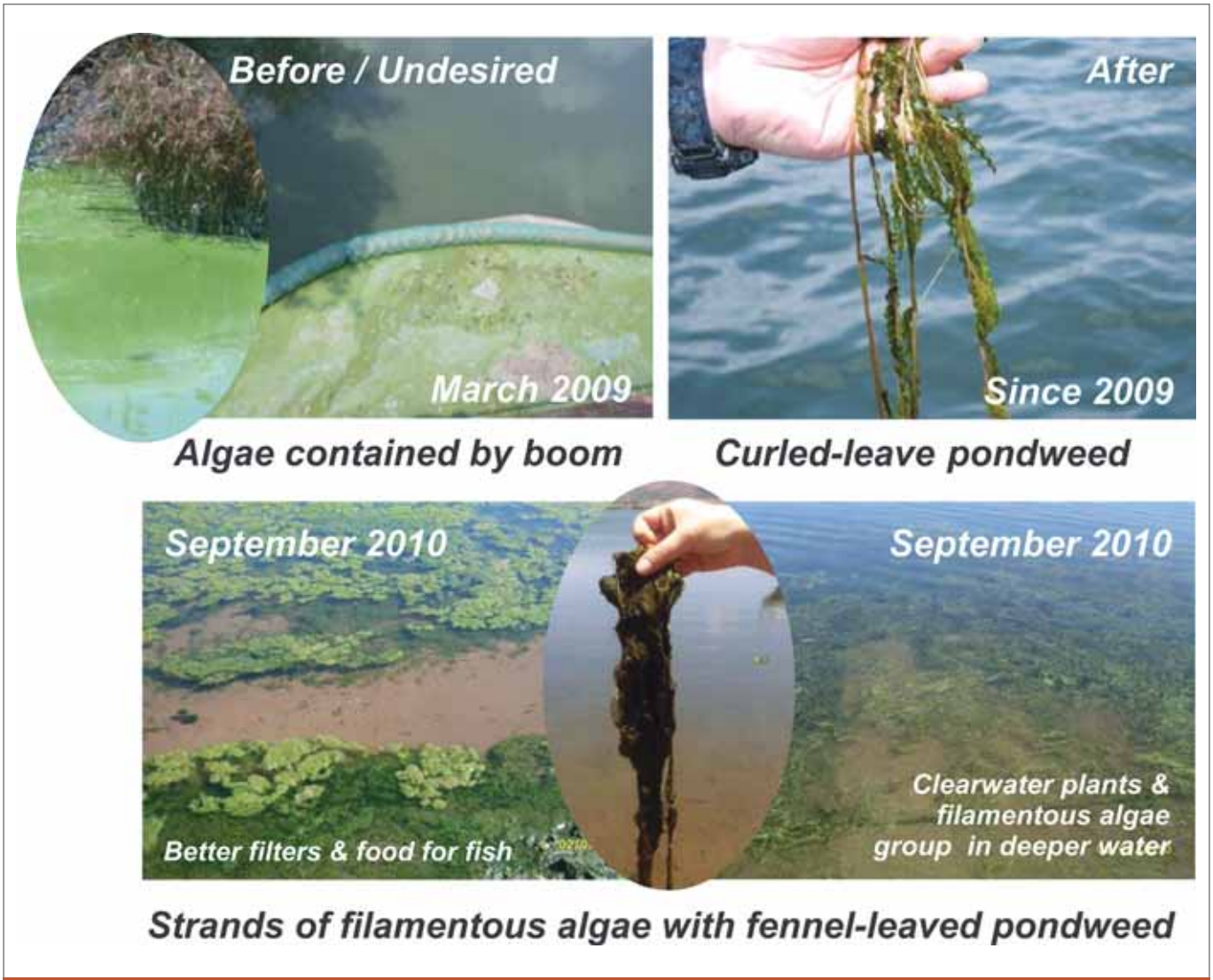
The results from the biomonitoring shows an overall improvement in the dam, with increased habitat and species diversity and densities observed for certain biota (some observations are seasonally linked). In terms of the fish population a reduction in carp was observed during the last fish survey, and an increase in Mozambique tilapia. Both zoo- and phytoplankton diversity and density have increased, and aquatic vegetation succession is also occurring during certain seasons.

The data is showing that the ecosystem of the Hartbeespoort Dam is generally becoming healthier, as an increase in species diversity and densities has been recorded. Increased diversity usually indicates improved aquatic health.

Environmental conditions are also noted at the time of sampling, such as excessive algae at a site, which may hinder sampling and species identification, as well as species colonisation. General weather conditions and wind directions are also noted. As a rule, monitoring is conducted during sunny weather conditions.

Since the introduction of the shoreline and food web reconstruction, clear water states are more prevalent and prolonged, with the dominant algae being the more desirable long-stranded filamentous algae *Spirogyra* sp ("paddaslyk" in Afrikaans). A plant succession is currently occurring with colonisation of previously barren areas by *Spirogyra* sp, now being followed by the true aquatic plants *Potamogeton pectinatus* (fennel-leaved pondweed) and *Potamogeton crispus* (curled pondweed), which will become dominant over time and utilise more nutrients, leaving less nutrients available for blue-green algae. The plants mentioned here are 'soft' plants and are utilised by the plant-eating fish species, as well as by waterfowl.

Monitoring of the zooplankton indicates that, when comparing the open water sampling sites to the island sites, there is greater species variability at the island sites, as expected, as a wider habitat variety is provided by the floating islands. The numbers of zooplankton were, however, primarily higher at the open water sampling sites than at the floating island sites.



Visible positive results of the Hartbeespoort Dam Integrated Biological Remediation Programme

Public awareness is essential in terms of the fisheries and the management of the Hartbeespoort Dam Remediation Programme. In this regard the *Harties metsi a me* programme has made huge strides informing the public since the start of the programme.

FUTURE CHALLENGES

- The Integrated Biomonitoring Programme for the Hartbeespoort Dam is a first for dams in South Africa and it is being developed for extension to other dams. A three-year data set is currently being analysed and the results from this analysis will verify the value of such a monitoring programme as part of a dam remediation or food web intervention programme.
- Bioremediation is an important tool which can be used in the remediation of eutrophic dams, or to adjust imbalanced fish populations (or the food web). The challenge is to carry this message through to all parties concerned, as there is great potential in terms of the improvement of the aquatic health and aesthetics of dams as recreational destinations and in terms of the monetary value of viable fisheries and SMME development.
- Any fish removal programme needs a strategy for utilising the mass of fish removed from the dam (i.e. slaughtering, freezing and marketing), and this needs to be in place before commencement of such a programme.

SUMMARY AND CONCLUSION

The food web monitoring at the Hartbeespoort Dam entails the development and updating of an Integrated Biological Monitoring Programme and Protocol Development to quantify the collective impacts of food web restructuring activities. The outcome is to outlay the sampling protocol for the food web monitoring of the Hartbeespoort Dam, which will integrate the collective impacts of the food web restructuring activities. The biomonitoring will serve as a 'barometer' to indicate trends in the monitored biotic components, and whether changes occur as a result of food web manipulation and bioremediation.

The restructuring of the food web is necessary to balance the trophic structure of the dam, and together with some of the other projects of the remediation programme, to improve the water quality in the dam. The establishment of floating wetlands to provide suitable habitat for zooplankton populations and other aquatic biota (such as invertebrates, fish fry and diatoms), precipitation of bonded phosphate and eradication of undesirable fish species are synergistic actions in the holistic process of food web manipulation.

The above-mentioned forms the basis of a bioremediation programme and can be applied to any other dam. An Integrated Biomonitoring Programme therefore also needs to run in unison with a bioremediation programme in order to assess improvements in the aquatic health of a new target dam in response to remedial actions, and to inform decisions.

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Source:
http://www.saice.org.za/downloads/monthly_publications/2012/2012-Civil-Engineering-August/#/0