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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

KNP crocodile deaths

Scientists are using state-of-the-art technologies and methods to solve the recent puzzling deaths of crocodiles in the Kruger National Park.

Towards explaining crocodile deaths: aquatic food chain analysis

During 2008, South African National Parks (SANParks) became aware of crocodile mortalities in the Olifants River Gorge of the Kruger National Park (KNP). All the affected animals suffered from pansteatitis, a condition caused by anti-oxidant depletion and painful hardening of the crocodile's fat reserves with its consequent loss of mobility. A total of 170 dead animals were recorded in 2008 and a further 28 in 2009. A further three animals also died in the Sabie River during 2009.

These incidents led to SANParks' formulating the following provisional hypotheses:

- Organic and/or inorganic pollutants build up in the food chain, which ultimately leads to death of the top predator in this aquatic ecosystem
- Harmful algae build up with bio-toxin production occurs.

The SIA approach investigated

Investigation of both hypotheses would normally be centred on foodchain analysis and confirmation of foodchain links. However, to undertake such an investigation using 'classical' means (i.e., based on analysis of gut contents) was, in this case, neither feasible nor practical. Accordingly, the use of a Stable Isotope Analysis (SIA) based approach needed to be considered as a possible means of defining the aquatic foodwebs and biota feeding patterns – the "who eats whom and where" approach.

To further explore this option, an investigation was launched to (a) determine the value of using SIA as a forensic tool to identify foodchain links between primary producers and crocodiles in the Olifants and Sabie River systems in the Kruger National Park and (b) attempt to link the the pansteatitis-related mortalities of crocodiles to a potential cause. Principally, the use of SIA was intended to identify links between catfish and crocodiles, and additionally, to examine possible involvement of cyanobacteria in the mortality events.

Of significance is the fact that Massingir Dam (downstream of the Olifants River Gorge in Mozambique) had been filled to capacity for the first time only in 2007. This resulted not only in the upstream loss of basking sites (sandbanks) for the crocodiles, but also inundated a massive area of previously farmed land. The limnological response of the dam to this sudden change in its hydro-morphology had not been monitored, but is likely to have brought about a massive change in the chemical and biophysical characteristics of the impoundment.

Results of an SIA-centred investigation

The SIA-centred investigation was constrained by being separated in time from the crocodile death events by a considerable extent. Sampling was undertaken more than a year after the first deaths were noted, i.e. when conditions in the affected rivers were no longer representative of conditions pertaining at that time of the events. In particular, no cyanobacterial blooms were present in the Olifants Gorge at the time of the investigation and the SIA results were dependent on a single crocodile sample only. However, these results were bolstered by fish samples collected both during and prior to the investigation.

At the time of the investigation, the phytoplankton population of Massingir Dam and the lower Olifants River was dominated by the K-strategist dinoflagellate, ***Ceratium hirundinella***. This organism is an alternate dominant in mild eutrophic conditions, and is typically alternate to a species such as ***Microcystis***. Although ***Microcystis*** was present in Massingir Dam, so was the toxin-producing ***Cylindrospermopsis raciborskii***, which is able to out-compete other cyanobacterial species by virtue of being able to suppress their ability to take up phosphorus.

While the crocodile diet is dominated by the fish typical of Massingir Dam and the lower Olifants Gorge, no link to phytoplankton via fish-zooplankton could be demonstrated by SIA analysis. Such a link is in fact unlikely, given the general inedibility and low food value that most colonial cyanobacteria offer to zooplankton. The results further suggest an invertivore linkage (phytoplankton, invertebrates, fish) in the foodchain of the relevant fish species, centred either in the benthos or the littoral of Massingir Dam.

Possible role of *C. raciborskii*

The presence of toxin-producing ***C. raciborskii*** in Massingir Dam is significant, in that this organism has been linked to large reptile (alligator) mortalities, as well as mortalities of other wildlife, for many years. The rapid appearance (globally) of this cyanobacterium is a relatively new and poorly-understood phenomenon.

The possible role ***of C. raciborskii*** in the Kruger National Park crocodile mortalities cannot be underestimated, even though a direct link cannot be established as no samples were collected at the time, nor was a comprehensive assessment made of the conditions prevailing in Massingir Dam. The presence of ***C. raciborskii*** has major implications for the future use of water from this dam – either local or downstream.

Conclusion

It is considered likely that the cause and effect pathway to the crocodile deaths was centred in Massingir Dam and its limnological ageing process following filling, rather than a riverine-based cause. However, the absence of primary data coincident with the event, as well as more time-based (seasonal) data, currently preclude the further development of this line of thinking.

The investigation showed that SIA-based forensic interpretation of foodweb characteristics can be deployed rapidly and cheaply in response to an event such as the crocodile mortalities. The data assembled in this investigation are likely to be of mutual, complementary value to other surveys being conducted around the issue of crocodile deaths in the Kruger National Park.

Further reading:
To obtain the report, ***Use of Stable Isotope Analysis to Describe Aquatic Foodwebs in the Kruger National Park*** (**Report No: KV 256/10**) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za