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Hypersalinity, the Link canal and dredging - a critical analysis.

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Introduction

In 1982 I was asked by the Natal Parks Board and this committee (SCADCO) to study the effect that freshwater inflow through the link canal might have on the fauna of the St. Lucia Narrows. Because of events which are familiar to all the major objective of the project was unfulfilled. I was however able to carry out a research project on aspects of the ecology of the Narrows biota, the results of which are contained in an almost complete thesis. During this period of research it became apparent that dredging operations in the Narrows were having a profound and detrimental effect on the ecology of the area , and that the effect of hypersalinity on the system as a whole had not been adequately investigated. I have submitted three reports to SCADCO concerning these aspects and the general reaction has been that they contain insufficient evidence to influence decision making. I shall therefore expand on these reports and clarify the arguments criticising current policy regarding management of the system.

There are three distinct aspects requiring consideration. These are the:-

1) effects of dredging and other reclamation activity in the Narrows region.

2) effects of hypersaline conditions (> 60 - 70 p.p.t.) on the

biota of the lake.

3) quality of freshwater to be diverted into the lake and Narrows.

Dredging in the Narrows

Dredging in the Narrows has had the following results.

1) Destruction of wetland areas through:-

a) incorrect spoil disposal.

b) increased drainage rates or alternatively the prevention of drainage from swamps.

c) pumping of saline water onto land.

2) Reduction of the carrying capacity of the system.

a) Macrobenthos.

Table 1

Mean density of macrobenthos (N/m^2) in altered and unaltered areas of the Narrows and Richards Bay.

	Narrows			R. B.
	Jul. 1983	Mar. 1984	Dec. 1984	Jan. 1984
Undredged mudflat	2982	9170	2161	4296
Dredged channel	96	7047	245	195

Table 1 above shows the mean abundance of macrobenthos occurring in undredged mudflat and dredged channel areas. The March 1984 data was collected immediately after the flood. The rapid current flow during that period caused adults and larvae to settle unselectively in both mudflat and channel areas. It was predicted that channel colonization would be temporary and this was confirmed from the results of the December 1984 sampling. It is concluded that the bottom living organisms actively avoid dredged channel areas. The March 1984 results also illustrate the rapid recovery of the benthos from flood conditions.

b) Prawns and large crabs (Scylla serrata). Results from trawling and trapping of these two species indicated that they too avoided channel areas in favour of mudflats. Trapping of large crabs in channel areas was discontinued because none were found there.

3) Permanent alteration of the geomorghology of the region by the artificial redistribution of sediments and an increase in their susceptibility to erosion during flood periods.

4) Alteration of the hydrology of the system. The first simulations carried out by the H.R.U. showed that dredging of the Narrows channel had significantly affected the hydrology of the system by increasing the rate of water exchange between lake and sea. This information was suppressed.

5) Reduction of detrital input into the Narrows due to changes in the topography of the banks thus reducing the area suitable for mangrove growth.

It must be noted that the Narrows is, from both an ecological and human utilization point of view, the most important area in the entire system. There is considerable input of detrital material from the sea, surrounding wetlands and mangrove areas making it nutritionally very rich. It contains the largest concentrations of large crabs (Hill, 1978), prawns (Forbes, pers. comm.) and benthos (this study). It is the migration route of the largely marine dependent fauna of the system. St. Lucia and most other South African estuaries are dominated by fish, prawn and crab species which are dependent on the sea for at least part of their lifecycle. The effect of the temporary loss of the North lake as a viable habitat during hypersaline periods is negligible compared with a possible loss of the Narrows as a viable migration route and nursery ground.

I do not intend to discuss at length the ecological effects of dredging and spoil disposal on a broader scale than St. Lucia but it is obvious that the results of research in other areas must influence decision making. There are numerous publications on this topic the most important being a synthesis by Morton (1977). The general concensus is that dredging is an undesirable but necessary aspect of economic development (shipping canals and harbours) and usually adversely affects the natural environment. The notion of dredging for ecological benefit is not even considered presumably because it is regarded as ridiculous.

<u>Hypersalinity</u>: effects on the lakes biota.

It should first be noted that hypersalinity is not unique to St. Lucia but is characteristic of a number of shallow estuarine/lagoonal systems occurring world-wide in regions of seasonal or erratic rainfall. Simmons (1975) surveyed the upper Laguna Madre on the Texas coast and reported that a salinity value of 113 p.p.t had been recorded and that values exceeding 70 p.p.t were not uncommon. He also noted that with increasing salinity the number of species declined but the number of individuals per species increased. The change was therefore compensatory rather than detrimental. His comment that "activities of mankind seldom lead to stability in the working of nature" in response to the effect dredging was having on siltation rates and salinity in the Laguna Madre might equally apply to St. Lucia. Another system which encounters hypersalinity is the Huizache Caimanero lagoonal compex in western Mexico (Edwards 1978). Salinity ranges annually from approximately 8 p.p.t to approximately 60 p.p.t with the system losing 80% of its volume through evaporation during the dry season. The amplitude of variation here is not as great as St. lucia's but the change is usually more rapid. It supports a similar fish and benthic fauna to St. Lucia and its prawn fishery produces over ten times the biomass of St. Lucia's despite it only being a third of the area. It also supports a large crab fishery. These two examples illustrate that hypersalinity is not necessarily detrimental to the functioning of a lagoonal system.

Effects on nutrients, detritus and primary production.

With evaporation there is an increase in the concentration of nutrients. The nett result is more nutrient per unit volume of water than during low salinity periods. There is no information as to the extent of this difference and the quality of the nutrients. Information on detritus which is typically the basic energy source driving an estuarine system is completely lacking. Primary production is affected by hypersalinity in two important ways. Clear water, a result of increased flocculation at high salinities allows light penetration to increase. Combined with a high concentration of nutrients and the result is high primary productivity which is observed as phytoplankton "blooms".

Quantitative information on these three important processes is almost non-existent. Without this information and comparable data for low salinity periods it is impossible to make objective management decisions concerning the alleged detrimental affects of hypersalinity. A parallel would be an attempt to make management decisions in a game reserve without knowing the state of the soil, grasslands, herbaceous plants and trees.

Effects on macrophytes (large aquatic plants)

Hypersalinity is detrimental to aquatic vegetation. Recovery rates are unknown.

Effects on zooplankton and benthos

During hypersalinity periods zooplankton consists of unicellular forms at high densities, presumably as a result of the increased primary productivity, while the benthos is impoverished and is dominated by chironomid larvae. Typical zooplankton and benthic communities consist largely of crustaceans and molluscs which in St. lucia cannot tolerate salinities in excess of 60 - 70 p.p.t .

However, as Boltt (1975) demonstrated, when salinity decreases the planktonic larvae of benthic species are rapidly transported into defaunated areas by water currents. These currents presumably also redistribute zooplankton.

Effects on fish.

Many of the fish species occurring in St. Lucia can tolerate considerable salinity extremes. Below is a list of fish which were captured during 1,5 hours gill-netting in North lake at a salinity of 77 p.p.t:-

Liza dumerilli (mullet)	-	132
Valamugil robustus (mullet)	-	1
Mugil cephalus (mullet)	-	105
Chanos chanos (milk fish)	-	2
Elops machnata (springer)	-	1
Rhabdosargus sarba (stumpnose)	-	4
Oreochromis mossambicus (bream)	-	1
total		246

Included in the above group are four detritivores, a piscivorous predator, a general feeder and a benthic predator. At least six out of the seven can probably tolerate salinities greater than 100 p.p.t.

Effects on birds

Bird community structure is altered by salinity but their mobility negates any detrimental effects hypersalinity might have on them. It benefits flamingoes which become especially common during these periods presumably feeding off the abundant unicellular zooplankton.

Effects on crocodiles and hippopotami

The effect of hypersalinity on crocodiles is uncertain. The conventional view that a reptile skin is impermeable is incorrect. They might become salt-loaded by taking salt in through the skin or orally while feeding (Sapsford pers. comm.). Hippopotami are not directly affected by hypersalinity. They require fresh water to drink and are affected by the drying out of freshwater pans surrounding the lake during periods of drought. The lake rarily provides a source of freshwater for either species.

Arising from this discussion of the effect of hypersalinity on the major biotic components are two points of note:-

1) Our previous view that hypersalinity is detrimental to the system needs to be reviewed.
2) The sort of detailed information on biological processes in the system required to make objective decisions is still largely lacking.

<u>The quality of available freshwater</u>

Assuming that freshwater introduction is considered desirable it would necessitate the transfer of approximately 54 million cubic meters of water from the Umfolozi annually to satify what the H.R.U reports consider to be "virgin" conditions. The introduction of this freshwater per sé does not appear to present a problem to the estuarine environment as the organisms occurring there can tolerate considerable salinity fluctuations. However the silt load that would be associated with the freshwater is unacceptible. Increased siltation due to catchment degradation is the single most important factor affecting Natal estuaries and this increased siltation was the original reason why the Umfolozi and St. Lucia systems were separated. Even if the silting basin removes much of that silt it will end up being deposited around the basin as dredge spoil and any flooding will transport it into the Narrows and lake.

Conclusion

In the light of this analysis I reaffirm the suggestions that I made in previous reports to SCADCO. They are that:-

1) the link canal project be scrapped and a policy of minimum interference be adopted.

2) dredging be confined to the mouth.

3) St. lucia and Umfolozi be maintained as entirely seperate systems.

4)funds be generated for ongoing fundamental research on the hydrology and biology of the St. Lucia system. The models developed and being developed are only as good as their data input and it is essential that this input be maintained.

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