COASTAL RESEARCH UNIT OF ZULULAND

Investigational report No. 123

Ecological impacts of a short-term diversion of the Umfolozi/Umsunduzi Estuary into the St Lucia System

A report prepared for Ezemvelo KZN Wildlife

by

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February 2008

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1. Introduction

The current drought in Coastal Zululand started in early 2001 and below average rainfall has continued to date. This coupled with high rates of evaporation, particularly during the summer months, has resulted in some of the lowest lake levels in Lake St Lucia in recorded history having occurred. As a consequence, some of the highest salinity levels ever recorded in St Lucia have been reached during this current drought. Added to this the mouth of the St Lucia Estuary has, apart from a six month period over March to August 2007, been closed since June 2002.

Following a reasonable rainy season in 2006/07 and despite lake levels still being low, salinities dropped to below that of sea water. However, Cyclone Gamede resulted in extremely heavy seas battering the coast line of KwaZulu-Natal in March 2007. These caused the mouth of the St Lucia Estuary to breach and sea water flowed into the lake due to its level being below sea level. This continued for some six months during which time the lake was filled to approximately the 75% level.

The net result of the breach was that large volumes of salt entered the system as the lake filled up with sea water. Despite reasonable spring rains in 2007, the summer rains over 2007/2008, have to date not resulted sufficient volumes of freshwater being delivered to the lake, from its catchment or through direct precipitation, to cause it to fill up. Consequently, salinities within the lake have once again started to rise as summer temperature drive up the evaporation rate. Currently some 70% of the lake is at salinities greater than 40ppt.

Ezemvello KZN Wildlife (EKZNW) is concerned that evaporation will cause a further lowering of the water levels in Lake St Lucia and that with the increased salt load that is currently present, hypersaline conditions will become more severe and these will be more widespread than before the 2007 breach. This will once again put stress on the ecosystem which will be detrimental to the fauna currently present, many of which entered the system as juveniles during the recent open mouth phase following the Cyclone Gamede breaching.

EKZNW are considering closing the Umfolozi Estuary mouth at the end of summer and removing the berm wall in a small channel that links the Umfolozi Estuary to St Lucia Estuary (Figures 1 & 2). This will result in water from the Umfolozi Estuary being diverted into St Lucia where it is anticipated that the fresh water will reduce salinities in the Estuary/Narrows as well as possibly in South Lake. In order to avoid excessive sediment entering St Lucia should the Umfolozi come down in flood during this time, EKZNW are planning to 'skim' the beach dune between the Umfolozi Estuary and the sea on the Mapelane (south) side (Figure 1). This will allow the estuary to breach to the sea should the river come down in flood resulting in any sediment laden water going out to sea rather than into the St Lucia Estuary. The

intention of this management intervention is to divert water to St Lucia over the entire winter period and beyond if possible.

The Coastal Research Unit Zululand (CRUZ) of the University of Zululand has been contracted to provide an expert opinion on the implications and significance of the above management action on the Umfolozi/Umsunduze as an estuarine system and the effects on its estuarine function. The approach taken by CRUZ was that each specialist provided comment on the potential impacts of the proposal related to their field of expertise and then the team as a whole provided an overall view of the issues relating to the effects of mouth closure on the Umfolozi Estuary which included recommendations. The only consideration given to the St Lucia System regarding the proposed action was related to views of the overall potential estuarine ecosystem benefits derived from the proposed management action versus the overall anticipated impacts on the Umfolozi Estuary.

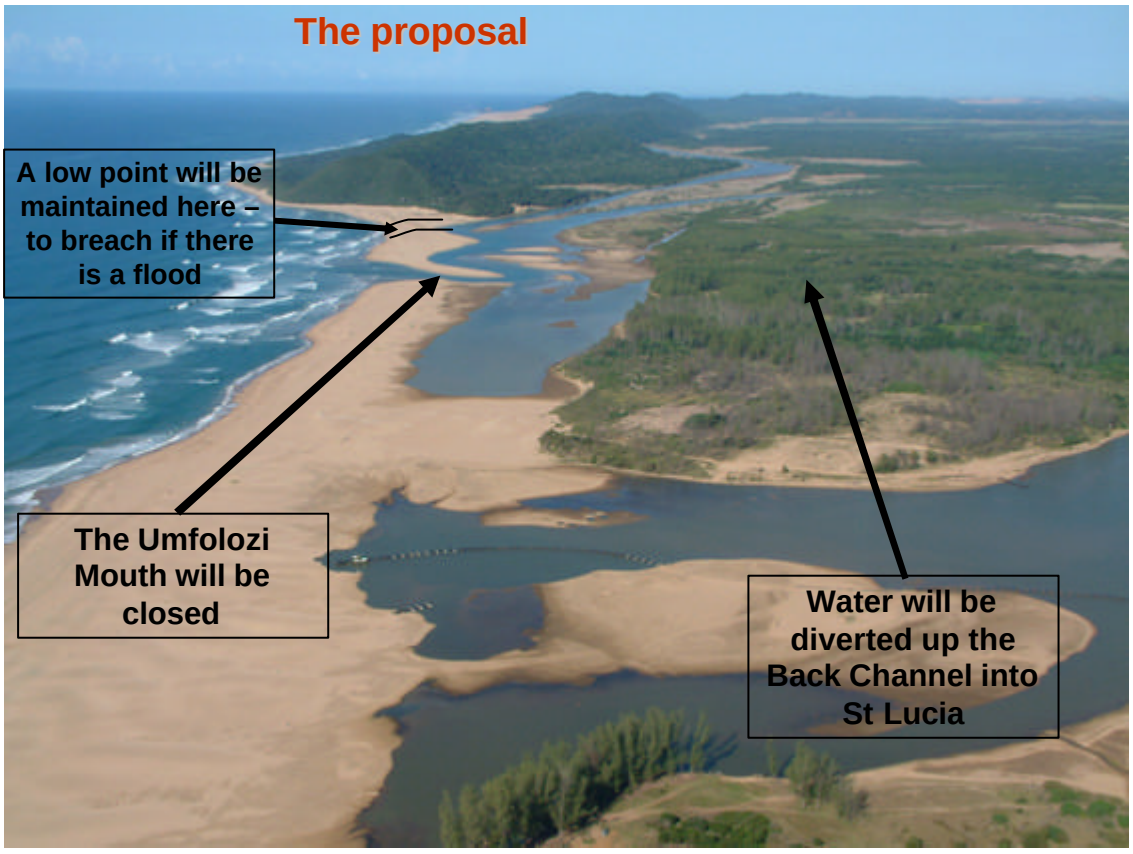

Figure 1. Layout of proposed plan to divert Umfolozi water into St Lucia (Photo provided by R.Taylor).

2. Components considered in this Assessment

In preparation of this expert opinion on the impacts of the proposed management activity on the Umfolozi Ecosystem the current state of the Water Quality of the Umfolozi/Umsunduzi system was assessed as well as the four major aquatic faunal biotic components (zooplankton, benthos, macrocrustacea and fish). It needs to be pointed out that the opinions expressed in this document represent the collective knowledge, expertise and experience of the team in relation to the Umfolozi/St Lucia systems. However, the current data base for the Umfolozi, apart from a few *ad hoc* observations over the past years, consists essentially of two fieldtrips undertaken by CRUZ in March and August 2007.

3. Water Quality (Mr L.Vivier)

Physical water quality parameters of the Umfolozi and Umsunduze estuaries were measured at a number of stations down the lengths of the two systems using a YSI multiprobe datalogger during March and August 2007 (Table 2). Chemical analysis of the water i.e. nutrients, was undertaken by the accredited Water Analysis Laboratory of the Mhlatuze Water Board.

The Back Channel was dredged in the late '60s/early 70's to bring Umfolozi water into St Lucia - it never worked because both the St Lucia and the Umfolozi Mouths were open and tidal

It was blocked off at the St Lucia end of the channel, and now is mangrove filled.

When the Umfolozi Mouth closed for a few weeks last year, Umfolozi water was diverted into St Lucia

Figure 2: Ariel view of the Back Channel that will be opened to allow water from the Umfolozi Estuary to run into St Lucia Estuary once the Umfolozi mouth has been closed (Photo provided by R.Taylor).

The mouth of the Umfolozi/Umsunduze system was open during the March 2007 sampling, but was closed during August 2007. This allowed a comparison between the normal open mouth condition when the system was tidal and the closed mouth condition when there was no direct link to the sea. During March, a typical salinity gradient was present, ranging from 35ppt at the mouth to less than 2ppt at the upper sampling sites. During August, the system had become fresh and salinities were low throughout, ranging from 5ppt at the mouth down to <1ppt at the upper sampling sites. Mouth closure, which occurred one month prior to sampling, therefore resulted in a relatively rapid freshening of the system. There were however still pockets of saline water in deeper sections of the estuary, such as that recorded at sites 2 and 3 in the Umfolozi (Table 2).

Closing of the Umfolozi/Umsunduze system for any length of time will result in a loss of the typical tidal salinity gradient, although pockets of saline water will still remain in the system. The rapid freshening of the system would be expected to adversely affect taxa dependent on higher salinities, although most taxa living or recruiting into estuaries have adapted to withstand salinity fluctuations.

Potential nutrient enrichment of the St Lucia system as a result of nutrient enriched water flowing from the Umfolozi/Umsunduze system into St Lucia is a potential issue of concern. Agricultural enrichment of water draining from the sugar cane fields situated on the Umfolozi floodplain could potentially affect the water quality in the Umfolozi/Umsunduze system and ultimately parts of the St Lucia system. During the March sampling, there was concern about the water quality in the middle reaches of the Umfolozi and Umsunduze estuaries after sections of the system in the vicinity of the drainage channels were observed to have a high phytoplankton load, however, no phytoplankton samples were collected. Water quality samples collected from the Umfolozi/Umsunduze main channels during both sampling periods showed no nitrogen and phosphorous enrichment (Table 2). Nitrogen and phosphate concentrations were generally low in the upper sections of the Umfolozi/Umsunduze system (Nitrate: 0.01-0.13 mg/l; Nitrite: 0.001- 0.1 mg/l; Ammonia: 0.05-0.1 mg/l; Ortho-phosphate: 0.05-0.1mg/l; Total phosphate: 0.05-0.44 mg/l) and were well below the Target Water Quality Range (TWQR) for aquatic ecosystems set by the Department of water Affairs and Forestry. The highest nitrogen concentrations were recorded in the vicinity of the mouth during March, with nitrate concentrations ranging from 2.6-2.8 mg/l. Although once-off recordings of nutrient concentrations in the water is of limited value, these readings do however provide some idea of the range of nutrient concentrations experienced in the system. As such, it is believed that nutrient enrichment of the St Lucia system due to water diversion from the Umfolozi/Umsunduze system is highly unlikely.

4. Zooplankton (Dr H.L.Jerling)

While the Umfolozi Estuary remains open to the sea a diverse mesozooplankton community, comprising marine and estuarine species, occupies the lower estuary, near the mouth. A salinity gradient exists along the main axis of the estuary, reflected by the presence of estuarine and freshwater zooplankton assemblages extending up-river from the mouth. If the mouth is closed, and if relatively large volumes of freshwater continue to flow in from the Umfolozi and Umsunduze rivers, the estuary will very quickly convert to a freshwater system, probably within weeks rather than months. This will cause the demise of steno- and euryhaline marine components of the zooplankton and, initially, an increase in the abundance of the major estuarine species, especially the calanoid copepods *Pseudodiaptomus stuhlmanni* and *Acartia natalensis*. These dominant estuarine species are quite tolerant of freshwater conditions, especially *P. stuhlmanni*. However, prolonged freshwater conditions, longer than six months as a rough estimate, will lead to a decline in the abundances of estuarine plankters and an increase in the numbers of freshwater zooplankton, such as freshwater cladocerans and cyclopoids.

Secondary production is directly linked to zooplankton densities. While the mouth is open the abundance of the zooplankton community in the lower estuary is diverse, but with relatively low abundances. Densities are higher in the mid and upper estuary. Zooplankton densities, and therefore also secondary production, should increase significantly after mouth closure, especially in the lower estuary. This increase would be as a result of a dramatic increase in the numbers of the dominant estuarine calanoid copepods. These tend to thrive under calm estuarine water conditions, with high nutrient input from the river, and in the absence of competition and predation from marine species. If the system remains fresh for an extended period (several months), production should decrease again as the numbers of estuarine plankters decline and freshwater zooplankton become more prominent.

One component of the zooplankton that is most likely to be negatively affected by mouth closure is the merozooplankton, e.g. larval stages of various invertebrates and fish, especially those that rely on an uninterrupted connection with the ocean to complete their lifecycle.

Once the Umfolozi mouth is open again to the sea, the marine zooplankton community will quickly re-establish in the lower regions of the estuary. The estuarine zooplankton community will also quickly re-establish itself but this will be throughout the saline areas of the estuary.

5. Benthos & Macrocrustacea (Dr R.K.Owen)

Site characteristics
Sediments in the Umfolozi are muddy at the mouth becoming sandier upstream, comprising medium to coarse-grained sands. Apart from near the mouth, sorting coefficients are generally moderately to well sorted. Organic contents are low (<1.5%), reflecting the generally sandy and relatively well-sorted nature of the substratum. Sediments in the Umsunduzi are predominantly muddy which indicates that this branch of the estuary is prone to silt deposition. Organic contents in the Umsunduzi are also low (2-3%), but about a percent higher than the Umfolozi as a result of its muddier nature.

Benthos
Quantitative sampling to date indicates that the benthos in the Umfolozi and Umsunduzi branches of the common estuary is impoverished compared with St. Lucia. The benthos in the Umfolozi/Umsunduzi is dominated by polychaetes with *Dendronereis arborifera* and *Ceratonereis sp* in the Umfolozi and D. *arborifera* and capitellids in the Umsunduzi, although the latter were recorded at only one site. The dominance of polychaetes is indicative of disturbed substrata with silt deposition in the Umsunduzi and generally well sorted sandy sediments in the Umfolozi preventing the establishment of benthic organisms adapted to more stable sediments. The absence or relative paucity of crustaceans, especially common estuarine amphipods (*Grandidierella spp, Victoriopsia chilkensis*), tanaids (*Apseudes digitalis*), mysids (*Mesopodopsis africana*) and brachyurans (*Paratylodiplax blephariskios*) is noteworthy, especially as these are generally common to abundant in the neighbouring St. Lucia estuary.

Macrocrustacea
Although not directly sampled, large and small seine netting for fish showed that the Umfolozi/Umsunduzi currently holds a healthy population of penaeid prawns comprising *Fenneropeaeus indicus*, *F.monodon* and *Metapenaeus monoceros*. These species also form the bulk of the prawn community in St. Lucia and it may be assumed that the community structure in both systems is similar.

Probable impacts of mouth closure and diversion to St. Lucia
Closure of the Umfolozi/Umsunduze mouth will allow water to be diverted into the Narrows, the lower portion of the St. Lucia estuary, at the expense of the Umfolozi system maintaining a predominantly open mouth and hence preventing direct recruitment into, and export from the estuary. Given the history of prolonged mouth closure of the St. Lucia estuary, the Umfolozi was thought to be able to act as a refuge from which St. Lucia would be recolonised. However, the relatively impoverished state of the benthos in the Umfolozi/Umsunduzi system after recent sampling (2007) indicates that the benthos in St. Lucia is far more diverse than in the

Umfolozi and effective recolonisation of gravimetrically important species in St. Lucia, particularly *P. blephariskios*, would be unlikely.

Macrocrustacean populations in the Umfolozi/Umsunduze, such as prawns and the swimming crab, *Scylla serrata*, will be affected to some degree. The freshening of the system may result in a movement of macrocrustacea out of the Umfolozi and into St Lucia where suitable habitats are available. Some recruitment may take place via overtopping of the 'skimmed' dune on the Mapelane side. However, as the export of sub-adults occurs primarily during mid and late summer, when the Umfolozi/Umsunduze mouth is expected to once again be open to the sea, there should not be any long lasting impacts on the Umfolozi fauna.

Recommendation
It is expected that negative impacts on the benthos and macrocrustacea in the Umfolozi/Umsunduzi estuary would be related to lack of recruitment and export. However, given the impoverished nature of the benthos in the Umfolozi/Umsunduzi, any detrimental impact on the biota could be considered less important compared with the positive impact of ameliorating excessively hypersaline conditions via additional freshwater input to the St. Lucia system. It would therefore be advisable to maintain/conserve the St. Lucia benthic community, especially in the lake compartments which tend to become excessively hypersaline during drought conditions. Benthic studies on the St. Lucia system following hypersaline periods indicated that the southern basin forms the reservoir from which the northern compartments (North Lake and False Bay) are recolonised. Water entering the St. Lucia system via the lower Narrows would combine with freshwater from the Mpate River to enter the southern basin (South Lake) and prevent it becoming excessively hypersaline.

The obvious impact on the Umfolozi/Umsunduze estuary would be through lack of recruitment and export with the mouth closed. The period of mouth closure for the Umfolozi/Umsunduzi would be over the winter months with a duration no longer than would be expected during a natural drought year. However, it is presumed that intermittent overtopping from the sea could occur and that this would provide a limited amount of recruitment into the Umfolozi and possibly also the St. Lucia systems. Should this occur it would offset the lack of recruitment via an open mouth to some degree. It is envisaged that the Umfolozi/Umsunduzi mouth would breach during moderate flooding (typically in late spring/early summer) and this would re-establish connectivity between the sea and the Umfolozi/Umsunduzi estuary, and possibly St. Lucia if the link between the two systems is maintained.

6. Fish (Prof D.P.Cyrus)

Apart from a one off sampling of the Umfolozi Estuary by T.Harrison (*pers comm.*) almost 10 years ago, the only other fish data of any significance is that collected by CRUZ during fieldtrips in March and August 2007. Harrison recorded 31 species whilst CRUZ recorded 48 (Table 1). Species composition of the CRUZ data indicates a major presence of juveniles of Estuarine Dependant/Partially Dependant marine species with high catch rates being recorded at several sites in the system. By comparison, a total of 63 species was recorded within Lake St Lucia during two sampling trips undertaken in 2007. The current, although limited, data indicate that the Umfolozi System is fulfilling an important role as a nursery for estuarine dependant/partially dependant marine species. The limited information from Harrison indicates that at the time he sampled, the Umfolozi was also acting as a nursery area for fish, however densities were very much lower.

It is considered that the Umfolozi, on a continual basis, offers estuarine nursery opportunities to juvenile marine species. However, the current high density and diversity of fish within the Umfolozi estuary may be as a result of the fact that the immediately adjacent St Lucia Estuary has been closed off from the sea since June 2002. This may have resulted in higher than normal recruitment levels into the Umfolozi. Essentially the post larval fish have nowhere else to go, as the next nearest estuaries (Mngobezeleni and Nhlabane) are a long distance to the North and South of the St Lucia and Umfolozi estuaries.

Given the above, it is considered that the closure of the Umfolozi estuary and its diversion into St Lucia will, with a freshening of the system, probably result in a major movement of fish into St Lucia where it is likely that they will find far better feeding grounds than they currently have available. This would particularly relate to the benthic feeding component of the fish fauna as it is known (see 5. above) that the Umfolozi Estuary benthos currently holds a very low species richness and density. This potential 'loss' of a major part of its estuarine fish fauna will only result in a short-term impact on the functioning of the Umfolozi ecosystem as once the mouth breaches to the sea it will again open the route for the inwards migration of post larval and juvenile estuarine associated marine species. The few truly estuarine species in the system will be able to tolerate the low salinities near the original mouth, added to which once the St Lucia mouth opens again it will also contribute to recolonization of the system by this component.

In terms of total water volume and surface area, the Umfolozi can only support a limited estuarine biomass when compared with the St Lucia system. The total faunal component that might be saved due to the diversion of Umfolozi water into St Lucia would be orders of magnitude greater than were the Umfolozi to be left to support its current fish fauna.

7. Comments from other Estuarine Experts

It was considered important that as part of this project some additional outside input should be obtained from other experts in the same field. As a result a summary of the proposed project, some of CRUZ's preliminary interpretations as well as a short scene setting paragraph were sent to Dr Alan Whitfield and Dr Steve Blaber. Both have in the past worked extensively on the Lake St Lucia system. Extracts from the e-mail responses received are included below. Essentially both think that the proposed management intervention is acceptable and Dr Whitfield also believes that the impact on the Umfolozi fish fauna would not be significant. Obviously, as can be seen from the responses, with the limited time available to complete this project it has not been possible to provide them with all the available data and scenario implications or to discuss them in detail.

The overall interpretation of their feed-back is that the proposed management intervention is acceptable and should go ahead as proposed. Further that the impacts on the Umfolozi/Umsunduze estuarine fauna and its ecosystem functioning will be limited and short-term in nature.

7.1 Dr A.K.Whitfield (SA Institute for Biodiversity, Grahamstown)

"Many thanks for the update on the St Lucia situation and the possible Mfolozi link. In reply I would like to say that I think it is an excellent management strategy to 'allow' the Mfolosi to join up with the St Lucia system for the duration of the up-coming winter. Obviously the fish and prawns that will become trapped in the Mfolozi due to mouth closure are likely to move into the Narrows and South Lake where there will

be far better feeding grounds. The Mfolozi freshwater may also allow South Lake to act as a proper refuge for the fish and inverts that have to leave False Bay and North Lake due to hypersalinity."

"I do not believe that the loss of the Mfolozi Estuary to fish and invertebrate recruitment this winter will be significant on two counts; (1) the system is probably already saturated with recruits for the reason mentioned below {St Lucia is closed and there are no other estuaries nearby} and (2) in terms of water volume and surface area the Mfolozi system can only support a limited estuarine biomass - especially when compared to St Lucia's potential which will be elevated considerably as a result of this action. This scenario may also allow the future breaching of the St Lucia mouth to be conducted earlier than would be the case if no water from the Mfolozi was allowed into the St Lucia system - indeed, it could make the difference between a breaching event and no breaching event depending on lake water levels."

7.2 Dr S.J.M.Blaber (CSIRO Marine Laboratories, Cleveland, Queensland, Australia)

"The main problem is that it is impossible to predict whether the next years rains will be good or not. If they fail then things won't look at all good. Regarding the connection to the Mfolozi, I can see some logic in this, but if there is rain in the Mfolozi catchment would there not also be rain in the St Lucia catchment? – i.e. would it really make much difference – if the Mfolozi gets lots more flow somehow, then yes."

"I really don't have anything substantive to suggest except that I assume the flow would only be from the Mfolozi to the narrows – there would be no flow the other way? I was thinking that there might be some advantages for the fauna in the lower reaches of St Lucia to be able to access the Mfolozi – is this possible or is the flow one-way preventing ingress? They could use some of the salt from St Lucia to maintain the lower Mfolozi as a more viable (alternative) habitat if it goes fresh? Just a thought. On balance I would support the idea of the Mfolozi connection."

8. General Discussion

8.1 Effects of management intervention on major biotic faunal groups

As can be gathered from the specialist comments given above, there will be impacts on the fauna and this will impact on the ecological functioning of the Umfolozi/Umsunduzi Estuary. However, it is considered that these impacts will only be short-term in nature and that the estuarine functions would re-establish themselves following breaching to the sea as a result of the first flush from spring rains. The main impact will be due to the almost complete freshening of the system and a lack of faunal recruitment and export. Each faunal component will respond differently to the changes brought about by mouth closure and the freshening of the estuary.

The zooplankton community of the Umfolozi, and in general also those of many other South African estuaries, is at times subjected to periods of mouth closure, which indeed lead to major changes in the community composition. However, the community structures of these systems revert quickly back to what can be regarded as a normal situation as soon as the mouth opens again, even after an extended period of closure. Closure of the mouth and diverting its flow to the St Lucia system should therefore not have any long-term negative effects on the Umfolozi zooplankton community. During an extended closed period the meroplankton will be affected, however, this impact should be weighed against the benefits of maintaining

functional ecological conditions and preventing a major ecological disaster due to hyper-saline conditions in the St Lucia system.

The benthic community appears to be impoverished and it is considered that whilst there will be changes due to the closing of the mouth, the impact will be insignificant. Further that once the mouth has re-opened and estuarine salinities have recovered re-colonization will occur fairly rapidly. As far as the macrocrustacea and fish are concerned it is considered that they may well move into more suitable habitats within St Lucia as the Umfolozi becomes fresher. Overtopping of the bar, on the Mapelane side, may provide some recruitment into the system. However, incoming organisms will be faced with almost totally fresh conditions which they will have to survive if they are to colonize the new set of conditions present in the Umfolozi estuary. As emigration and immigration mainly occur mid to late summer, by when the mouth is expected to have reopened, the impacts on this group will be reduced and only short-term in nature.

8.2 Impact on the Mangrove Flora

Details regarding the mangrove flora of the Umfolozi/Umsunduzi are limited. However as water levels will be rising and the water freshening it needs to be noted that the potential for impacting on this component exists. This will only be a concern if the water level rises to a level where it drowns the mangrove pneumatophores. In the past EKZNW, have with mouth closure at the Umlalazi estuary, started to raise concerns after about three to four weeks of inundation. This may be an issue that needs to be monitored, however it is not known if there are any major stands of mangroves present in the system, particularly in the vicinity of the link canal that is to be opened.

8.3 Water Quality Issues

Based on the current, although limited, set of water quality data it appears that there should be no concern related to any potential impacts on the system are a result of the diversion of Umfolozi water into St Lucia.

8.4 Recovery and Re-establishment of Ecosystem Functioning

As already indicated above recovery of the animal fauna should occur fairly rapidly and within the short-term the system should be back to its current state. The zooplankton community will quickly revert back to the typical community structure associated with estuaries with a salinity gradient along its main axis, as soon as the mouth is breached. The benthos consists primarily of a few species of polychaetes, a group that appears able to recolonise even dried out substrata very rapidly, which is why they are indicative of disturbed systems. However, should the mangrove flora be adversely affected there would be a much longer period needed for recovery to take place.

8.5 Viability of the Management Action

Despite the fact that it is considered that there will only be short-term impacts on the faunal components and that it is felt that the overall ecosystem functioning will return to the pre-closure condition in the short-term it must be realized that the data on which this expert opinion has been based is limited. Added to which, without some form of modeling or river flow data it is currently not known what sort of water volumes will be diverted into St Lucia. This could be a critical issue as, should water from the Umfolozi be insufficient to result in water flowing into South Lake and contribute to reduced salinities there then the viability of the management option would need to be questioned. CRUZ is however unable to comment on this but is of the opinion that if there are good indications that such an inflow will occur then the project should go ahead.

8.6 Impacts on the St Lucia Estuary

It is highly likely that the St Lucia Narrows will become very fresh as a result of the diversion of water from the Umfolozi. However, this has occurred in the recent past when the mouth was closed and it did not appear to impact negatively on any of the major biotic components (*per obs*.). At the same time mobile fauna that may be affected by reduced salinities could move to more saline areas that would still be present in South Lake and further to the North.

8.7 Benefits to St Lucia and the Estuarine Fauna as a whole

Some consideration needs to be given to the potential benefits to be derived by St Lucia from the diversion of freshwater from the Umfolozi system. As has been eluded to by Dr Withfield, the sheer size of St Lucia when compared to the limited surface area of the Umfolozi immediately indicates the overall benefits to St Lucia and the estuarine fauna as a whole if this management option if it is successful. Any action that reduces the potential for salinity increases, such as have occurred in the recent past, would significantly contribute towards St Lucia fulfilling its primary role as a nursery area for juvenile marine fish and macrocrustacea. In addition, as South Lake is considered to function as a reservoir for benthic faunal recolonization of other parts of the lake which have been subjected to increased salinities, the proposed management action is considered to be a good option which could have positive outcomes. The role played by South Lake is considered crucial to St. Lucia being able to withstand prolonged periods of excessive salinities during drought/high salinity periods.

9. Conclusions

CRUZ consider that, based on the above assessment and despite the limited data available, there will only be short-term impacts (6 to 12 months) on the major biotic fauna of the Umfolozi/Umsunduzi system and its ecological functioning if the proposed management intervention is in place for up to six months.

In the boarder context, benefits to be derived by St Lucia and the estuarine fauna as a whole if this diversion is successful are considered to totally outweigh the perceived short-term impacts on the Umfolozi/Umsunduzi system. This point is also highlighted in the brief responses received from the two external experts who where contacted for their opinions on the proposed management intervention.

As a result of the above it is considered that the proposed management intervention of closing the Umfolozi estuary mouth and diverting its water into the St Lucia system should go ahead as proposed.

10. Recommendations

In order to obtain some idea of the effects of this type of management intervention, which may need to be used again in the future, or may even become a permanent fixture if the historical shared mouth situation were to be re-established, it is recommended that some form of monitoring of the activity should take place.

At the outset basic physical data (salinity, turbidity, dissolved oxygen etc.) should be collected preferably on a weekly basis at a point just before the Umfolozi water enters St Lucia. Water Quality samples, for nutrient analysis, should also be collected at the same site at two, six and 12 weeks after the linking of the Umfolozi estuary with St Lucia. At the same time water level and salinity changes in the St Lucia

Narrows should be monitored as regularly as possible for the duration of the closure of the Umfolozi mouth and for several months thereafter. River flow data should be retrieved from gauging weir on the Umfolozi and Umsunduzi rivers in order to calibrate, as close as possible, the actual volume of water reaching their estuary. In addition monitoring should be undertaken to determine how much Umfolozi estuary water is actually diverted into the St Lucia system during the management intervention exercise.

Furthermore, it is recommended that consideration be given to monitoring and documenting the changes and recovery of the major biotic components of the Umfolozi/Umsunduzi system over this event. This could possibly take the form of a survey midway through the perceived minimum closure period of the Umfolozi mouth, with a second survey some eight to 10 months after the estuary's connection to the sea has been re-established.

Once the proposed management intervention exercise has been completed, the data collected should be compiled into reports and the overall outcomes of the exercise evaluated in terms of its success related to the aims of the project. In addition it is important to be able to determine as far as possible what impacts occurred during the intervention and to what extent there has been recovery.

If as anticipated this intervention is successful, with only short-term impacts occurring, then it will be important to take note of the final comment in Dr Whitfields response. This is related to the use of this particular type of intervention to allow earlier opening of the St Lucia mouth to the sea under low lake level conditions in the future. The closing of the Umfolozi estuary and its linking to St Lucia may provide the last 'top-up' of levels required in order for St Lucia breaching to go ahead.

28th February 2008
University of Zululand
Kwa-Dlangezwa

Table 1: The species and CPUE of fish recorded at different sampling sites in the Umfolozi/Umsunduzi system during May and August 2007.

	March 2007						August 2007							
	Mfolozi estuary						Mfolozi estuary			Msundusi Estuary				Grand
SPECIES	MFE1	MFE4	MFE4D	MFE5	MFE5D	**Total**	MFE1	MFE4	MFE5	MSE1	MSE2	MSE3	**Total**	**Total**
Acanthopagrus berda	0.01		0.00			**0.02**	0.10	0.11		0.10		0.10	**0.41**	**0.43**
Ambassis ambassis			0.07			**0.07**	0.11	0.03	0.27	0.10		0.30	**0.81**	**0.88**
Ambassis dussumieri	5.07	0.03				**5.10**								**5.10**
Ambassis natalensis	2.44		1.67			**4.10**	0.13						**0.13**	**4.24**
Argyrosomus japonicus	0.03			0.02	0.14	**0.19**	0.01	0.05		0.04		0.02	**0.11**	**0.30**
Atherinomorus sp	0.47					**0.47**								**0.47**
Awaous aeneofuscus							0.03					0.16	**0.19**	**0.19**
Caranx ignobilis		0.01	0.01		0.01	**0.04**								**0.04**
Caranx sem					0.04	**0.04**								**0.04**
Caranx sexfaciatus	0.24	0.11	0.05	0.06	0.05	**0.51**	0.01	0.03		0.02			**0.06**	**0.57**
Carcharhinus leucas	0.13	0.26				**0.39**								**0.39**
Clarias gariepinus						**0.00**						0.02	**0.02**	**0.02**
Drepane longimana	0.01					**0.01**								**0.00**
Elops machnata	0.02	0.04				**0.05**						0.01	**0.01**	**0.07**
Gerres acinaces				0.07		**0.07**								**0.07**
Gerres metheuni							0.03	0.40	0.05				**0.48**	**0.48**
Gilchristella aestuaria		0.10			0.20	**0.30**								**0.30**
Glossogobius callidus							0.40	0.25	0.17			0.11	**0.93**	**0.93**
Glossogobius giurus								0.01					**0.01**	**0.01**
Goby sp							0.10	0.04					**0.14**	**0.14**
Hilsa kelee	0.27	0.25		0.23	0.49	**1.24**	0.02	0.01	0.01				**0.05**	**1.29**
Himantura uarnak	0.01					**0.01**								**0.01**
Johnius dussumieri								0.03					**0.03**	**0.03**
Leiognathus equula	0.07	0.13	0.36	4.65	1.98	**7.18**	0.18	1.03	1.22			0.03	**2.45**	**9.63**
Liza dumerilii	0.19	0.07	0.31		0.05	**0.61**	0.28		0.06			0.01	**0.35**	**0.97**
Liza luciae	0.06	0.04				**0.09**								**0.09**
Liza macrolepis	0.14	0.44	0.30	0.28	0.03	**1.18**	0.31	0.28	0.16	0.02			**0.77**	**1.95**
Lutjanus argentimaculatus	0.03					**0.03**								**0.03**
Lutjanus fulviflamma							0.01						**0.01**	**0.01**
Monodactylus argenteus									0.02				**0.02**	**0.02**
Mugil cephalus	0.06	0.06	0.00			**0.12**	0.05	0.06		0.02	0.07		**0.20**	**0.32**
Mullet fry		0.40				**0.40**	0.40	0.38	5.38			0.04	**6.20**	**6.60**
Oligolepis keiensis			0.07			**0.07**								**0.07**
Oreochromis mossambicus	0.07	0.01	0.02		0.03	**0.13**		0.03	0.02			0.16	**0.21**	**0.34**
Periopthalmus africanus												0.02	**0.02**	**0.02**
Platycephalus indicus							0.03						**0.03**	**0.03**
Pomadasys commersonnii	0.00					**0.00**	0.07						**0.07**	**0.08**
Pomatomus saltatrix	0.04				0.01	**0.05**								**0.05**
Pseudorhombius arsius			0.03			**0.03**							**0.00**	**0.03**
Rhabdosargus sarba							0.30	0.03		0.10		0.02	**0.45**	**0.45**
Scomberoides lysan	0.01	0.01				**0.02**								**0.02**
Sillago sihama				0.03		**0.03**		0.05					**0.05**	**0.09**
Solea bleekeri										0.10		0.08	**0.18**	**0.18**
Syngnathus asus					0.01	**0.01**	0.03						**0.03**	**0.05**
Terapon jarbua	0.30	0.68	0.11	0.09	0.56	**1.74**	0.03	0.25	0.10	0.10			**0.48**	**2.22**
Upeneus sulphureus	0.00					**0.00**								**0.00**
Valamugil buchanani	0.02					**0.02**	0.01						**0.01**	**0.03**
Valamugil cunnesius	1.01	0.81	1.00	0.17	0.09	**3.07**	0.99	0.10	0.06	0.02	0.01	0.03	**1.20**	**4.28**
Valamugil seheli	0.20	0.06	0.83		0.48	**1.57**	0.11	0.17					**0.29**	**1.86**
Total	10.89	3.50	4.84	5.59	4.18	**29.00**	3.76	3.32	7.51	0.62	0.09	1.11	**16.42**	**45.42**
Species count	26	17	15	9	15	**36**	23	19	11	10	2	14	**33**	**48**

Table 2: Water quality data recorded in the Umfolozi/Umsunduze system during March and August 2007. M=mid-water sample, B=bottom sample, S=surface sample, MFE = Umfolozi Estuary, MSE = Umsunduze Estuary.

Station	Level	Salinity	Depth	Nitrate	Ammonia	Nitrite	Ortho phosphate	Total phosphate
			m	mg/l	mg/l	mg/l	mg/l	mg/l
				March 2007				
MFE1A	M	35.82	0.400	2.76	0.005	0.0007	0.05	0.08
MFE1B	B	32.08	1.368	2.8	0.05	0.001	0.14	0.16
MFE1S	S	31.72						
MFE2B	B	26.58	1.266	0.09	0.05	0.003	0.05	4.9
MFE2S	S	9.32						
MFE3B	B	31.93	1.570	0.09	0.08	0.002	0.06	0.2
MFE3S	S	20.92						
MFE4B	B	22.74	1.762	0.09	0.05	0.002	0.05	0.11
MFE4S	S	4.11						
MFE5S	S	0.63	0.250	0.09	0.11	0.004	0.06	0.26
MSE1AM	M	35.06	0.692	2.76	0.05	0.001	0.05	0.08
MSE2M	M	27.36	0.447	2.6	0.05	0.003	0.08	0.3
MSE3B	B	2.10	0.700	0.09	0.05	0.016	0.05	0.35
MSE3S	S	2.10						
MSE4B	B	0.92	1.161	0.09	0.05	0.008	0.06	0.3
MSE4S	S	0.93	0.386					
MSE5M	B	0.89	0.519	0.09	0.05	0.01	0.07	0.44
MSE6B	S	0.91	1.150	0.09	0.05	0.008	0.09	0.31
MSE6S	B	0.90	0.299					
				August 2007				
MFE1S	S	5.00						
MFE1B	B	5.50	1.200	0.1	0.04	0.28	0.09	0.37
MFE2S	S	10.50						
MFE2B	B	31.20	1.200	0.1	0.03	0.031	0.1	0.31
MFE3S	S	13.60						
MFE3B	B	9.50	0.800	0.1	0.03	0.0416	0.11	0.12
MFE4S	S	10.00						
MFE4B	B	3.70	1.900	0.1	0.03	0.0237	0.11	0.13
MFE5S	S	9.00		0.01	0.03	0.0146	0.09	0.24
MFE5B	B	7.50	0.900					
MFE6S	S	10.00		0.01	0.03	0.009	0.1	0.14
MFE6B	B	10.00	1.200					
MSE1AS	S	5.0						
MSE1AB	B	5.2	2.200	0.1	0.03	0.03	0.05	0.14
MSE2S	S	4.4						
MSE2B	B	4.5	0.900	0.13	0.03	0.025	0.05	0.5
MSE3S	S	2.9						
MSE3B	B	2.9	1.200	0.1	0.03	0.0168	0.05	0.21
MSE4S	S	1.9						
MSE4B	B	1.9	2.000	0.1	0.03	0.013	0.06	0.17
MSE5S	S	1.2						
MSE5B	B	1.3	1.900	0.1	0.04	0.112	0.08	0.23
MSE6S	S	1.1		0.13	0.04	0.017	0.05	0.05
MSE6B	B	1.1	1.900					