

KZN Estuary Observer Programme

Summary of conditions, pressures and recommended management actions for KZN estuaries



INCORPORATING



Helping people to care for our ocean

Compiled For:	KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs	 KWAZULU-NATAL PROVINCE ECONOMIC DEVELOPMENT, TOURISM AND ENVIRONMENTAL AFFAIRS REPUBLIC OF SOUTH AFRICA
Funded By:	KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs & South African Association for Marine Biological Research (SAAMBR)	 KWAZULU-NATAL PROVINCE ECONOMIC DEVELOPMENT, TOURISM AND ENVIRONMENTAL AFFAIRS REPUBLIC OF SOUTH AFRICA    Helping people to care for our ocean
Compiled By: Fiona MacKay Bianca McKelvey	Oceanographic Research Institute	

ORI Unpublished Report No. 364

KZN Estuary Observer Programme: Summary of conditions, pressures and recommended management actions for KZN estuaries

March 2022

The ORI Unpublished Report Series is intended to document various activities of the Oceanographic Research Institute. This is the research department of the South African Association for Marine Biological Research.



Oceanographic Research Institute
P.O. Box 10712
Marine Parade, 4056
Durban, KwaZulu-Natal, South Africa
Tel: +27 31 3288222
Fax: +27 31 3288188
Web site: www.ori.org.za |
www.coastkzn.co.za

© 2022 Oceanographic Research Institute

Title:	KZN Estuary Observer Programme: Summary of conditions, pressures and recommended management actions for KZN estuaries
Document Creator/s:	Fiona MacKay, Bianca McKelvey
Client/Funding Agency:	KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (KZN EDTEA)
Subject and keywords:	Estuary health, human activities, biophysical condition, coastal zone management
Description:	Synopsis of information from various activities of the Estuary Observer Programme (EOP), initiated by the ORI through the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA) to provide summarised background knowledge on KwaZulu-Natal's 76 estuaries. The target audience is coastal and estuarine managers. Many KZN systems remain unsampled from the early 1980's, resulting in shifting baselines as estuaries degrade. Considering provincial challenges, including lack of management and enforcement capacity, no current estuarine-related ecological monitoring and outdated information, the EOP makes use of data generated by various other coastal studies and large country-wide assessments (e.g., the National Biodiversity Assessment and previous Environmental Water Requirement studies) to present a status quo of the condition and activities for each estuary. It is intended that the information will guide various management actions, some of which have been tabulated. Each estuary has its own circumstance related to its inherent biophysical function and influences of surrounding pressures, but the pressure types are common to many KZN systems. The EOP is intended as a stopgap for in-depth and continuous estuarine monitoring.
ORI Project Code:	320
Document Status:	Complete
Year Issued:	2022
Report Type:	Unpublished Report
ORI Report No.:	364
Latest Version	EOP Report 2022_ORI unpublished report 364.pdf
Language:	English
Coverage:	South Africa, KwaZulu-Natal, estuaries Richards Bay to Port Edward (iNhlabane to uMthavuna) excluding the Ports of Richards Bay and Durban and the uMhlathuze Estuary. Data until end March 2022
Distribution:	ORI Library, authors and KZN Department of Economic Development, Tourism and Environmental Affairs, Ezemvelo KZN Wildlife
Citation:	MacKay CF, McKelvey B (2022). KZN Estuary Observer Programme: Summary of conditions, pressures and recommended management actions for KZN estuaries. Report prepared for the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs. Unpublished Report No. 364 Oceanographic Research Institute, Durban: 152 pp.
Acknowledgements:	O Parak EDTEA S Bachoo Ezemvelo KZN Wildlife C Pillay ORI N Siro ORI K Wright ORI S Weerts CSIR (Ichthyofauna)
Graphics:	D Hadlow, F MacKay, B McKelvey
Design & layout:	F MacKay, B McKelvey

DISCLAIMER

The report is based on research and expert knowledge of the contributing authors and was current as the time of printing. The authors and the EDTEA do not accept liability for any information or advice given as a consequence of this report.

COPYRIGHT RESERVED

Copyright subsists in the work. This publication or any part thereof may not be reproduced or transmitted in any form or by any means, electronic, mechanical or optical, for any purpose, without the express written permission of the Director of the Oceanographic Research Institute, and the individual authors of the document.

The distribution and use of this document is restricted to the parties for which it was produced unless otherwise indicated.



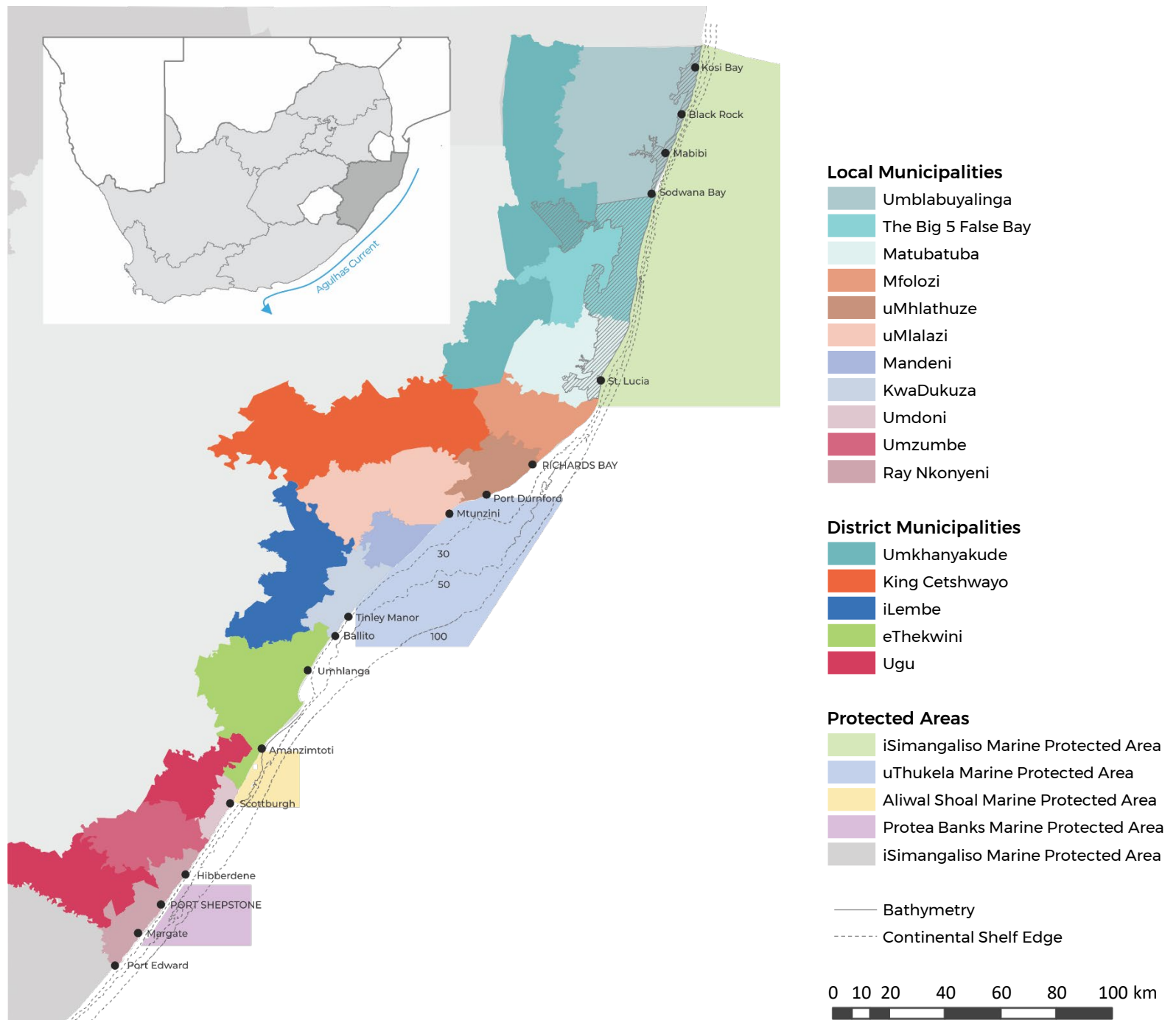
Contents

01	Abbreviations
02	Governance areas
03	Estuary locations
04	Introduction
05	EOP objectives & purpose of summary
06	Methods
08	Estuary types
10	Management actions
14-20	King Cetshwayo District Municipality

Abbreviations

AIS	Aquatic Invasive Species
Ave	Average
B	Present Ecological Status - Largely natural
B/C	Present Ecological Status - Largely natural to Moderately modified
C/D	Present Ecological Status - Moderately modified to Largely modified
CE	IUCN vulnerability assessment – Critically Endangered
CE	Present Ecological Status - Moderately modified
CME	Compliance Monitoring and Enforcement
D	Present Ecological Status - Largely modified
D/E	Present Ecological Status - Largely modified to Highly degraded
DEDEAT	(EC) Department of Economic Development, Environmental Affairs and Tourism
DWS	(SA) Department of Water and Sanitation
E	Present Ecological Status - Highly degraded
EC	Eastern Cape
EDTEA	(KZN) Department of Economic Development, Tourism and Environmental Affairs
EFZ	Estuarine Functional Zone
EKZNW	Ezemvelo KZN Wildlife
EMP	Estuarine Management Plan
EN	IUCN vulnerability assessment – Endangered
EOP	(KZN) Estuary Observer Programme
EUS	Epizootic Ulcerative Syndrome (Red Spot Disease) of fishes
EWR	Environmental Water Requirements
F	Present Ecological Status - Extremely degraded
FIMs	Floating Invasive Macrophyte Species
Ha	Hectares
IBA	Important Bird and Biodiversity Area
IUCN	International Union for Conservation of Nature
Km	Kilometres
KZN	KwaZulu-Natal
L	Lower estuary reach
LFD	Large Fluvially Dominated estuary
LTC	Large Temporarily Closed estuary
m	Metres
M	Middle estuary reach
Max	Maximum
ML/day	Megalitres per day
MMP	Mouth Management Plan
N	North
NBA	National Biodiversity Assessment
NGO	Non-Government Organisation
NT	IUCN vulnerability assessment – Near Threatened
ORI	Oceanographic Research Institute
PO	Predominantly Open estuary
S	South
SA	South Africa
SAAMBR	South African Association for Marine Biological Research
SLR	Sea Level Rise
STC	Small Temporarily Closed estuary
U	Upper estuary reach
VU	IUCN vulnerability assessment – Vulnerable
WWTW	Waste Water Treatment Works

KZN governance areas



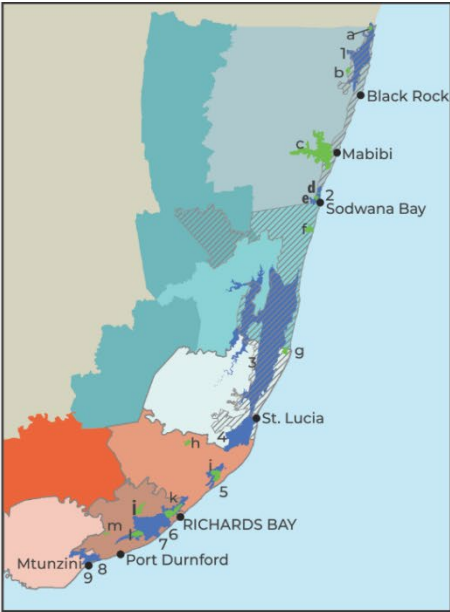
KZN estuary locations

Estuaries

1 Kosi	31 iNgane	61 oHlangeni
2 uMgobezeleni	32 uMkhomazi	62 uVunguza
3 St Lucia	33 uMahlongwane	63 iKongeni
4 iMfolozi/uMsunduze	34 aMahlongwa	64 uVuzana
5 iNhlabane	35 uMphambanyoni	65 iBilanhlonhlo
6 Richards Bay	36 Rocky Bay	66 iMvutshini
7 uMhlathuze	37 uMzimayi	67 iMbizana
8 uMlalazi	38 uMuziwezinto	68 iKhaba
9 iSiyaya	39 iNkomba	69 uMhlangomkhulu (S)
10 aMatigulu/iNyoni	40 uMkhumbane	70 iMpenjani
11 uThukela	41 iSezela	71 iKhandalendlovu
12 iZinkwazi	42 uMdesingane	72 uMuntongazi
13 iNonoti	43 iFafa	73 uMbhoyibhoyi
14 uMdlotane	44 uMvuzi	74 iSandlu
15 uMvoti	45 uMthwalume	75 iSolwane
16 uSetheni	46 uMnamfu	76 uMthavuna
17 Bob's Stream	47 uMakhosi	
18 uMhlali	48 uMfazezala	
19 uThongathi	49 uMhlungwa	
20 uMdloti	50 uMhlabashana	
21 uMhlanga	51 uMzumbe	
22 uMngeni	52 iNjambili	
23 Durban Bay	53 iKhoshwana	
24 iSiphingo	54 iDombe	
25 iZimbokodo	55 uMhlangomkhulu (N)	
26 aManzimtoti	56 uMthente	
27 aManzanamtoti	57 uMzimkhulu	
28 iLovu	58 uMbango	
29 uMsimbazi	59 iBhobhoyi	
30 uMgababa	60 iZotsha	

Coastal Lakes

a Zilonde
b Shengaze
c Sibaya
d Shazibe
e iMgobezeleni
f Bhangazi (N)
g Bhangazi (S)
h Eteza
i iNhlabane
j Nsezi
k Mzingazi
l Qubhu
m Mangeza



Introduction

Estuaries are important coastal environments that are at the interface between land, freshwater, and the sea. They are characterised by complex multiscale variability in space and time, of geomorphology, hydrodynamics, and physico-chemical conditions that produce unique estuarine conditions and specially adapted biological communities. They provide critical ecological services, acting as nurseries for fishery species, filtering land derived nutrients and pollutants, delivering freshwater and sediments to the coast and sequestering and storing carbon. They have high socio-economic value, providing resources for coastal communities, and support various recreational activities and tourism.

KwaZulu-Natal's coastal towns and its two major port cities have developed around its estuaries. Most are small systems which close naturally during low flow periods, back-flooding into surrounding landscapes to create important habitats that are necessary for the functioning estuary. The estuary and the immediate surrounding areas that support its functioning, including the riparian zone, connected wetlands and swamp forests, back-flooded areas when the mouth is closed and areas that are inundated during periodic flooding, form the estuarine functional zone (EFZ). This is an accepted delineation boundary and is listed in the National Environmental Management Act (NEMA), Environmental Impact Assessment (EIA) Regulations (2010). This listing recognises the sensitivity of estuaries in their entirety, and the importance of their supporting habitats. Any future activity in these habitats requires environmental authorisation. As a spatial demarcation, the EFZ is incorporated into planning processes involving estuaries such as conservation plans and

Integrated Development Plans (IDPs). Important is the recognition that the functional estuarine area can be significantly larger than the water surface area when the system is open.

Estuaries are the most susceptible of the coastal ecosystems to the interaction of various climate and anthropogenic drivers because coasts are areas of growth, and development-associated activities happen around estuaries (Kennish 2021). Development and population growth are the main drivers of pressures on KZN estuaries. There are 76 estuaries across KZN. All of them are ecologically impacted to some degree, and only 12 (16%) are in a near natural state. Most (56) are moderately degraded to degraded and eight are considered extremely degraded (data from Van Niekerk et al., 2019). This is set to worsen, as there is a trend of declining health in KZN estuaries, including those in protected areas. Estuaries near large urban areas (eThekweni and Mhlathuze), are very vulnerable to further degradation as there the pressures are multiple and highest. Some of these are already in the worst possible state and further deterioration will likely create dysfunctional systems. Some estuaries on the KZN south coast are still largely natural and function well, but this is not guaranteed into the future if the low to medium pressures affecting them increase. The declining state of KZN's estuaries has numerous impacts on estuary function, changes in estuarine biotic communities and habitats, and the goods and services these systems provide to the people of KZN.

EOP objectives & purpose of summary

Many of the pressures on KZN estuaries result from inadequate compliance monitoring and enforcement. Common and widespread offences include illegal breaching, sand mining, illegal netting, pollution spills, sewage spills, habitat destruction and riparian vegetation removal. These activities and system responses are also in the context of limited integrated planning and poor allocation of available resources. A paucity of baseline biophysical data at the individual estuary level, makes it difficult to fully assess the impact of these transgressions, particularly where the impacts are indirect e.g., sandmining upstream starving an estuary of sediment, or wastewater significantly altering mean annual runoff entering an estuary.

National and provincial reviews of estuary health, most recently during the development of the 2018 National Biodiversity Assessment (Van Niekerk et al., 2019), have repeatedly highlighted the trajectory of degradation of the KZN estuary resource in recent decades. However, management actions through land-use planning and legislative provisions for pollution management are additionally constrained by the lack of basic information for managers and decision-makers on the pressures that drive changes in health status. This is compounded by the limited resources at national, provincial and local levels.

The Estuary Observer Programme (EOP) was initiated by the Oceanographic Research Institute (ORI) through the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA) to provide background knowledge on KwaZulu-Natal's 76 estuaries. It is intended to support conservation planning, protect biodiversity and estuarine ecosystem function and the sustainable use of the critical resources that are unique to estuarine habitats, as envisioned in the Draft National Estuarine Management Protocol (of the Integrated Coastal Management Act, No 24 of 2008). The programme focuses on anthropogenic activities that impact

these ecosystems and their ability to continue to provide critical ecosystem services. Data sourced are processed and presented in a spatially referenced, user-friendly 'toolkit' that is made widely available on the CoastKZN information portal www.coastkzn.co.za, providing support to policy makers, planners, decision-makers and estuary managers.

Many KZN systems remain unsampled from the early 1980s, resulting in shifting baselines as estuaries degrade and living memory of healthy states are lost. Physical monitoring is however expensive in both time and cost. Considering these provincial challenges, the EOP makes use of data generated by various coastal studies (none of which are monitoring studies) and large country-wide assessments (e.g., the NBA) and previous EWR studies. The information gathered serves as a summary of the condition, status and pressures influencing each KZN estuary. This summary reports on the condition, status and pressures of 69 estuaries that are outside of the iSimangaliso Wetland Park (Kosi, uMgobezeleni, St Lucia, uMfolozi), the uMhlathuze Estuary at Richards Bay and the two KZN ports (Richards Bay and Durban Bay).

It is intended that the information presented here will guide various management actions, some of which have been tabulated. Each estuary has its own circumstance related to its inherent biophysical function, and influences of surrounding pressures. However, the pressures are common to many KZN systems. The EOP is intended as a stopgap to important estuarine monitoring. Monitoring is a critical inclusion for future provincial plans if KZN estuaries are to be managed sustainably and continue to deliver ecosystem goods and services, be able to reach national and local estuary conservation targets and mitigate against the projected socio-ecological consequences of climate change.

Methods

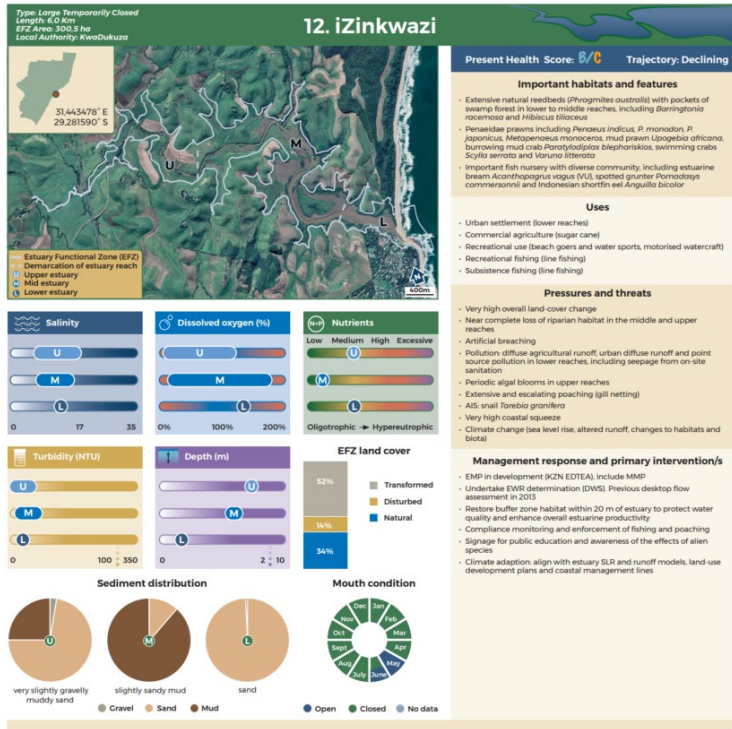
Estuaries that have World Heritage protection (iSimangaliso Wetland Park) or under South African Ports jurisdiction were excluded from this assessment. Information and data were collated for 69 KZN estuaries using previous system comparison studies of Begg (KZN wide; 1978, 1984), Forbes & Demetriades (eThekweni; 2010), the estuarine component of South Africa's NBAs (Van Niekerk & Turpie, 2012; Van Niekerk et al., 2019) and new literature that incorporates KZN-specific estuarine information (e.g., Adams et al., 2020; Van Niekerk et al., 2020, 2022). Notable is that the EOP has contributed data and information to many of these new estuarine assessments, including basic critical information that is constantly updated e.g., refining of the KZN EFZs, surrounding land cover change, sand mining and mouth status of KZN estuaries, and used by environmental practitioners, managers, scientists etc.

Also, each of the 69 estuaries was visited (2019-2020)* through the EOP to fully assess pressures and current condition, as in-depth data is critically lacking at an individual estuary level. No biological sampling was conducted, but physico-chemical condition, the pressures, uses and other notable observations influencing estuarine state were made. The EOP data now includes more recent once-off sediment habitat type and water quality data from the upper, middle and lower reaches of all estuaries (where possible) and is invaluable in that this is a contemporary time stamp for comparative analysis and future monitoring. These data will also be made available through the www.CoastKZN.co.za. In parallel, land cover for all estuaries is being captured to the 20m topographical contour, through time (1939 to present). These data are used to inform various other projects funded or co-funded by EDTEA e.g., CMLs, estuary SLR and shoreline change monitoring.

* These data pre-date the April 2022 flood events that resulted in large-scale biophysical changes in several systems.

The summary for each estuary is presented as a single page:

Example of an Estuary Summary Page



Each page notes the location, basic facts (including estuary type, length, area) depicts the EFZ and the reaches (U, M, L), gives present-day, summer season ranges of salinity, dissolved oxygen, turbidity and nutrient status (which is a consolidated evaluation of nitrate, and phosphate elements and primary productivity). Physical aspects of estuary depth and the sediment type of each reach is denoted from grain size distributional analysis. The mouth condition is an assessment of the average monthly state based on records from the 1980s to present, from site visits and aerial surveys conducted variously by Begg (1984), EKZNW and ORI.

The state of KZN estuaries is evaluated by the South African Estuarine Health Index (EHI) which assesses biophysical components relative to specific pressures (Van Niekerk et al. 2013). Estuary health is a measure of the difference in the state of a system between natural (or reference) and present-day conditions. The EHI is used variously in the determination of environmental flows, in planning frameworks for development, conservation planning and protection, to inform land-use planning and in the National Biodiversity Assessment. Estuaries are classified on a scale ranging from A – Natural to F – Extremely Degraded, using available information on hydrology, hydrodynamics, mouth condition, water chemistry, sediment processes, microalgae, macrophytes, invertebrates, fish, and birds.

The trajectory of the present health score is denoted for every estuary. This is based on the recent estuary visits and are an update of the latest NBA assessment (Van Niekerk et al., 2019). The trajectories are either stable or declining. No estuaries were noted as improving in state.

The important habitats and features sections note communities and species that are important to protect (if given an IUCN threat status), are notable for estuarine function, or indicate connectivity with adjacent realms (freshwaters or the marine environment). Estuarine uses are denoted as they link to pressures and the suggested management actions.

Pressures and threats are linked to the suggested management responses and primary interventions. Notably, is the EMP and EWR status of each estuary. These are brought together in a dedicated section of ‘Summary of management actions’ which is to be used as a roadmap for the critical management focus points for KZN estuaries.

References

- Adams, J.B., Taljaard, S., van Niekerk, L. & Lemley, D.A. (2020). Nutrient enrichment as a threat to the ecological resilience and health of South African microtidal estuaries. *African Journal of Aquatic Science* 45:1-2, 23-40, DOI: 10.2989/16085914.2019.1677212.
- Begg, C. (1978). The Estuaries of Natal. Natal Town and Regional Planning Report Vol. 41.
- Begg, C. (1984). Estuaries of Natal Part 2. Supplement to NTRP Report Vol. 41. Natal Town and Regional Planning Main Series Report, Volume 55.
- Forbes, A.T. & Demetriades, N.T. (2010). Estuaries of Durban, KwaZulu-Natal, South Africa. 2010 report, second edition. Report prepared by Marine and Estuarine Research for the Environmental Management Department, eThekweni Municipality.
- GBIF.org. GBIF Occurrence Downloads for 69 estuaries [Accessed, 01 July 2020].
- Google Earth Pro (Version 7.3.4.8248). (2019 – 2021). Map showing individual locations of 69 KZN estuaries; multiple elevations. <http://www.google.com/earth/index.html>.
- Kennish M.J. (2021). Drivers of Change in Estuarine and Coastal Marine Environments: An Overview. *Open Journal of Ecology* 11, 224-239. <https://doi.org/10.4236/oje.2021.113017>.
- SANBI Biodiversity GIS. (2018). National Biodiversity Assessment spatial datasets available at <http://bgis.sanbi.org/SpatialDataset>.
- Van Niekerk, L., Turpie, J., & (eds). (2012). South African National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report No. CSIR/NRE/ECOS/ER/2011/0045/B (Vol. 3). <http://bgis.sanbi.org/nba/project.asp>.
- Van Niekerk, L., Adams, J. B., Bate, G. C., Forbes, A. T., Forbes, N. T., Huizinga, P., Lamberth, S. J., MacKay, C. F., Petersen, C., Taljaard, S., Weerts, S. P., Whitfield, A. K., and Wooldridge, T. H. (2013). Country-wide assessment of estuary health: An approach for integrating pressures and ecosystem response in a data limited environment. *Estuarine, Coastal and Shelf Science* 130: 239–251. <https://doi.org/10.1016/j.ecss.2013.05.006>.
- Van Niekerk, L., Adams, J., Lamberth, S., MacKay, C., Taljaard, S., Turpie, J., Weerts, S., & Raimondo, D. (2019). South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. CSIR report number CSIR/SPLA/EM/EXP/2019/0062/A. South African National Biodiversity Institute, Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A.
- Van Niekerk, L., Adams, J.B., James, N.C., Lamberth, S.J., MacKay, C.F., Turpie, J.K., Rajkaran, A., Weerts, S.P., & Whitfield, A.K. (2020). An Estuary Ecosystem Classification that encompasses biogeography and a high diversity of types in support of protection and management. *African Journal of Aquatic Science* 45: 199-216.
- Van Niekerk, L., Taljaard, S., Lamberth, S.J., Adams, J.B., Weerts, S.P., & MacKay, C.F. (2022). Disaggregation and assessment of estuarine pressures at the country-level to better inform management and resource protection - the South African experience. *African Journal of Aquatic Science*. In Press.

Estuary types

The KZN climate, the coastal profile, and the size of coastal rivers contribute to the diversity of estuarine types in KZN. South Africa has nine estuary typologies (Van Niekerk et al., 2020), six occurring in KZN, namely Estuarine Lakes, Estuarine Bays, Predominantly Open, Large Temporarily Closed, Small Temporarily Closed and Large Fluvially Dominated systems. Each type is characterised by a range of process and morphology features that are often impacted by coastal pressures. The 76 estuaries in KZN account for two thirds (400km²) of the total 600km² of South African estuarine area. In particular, the North Coast has the greatest diversity of estuarine types and estuarine areas with the St Lucia and Kosi Estuarine Lake systems accounting for 90% (365km²) of KZN's estuarine area. This

assessment considered four estuary types (see Table 1) across the 69 KZN estuaries assessed (Table 2). These estuaries are an important part of the KZN ecological infrastructure and collectively support important and critical habitats such as salt marshes, mangroves, submerged macrophytes, reeds and sedges and many have associated swamp forests. These habitats, and their associated species and communities are under threat and influence the ecosystem threat status of the estuaries they characterise. In KZN, 45 estuaries are Endangered, 30 are Vulnerable and Durban Bay (not assessed here) is Critically Endangered (Van Niekerk et al., 2019).

Table 2. Key features of the four South African estuary types considered for this KZN EOP summary (From Van Niekerk et al., 2020)

Estuarine type	Area (ha)	% time mouth is open	Geomorphology	Ave. tidal range (m)	Max. water level determined by:	Typical salinity range	Sediment stability	Mean annual runoff (x 10 ⁶ m ³)
Large Fluvially Dominated (LFD)	100-3700	>90	Linear, highly restricted inlet	0.5-1.0	Mouth state	0-10	Riverine	370-10830
Predominantly Open (PO)	10-7500	90-100	Linear, restricted inlet	0.75-1.5	Tides	0-40	Stable	10-1790
Large Temporarily Closed (LTC)	>15	>50	Linear/funnel, highly restricted inlet	0.25-0.5	Mouth state	0-60	Mobile (breaching and floods)	1-280
Small Temporarily Closed (STC)	<15	<50	Linear/funnel, highly unrestricted inlet	0.15-0.3	Mouth state	0-30	Mobile (breaching and floods)	0.1-70

Table 2. KZN estuaries and their typologies considered for this summary. King Cetshwayo District Municipality estuaries highlighted

Estuary number	Estuary name	Estuary type	Estuary number	Estuary name	Estuary type	Estuary number	Estuary name	Estuary type
15	uMvoti	LFD	20	uMdloti	LTC	71	iKhandalendlovu	STC
11	uThukela	LFD	48	uMfazezala	LTC	63	iKongeni	STC
10	aMatigulu/iNyoni	PO	30	uMgababa	LTC	66	iMvutshini	STC
24	iSiphingo	PO	50	uMhlabashana	LTC	31	iNgane	STC
32	uMkhomazi	PO	18	uMhlali	LTC	5	iNhlabane	STC
8	uMlalazi	PO	21	uMhlanga	LTC	52	iNjambili	STC
22	uMngeni	PO	55	uMhlangomkhulu North	LTC	39	iNkomba	STC
57	uMzimkhulu	PO	69	uMhlangomkhulu South	LTC	74	iSandlu	STC
26	aManzimtoti	LTC	49	uMhlungwa	LTC	9	iSiyaya	STC
54	iDombe	LTC	29	uMsimbazi	LTC	75	iSolwane	STC
43	iFafa	LTC	76	uMthavuna	LTC	36	Rocky Bay	STC
53	iKhoshwana	LTC	56	uMthente	LTC	47	uMakhosi	STC
28	iLovu	LTC	45	uMthwalume	LTC	58	uMbango	STC
67	iMbizana	LTC	38	uMuziwezinto	LTC	73	uMbhoyibhoyi	STC
70	iMpenjani	LTC	44	uMvuzi	LTC	42	uMdesingane	STC
13	iNonoti	LTC	51	uMzumbe	LTC	40	uMkhumbane	STC
41	iSezela	LTC	19	uThongathi	LTC	46	uMnamfu	STC
25	iZimbokodo	LTC	34	aMahlongwa	STC	35	uMphambanyoni	STC
12	iZinkwazi	LTC	27	aManzanamtoti	STC	72	uMuntongazi	STC
60	iZotsha	LTC	17	Bob's Stream	STC	37	uMzimayi	STC
61	oHlangeni	LTC	59	iBhobhoyi	STC	16	uSetheni	STC
33	uMahlongwane	LTC	65	iBilanhlonhlo	STC	62	uVunguza	STC
14	uMdlotane	LTC	68	iKhaba	STC	64	uVuzana	STC

Summary of management actions

KwaZulu-Natal estuaries face multiple, often interacting threats which can be attributed to direct and indirect pressures on these systems. Seven main pressures influence KZN estuaries (Van Niekerk et al., 2019, 2022):

- 1. Freshwater flow modification**
- 2. Pollution**
- 3. Exploitation of living resources (plants and animals)**
- 4. Land-use and development (including estuary habitat modification)**
- 5. Mouth manipulation**
- 6. Sand mining**
- 7. Biological invasions (plants and animals)**

The declining state of KZN's estuaries has numerous impacts on estuary function, estuarine biotic communities and habitats, and the goods and services these systems provide to the people of KZN. The main impacts on KZN estuaries are from chronic pollution, changes to freshwater inflow, estuarine fisheries and estuary mouth manipulation, habitat loss and changes to natural communities through infestation of alien species and loss of ecosystem connectivity. Pressure impacts may be nonlinear and cumulative, cascade from organism to ecosystem-level and seem challenging to mitigate for and manage. However, there is a variety of tools currently available that can provide clear guidance for management actions, namely, existing policy and legislation, protocols and guides, the use of the EFZ as a management area and the instigation of KZN-specific estuary monitoring.

The KZN EOP assessment formulated several management responses and primary interventions which if implemented, will greatly improve the condition, health, function and intrinsic value of KZN estuaries. Healthy estuaries provide a diversity and abundance of goods and services to coastal communities. Although estuaries were individually assessed and specific actions noted for each, a summary of the important actions required is:

- **EMPs**
 - Develop EMPs for the majority of KZN estuaries
 - Ensure implementation of EMPs that are complete
 - Develop individual MMPs for estuaries with serial breaching requests, or previous instances of illegal breaching
- **EWRs**
 - Undertake EWR determinations. Specifically, where previous assessments were conducted >10 years ago and were rapid or desktop assessments using historical data
 - Ensure flow management includes river-dependent marine systems. These are particularly prevalent in KZN and contribute to important regional resources and biodiversity
 - Implement flow requirements of estuaries to improve hydrological and hydrodynamic conditions and improve water quality. In particular for systems that also receive wastewater and require an improvement in water quality. Increased flow will also limit macrophyte proliferation (including of invasive species)
 - Flow management must similarly consider unnatural flow augmentation to estuaries. An example is the uMhlanga Estuary, where implementation of the treated wastewater management plan should divert excess volume to the uMngeni catchment rather than to the system, which is now ecologically dysfunctional
- **Water quality management**
 - Declining water quality is one of the primary causes of estuary health decline. Improved water quality is a necessity to reduce and avoid eutrophication, nuisance plants, anoxia, fish kills and human health risks, all of which are noted impacts in many KZN estuaries

- Estuaries have reached their assimilative capacity and to prevent further degradation into a critical state, additional new wastewater disposal into estuaries should be avoided, including into the sensitive, upstream river-estuary transition zone which is an important animal movement corridor
 - Failing and aging sewerage infrastructure is responsible for spills into estuaries in most urban areas, and incidences are increasing. Municipalities must be encouraged to address this, especially in serially affected systems. New and alternate technologies are required to improve wastewater treatment and effluent water quality
 - Storm water management and control over illegal inputs into the KZN storm water system is not quantifiable but is certainly a source of poor water quality and even chemical pollution incidences in urban estuaries. Support should be given to local authorities to systematically survey storm water reticulation infrastructure to identify and remedy illegal connections
 - Solid waste in the form of plastic litter flowing into, and through, estuaries is significant and has far-reaching effects across the KZN coast. All authority support should be given to independent litter collection projects including litter boom initiatives, and beach clean-ups by NGOs and the public
- **AIS management**
 - Estuaries are increasingly affected by floating invasive plant species and the invasive snail *Tarebia granifera* is spreading southwards in KZN, being present in two thirds of estuaries. Alien invasive species proliferate in degraded systems. A provincial plan to document and monitor alien invasive plants, invertebrates and fishes in estuaries is a priority, as is a management plan, including creating public awareness on how to limit their spread and proliferation
- Terrestrial and floating macrophyte species control is undertaken using herbicides, particularly on the KZN South Coast. This is not environmentally safe or sustainable. Management plans must also investigate causes of infestation and suggest environmentally appropriate means of control, including mechanical removal (creating jobs) and the possibility of using the alien material for other technologies (e.g., biofuels)
- **Land-use change**
 - Activities adjacent to estuaries, in the EFZ, and even the surrounding catchment, are important for estuarine management if the ensuing pressures and impacts have direct bearing on an estuary. Land-use change recommendations have been suggested for specific KZN estuaries, but are aggregated to the following:
 - o Restore buffer zone habitat within 20m of an estuary to minimise flooding, improve estuary function, water quality and habitat diversity and enhance overall estuarine productivity
 - o Agricultural retreat from an estuary edge or to allow historical wetlands to restore and become functional supporting habitats to the estuary
 - o Managed retreat of low-lying development, to prevent periodic flooding during seasonal estuary mouth closure
 - o Land-use planning to avoid further encroachment of peri-urban development into the EFZ
 - o Retreat of unused sports fields to allow estuarine-associated natural habitats to rehabilitate
 - o Retreat of residential gardens from the EFZ to re-establish vegetation buffers of indigenous species that are flood-protecting

- **Estuary restoration**

- The decline in KZN estuarine health means that many estuaries have lost resilience and the capacity to absorb further impacts. Active restoration efforts need to be considered and implemented collaboratively with EMPs. A selection of individual recommendations across KZN estuaries are:
 - Restore EFZ wetlands to improve estuarine habitat diversity and quality, improve water quality and to support animal movement corridors
 - Remediation and restoration of estuaries following chemical spill impacts
 - Restore natural EFZ vegetation, commencing with the removal of water-dependent alien terrestrial species to improve habitat diversity and overall estuarine productivity
 - Restore buffer zone habitat within 20 m of an estuary to increase the natural filtration function, thereby conserving good water quality and high estuarine productivity
 - Restore instream estuarine habitats by improving water quality and removal of alien species to return natural estuarine function and increase conservation value

- **Structure removal**

- Many KZN estuaries have a legacy of various failed structural interventions (e.g., weirs, levees, erosion protection) or for manipulating flow (pipes and embankments) and remnant transport infrastructure after severe coastal flooding. These still impede the contemporary natural hydrodynamics of these systems. Where pertinent, individual actions are recommended for a system, examples are:
 - Decommission earth-wall dam to improve hydrology and hydrodynamics (Bob's Stream)
 - Remove dysfunctional mouth weir to improve hydrodynamics and facilitate a more natural mouth configuration (aManzimtoti)

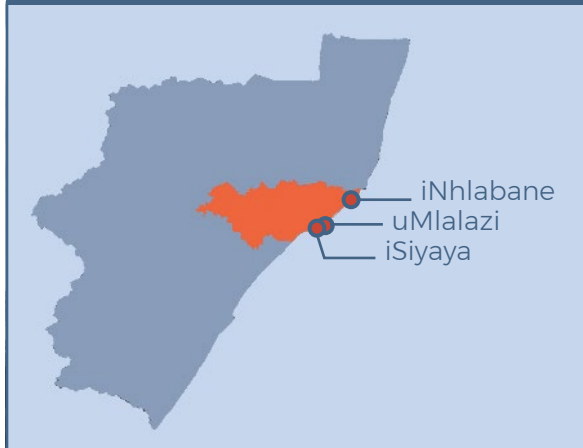
- Remove informal causeway to re-establish connectivity at the river-estuary interface (iLovu)
- Remove remnant sea wall to improve mouth dynamics (uMuziwezinto)
- Remove weir to restore natural estuarine area and function (uMdesingane)
- Remove informal road crossing at estuary head to restore connectivity and flow (uMthwalume)
- Remove sandbag weir in estuary middle reaches to restore connectivity and flow (iZotsha)
- Remove private property boundary fences from estuary channel (iZotsha, uVuzana, uMuntongazi)

- **Compliance monitoring and enforcement**

- There is room for improvement in monitoring and enforcement, across a range of activities, to avoid further estuarine habitat degradation, water quality deterioration and excess use of living marine resources in important nursery areas. The activities requiring attention are:
 - Fishing activities (recreational and subsistence use)
 - Poaching, in particular destructive gill netting which has increased significantly within and across estuaries of KZN
 - Sand mining, most (if not all) operations do not mitigate whilst mining or rehabilitate post mining, and it is difficult to ascertain which are permitted operations
 - Industrial and domestic wastewater disposal, the minimum standards required for each system are not reported in the public sphere (e.g., Green Drop Reports). Consistent infrastructure breakdowns have resulted in serious spills into estuaries. Also, daily operations do not seem to maintain a high effluent standard in many systems

- Littering and dumping is increasing, with urban systems receiving tons of solid waste that is transported out to KZN beaches and the ocean. KZN has a major litter crisis, and it has seriously affected sensitive coastal waterways and the marine environment
 - Across KZN estuarine habitats are cleared, including streambeds and banks for private developments or subsistence farming. These transgressions are prolific and are mushrooming particularly along the South Coast
 - Small, private water offtakes are increasing in rural estuaries. These can have large, deleterious effects on small estuaries
- **Artificial breaching**
 - Artificial breaching of estuary mouths remains a notable activity. The reasons for doing so are varied, ranging from protection of private property against flooding to recreational purposes (holiday makers). This is a highly degrading activity to an estuary and may alter the mouth dynamics in the long term if estuaries are not properly flushed leading to further mouth closures and breaching requests
- **Climate change mitigation and adaptation**
 - Rising sea levels, altered rain patterns (leading to changes in water quality, sedimentation etc.), drought, and ocean acidification threaten to degrade estuaries. Climate change research in South African estuaries is in its infancy, but KZN development and planning must align with work being undertaken for:
 - Estuary sea level rise and runoff modelled projections for various future time horizons
 - Local land-use development plans
 - Coastal management lines which will include the EFZ and a protection buffer
- **Education and awareness**
 - Public education and engagement are essential to build support for environmental conservation, restoration and to initiate behaviour changes. There are opportunities to provide education and engagement opportunities through awareness campaigns with the goal of building stewardship for KZN estuaries across the socio-economic and socio-cultural spectrum. A first step is good signage at key public points that discuss the environmental consequences of for e.g., littering and alien species introductions
- **Conservation and protection potential**
 - Despite the declining health status of many KZN estuaries, some are still excellent nursery areas and biodiversity hubs in good condition. These must be formally recognised and if not already afforded levels of protection, should be included in future coastal-marine spatial planning initiatives

King Cetshwayo District Municipality



Type: Small Temporarily Closed
Length: 3,0 Km
EFZ Area: 1875,7 ha
Local Authority: Mbonambi

5. iNhlabane Estuary



Present Health Score: E Trajectory: Stable

Important habitats and features

- Swamp forest including *Barringtonia racemosa* and *Hibiscus tiliaceus*
- Supratidal saltmarsh
- Aquatic vegetation including submerged aquatic *Ceratophyllum demersum*, *Potamogeton* spp. floating *Nymphaea* spp., *Ruppia cirrhosa*
- Sand prawn *Kraussillichirus kraussi* in the lower reaches
- Barebreast goby *Silhouettea sibayi* (EN)
- African finfoot *Podica senegalensis* (VU)

Uses

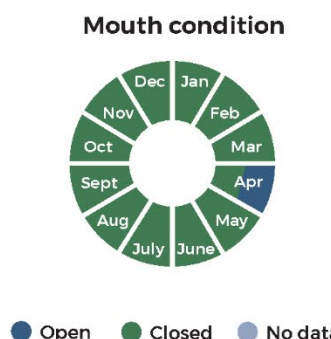
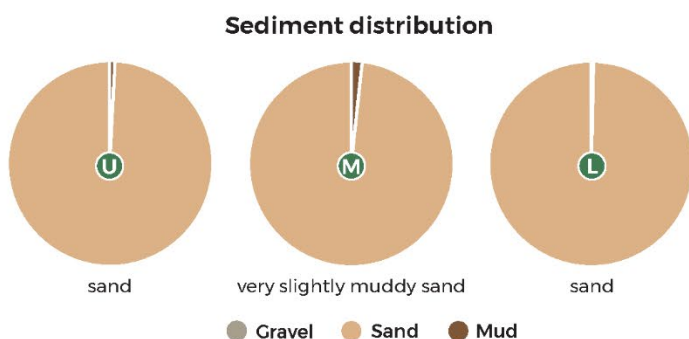
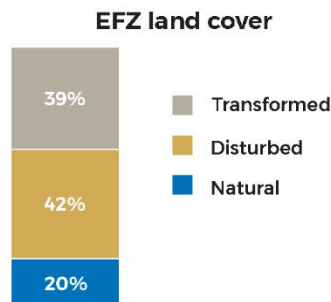
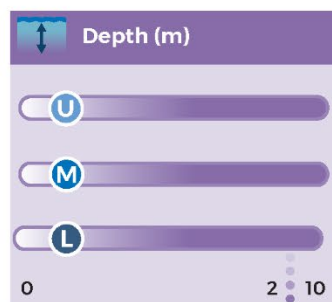
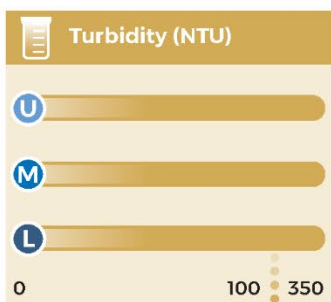
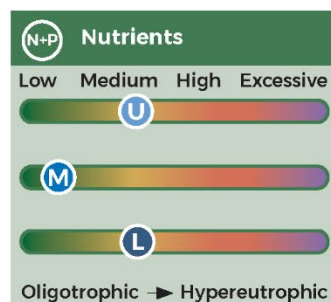
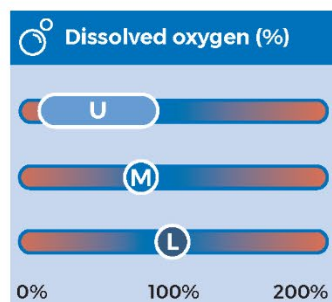
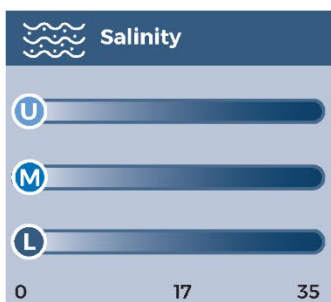
- Freshwater supply (dune mining, domestic use, small growers)
- Rural settlement
- Forestry (independent growers)
- Commercial agriculture (sugarcane)
- Subsistence farming (horticulture) and livestock watering
- Subsistence fishing (line fishing)
- Hunting with dogs
- Beach driving
- Raw materials (sand and heavy minerals)

Pressures and threats

- Severe habitat modification and flow manipulation due to mining operations (including barrage construction) and domestic abstraction
- Loss of connectivity (barrage in upper reaches artificially disconnected lake system from the estuary)
- Pollution: Eutrophication leading to algal blooms. Littering
- Very high fishing pressure, including poaching (gill netting)
- FIMs: *Pistia stratiotes*, *Spirodela punctata*
- ALS (fauna): Snail *Tarebia granifera*
- Influences on human health: bilharzia vector snails (*Bulinus* and *Biomphalaria* spp.)
- Climate change (sea level rise, altered runoff, changes to habitats and biota)

Management response and primary intervention/s

- Requires EMP
- Undertake EWR determination (DWS)
- Removal of reservoir barrage separating upper estuary and southern lake basin to restore estuarine hydrodynamics, estuarine lake function, and connectivity for estuary fauna movement
- Interim measure is to restore the fish ladder functionality
- CME of fishing and poaching
- Climate adaption: align with estuary SLR and runoff models, land-use development plans and coastal management lines



Type: Predominantly Open
Length: 12,4 Km
EFZ Area: 1851,7 ha
Local Authority: uMlalazi

8. uMlalazi Estuary



Present Health Score: **B** Trajectory: Declining

Important habitats and features

- Partially protected, Umlalazi Nature Reserve (part of Siyaya Coastal Park)
- Most functional, least modified Predominantly Open KZN estuary
- Swamp forest including *Barringtonia racemosa* and *Hibiscus tiliaceus*
- Mangroves including *Avicennia marina* and *Bruguiera gymnorhiza*
- Lower intertidal including *Sarcocornia natalensis* and *Triglochin striata*, and supratidal saltmarsh
- Aquatic vegetation including submerged macrophyte *Zostera capensis* (rare in KZN)
- Penaeidae prawns, *Penaeus indicus*, *P. monodon*, *Metapenaeus monoceros*, burrowing mud crab *Paratylodiplax blephariskios*, crown crab *Hymenosoma* spp. swimming crabs *Scylla serrata* and *Varuna litterata*
- Critical fish nursery for estuarine dependent species, dusky kob *Argyrosomus japonicus* (EN), estuarine bream *Acanthopagrus vagus* (VU), mangrove snapper *Lutjanus argentimaculatus* and spotted grunter *Pomadasys commersonnii*. Also, juvenile brindle bass *Epinephelus lanceolatus*, barebreast goby *Silhouettea sibayi* (EN), sleeper gobies *Eleotris* spp., tropical sand goby *Favonigobius reichei* and bellybarred pipefish *Hippichthys spicifer*
- African finfoot *Podica senegalensis* (VU)
- Nile crocodile *Crocodylus niloticus* (VU)

Uses

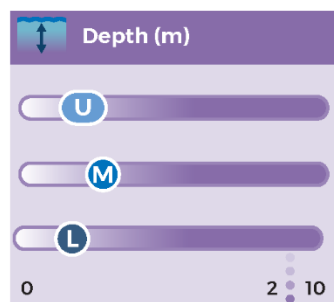
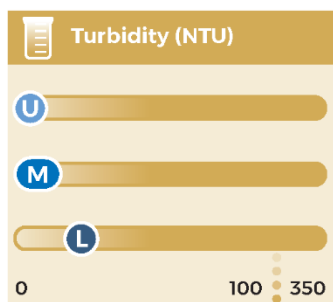
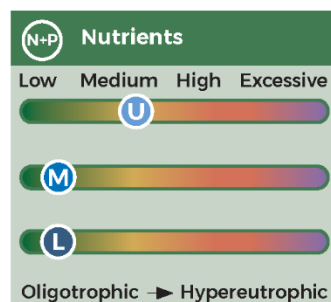
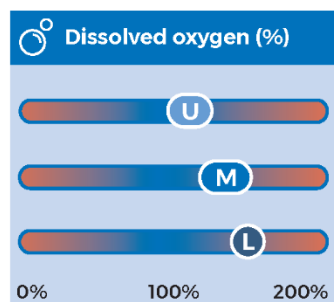
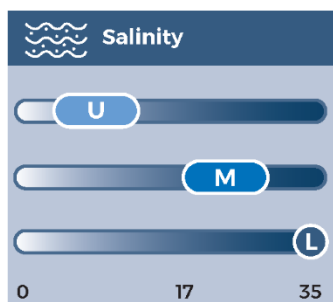
- Biodiversity conservation and ecosystem resilience
- Rural settlement, urban and suburban infrastructure
- Freshwater supply
- Waste disposal and assimilation: Small WWTW (1.54 Ml/day)
- Aquaculture (prawns and *Argyrosomus japonicus*) and commercial agriculture (sugar cane)
- Tourism and recreation (boat launch site, paddling, swimming, line fishing)
- Subsistence farming (horticulture)
- Subsistence fishing (line fishing, cast netting)
- Raw materials (sand, reeds)

Pressures and threats

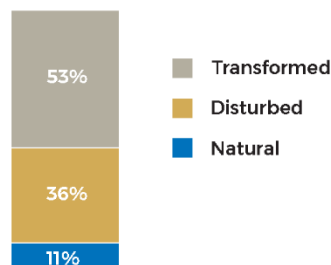
- High overall land-cover change in upper reaches (formal/informal residential development, agriculture)
- Freshwater abstraction (aquaculture)
- Pollution: Urban wastewater disposal. Aquaculture wastewater disposal, possible route for species introductions. Incidental diesel spill. Nurdles (2017 spill). Littering
- FIMs: *Spirodela punctata*
- AIS (fauna): Snail *Tarebia granifera*, bass *Micropetrus* spp.
- Exploitation of marine living resources (reeds, prawns, fishes), and poaching (gill netting)
- Sand mining: Low pressure – small ephemeral operations for local use
- Climate change (sea level rise, altered runoff, changes to habitats and biota)

Management response and primary intervention/s

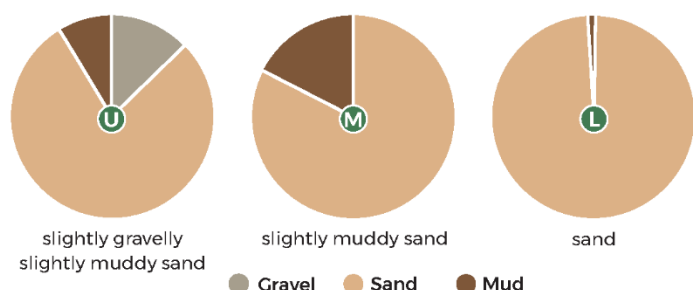
- Requires EMP development
- Undertake EWR determination (DWS). Rapid assessment in 2015
- Agricultural retreat to restore wetland function and connectivity
- CME of fishing and poaching
- Climate adaption: align with estuary SLR and runoff models, land-use development plans and coastal management lines



EFZ land cover



Sediment distribution



Mouth condition



8. uMlalazi Estuary



Habitats and features		Swamp forest
		Mangroves
		Intertidal saltmarsh
		Aquatic vegetation
		Important prawns
		Important crabs
		Important fish
		Important birds
		Crocodiles
Uses		Urban infrastructure
		Suburban infrastructure
		Rural settlement
		Freshwater supply
		Forestry
		Commercial cultivation
		Subsistence farming
		Aquaculture
		Tourism
		Recreation
		Boat launch site
		Motorised watercraft
		Paddling
Pressures and threats		Freshwater abstraction
		Pollution
		Solid waste / litter
		FIMs
		Invasive invertebrates
		Invasive fish
		Gill netting
		Sand mining
		Climate change
		Protected area / conservation
		Reed harvesting
		Subsistence fishing
		Recreational fishing



Type: Small Temporarily Closed
Length: 2,8 Km
EFZ Area: 90,4 ha
Local Authority: uMlalazi

9. iSiyaya Estuary



Present Health Score: **E** Trajectory: Declining

Important habitats and features

- Located within the Siyaya Coastal Park, but estuary has no formal connection status
- EFZ habitat largely natural (94%), dominated by coastal forest
- Swamp forest including *Barringtonia racemosa* and *Hibiscus tiliaceus* as a result of extensive restoration project during 1980s
- Natural frontal dune succession along a prograding coast. Frontal dunes intact
- Supratidal saltmarsh
- Sand prawn *Kraussillichirus kraussi* in the lower reaches
- Barebreast goby *Silhouettea sibayi* (EN), sleeper gobies *Eleotris* spp., and historical records of estuarine bream *Acanthopagrus vagus* (EN)
- African finfoot *Podica senegalensis* (VU)
- Nile crocodile *Crocodylus niloticus* (VU)
- African clawless otter *Aonyx capensis* (NT)

Uses

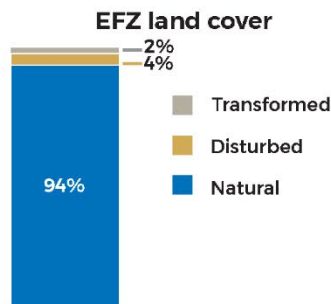
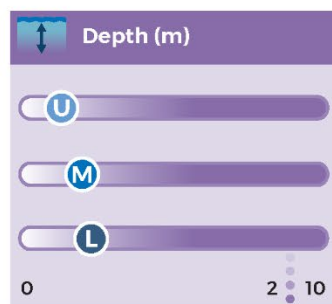
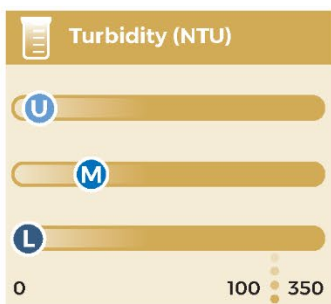
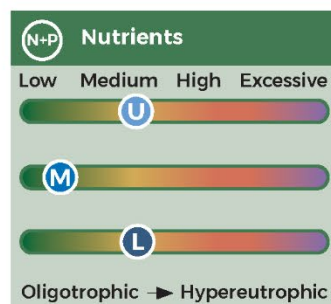
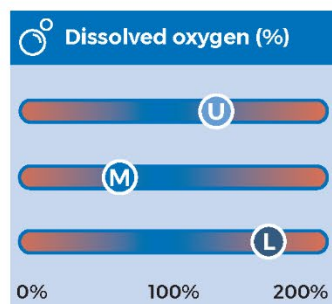
- Highly influenced by catchment heavy mineral mining
- Waste assimilation: Small WWTW (0.38 Ml/day). Mine wastewater runoff. Littering
- Tourism and recreation
- Catchment forestry

Pressures and threats

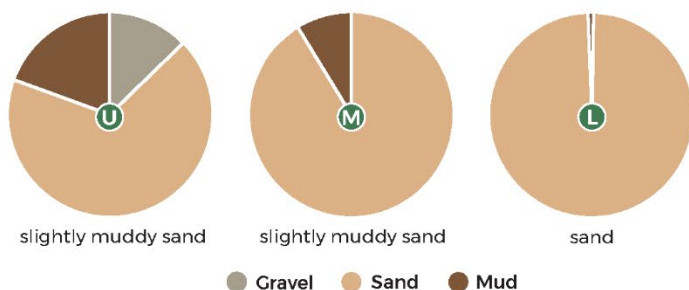
- High land-cover transformation in catchment areas for commercial timber plantation and sugar cane
- Severely diminished freshwater flows and compromised hydrodynamics lead to excessively long closure periods
- Loss of connectivity (weir in upper reaches)
- Pollution: Wastewater disposal. Poor water quality (turbidity and eutrophication). Excess siltation (mining) and nutrient inputs (wastewater seepage) leads to extensive reed encroachment (*Phragmites australis*). Littering
- FIMs: *Azolla filiculoides*, *Ceratophyllum demersum*, *Spirodela punctata*
- AIS (fauna): Snail *Tarebia granifera*, *Tilapia* fish spp.
- Climate change (sea level rise, altered runoff, changes to habitats and biota)

Management response and primary intervention/s

- Requires EMP development
- Undertake EWR determination (DWS). Rapid assessment in 2006
- Increase freshwater flow to improve water quality and limit *Phragmites australis* expansion. Improve water quality to limit macrophyte proliferation (including invasive species)
- Signage for public education and awareness of the effects of alien species
- Climate adaption: align with estuary SLR and runoff models, land-use development plans and coastal management lines



Sediment distribution



Mouth condition



9. iSiyaya Estuary



Habitats and features	Uses	Pressures and threats			Reed encroachment
Coastal forest	Forestry	Impoundment / connectivity	Reed encroachment		
Natural foredunes	Commercial cultivation	Flow reduction	Heavy mineral mining		
Swamp forest	Tourism	Altered hydrodynamics	Climate change		
Supratidal saltmarsh	Recreation	Pollution			
Important prawns	Subsistence fishing	Poor water quality			
Important fish		Solid waste / litter			
Important birds		FIMs			
Crocodiles		Invasive invertebrates			
African clawless otter		Invasive fish			

