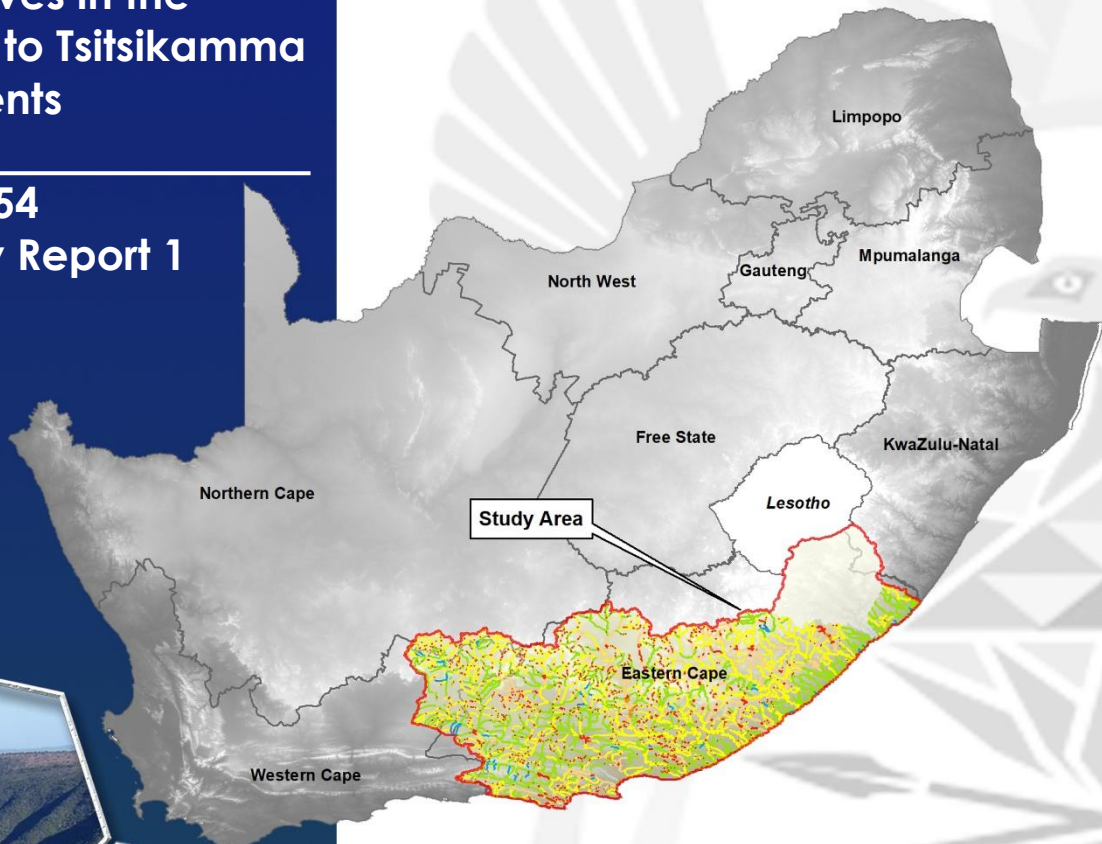


DEPARTMENT OF WATER AND SANITATION

Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments

WP11354 Estuary Survey Report 1



REPORT NO.:
WEM/WMA7/00/CON/RDM/1022

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DOCUMENT INDEX**Reports as part of this project:****Bold type indicates this report**

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3.0	WEM/WMA7/00/CON/RDM/0322	Status quo and delineation of Integrated Units of Analysis Report
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LIST OF ACRONYMS

DWS	Department of Water and Sanitation
EI	Ecological Importance
EFZ	Estuarine Functional Zone
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
NWA	National Water Act No 36 of 1998
RDM	Resource Directed Measures
RQO	Resource Quality Objectives
PES	Present Ecological State
WWTW	Wastewater Treatment Works
WMA	Water Management Area
WRCS	Water Resources Classification System

1. INTRODUCTION

1.1 Background

The National Water Act, 1998 (No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without affecting the functioning of water resource systems. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM). These measures are protection-based and include Water Resource Classification, determination of the Reserve and setting the associated Resource Quality Objectives (RQOs). These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing economic development. The provision of water required for the maintenance of the natural functionality of the ecosystem and provision of Basic Human Needs (BHN) is the only right to water in the National Water Act (No. 36 of 1998) (NWA). The other water users from a strategic use who are second in line to other water users are subject to formal gazetted General Authorization and water use authorization as per Section 21 of the NWA.

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems and that the essential needs of individuals that are directly dependent on these water resources.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA7) are amongst many waters stressed catchments in South Africa. These areas are important for conservation and have recognisable protected areas, natural heritage, cultural and historical sites that require protection. However, water use from surface as well as groundwater for agricultural and domestic purposes are high, especially in the more arid catchments, impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities.

Water transfers into the study area from adjacent WMAs and within the study area as well as the numerous storage dams change the flow patterns, impacting on the estuary physical habitats and biota.

Thus, the main purpose of the study is to determine appropriate Water Resource Classes, the Reserve and associated RQOs for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity.

The aim is to:

- implement the Water Resource Classification System (WRCS) (Regulation 810, 2010) to determine the Water Resource Classes,
- follow the integrated framework (DWS, 2017),
- undertake the 7-step process to determine and set RQOs, and
- determine the Reserve for the water resources of the study area.

This will ultimately assist the DWS in the management of the water resources in the study area and making informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

1.3 Purpose of this report

This report provides an overview of the first estuary surveys undertaken from 18 October - 4 November 2022. It provides information for each priority estuary resource unit (RU) identified in the Keiskamma, Fish to Tsitsikamma catchment areas for this study, coupled with the Reserve level assessment for the river reach.

2. METHODS

The following section provides an overview of the methods adopted. It should be noted that this fieldwork report should be read in conjunction with Resource Units Prioritisation Report (WEM/WMA7/00/CON/RDM/0422), which highlights the selection process for the estuary RUs, and as such, the methods associated with the selection process has not been repeated in this report.

Appropriate and relevant procedures as prescribed by the Department of Water and Sanitation (DWS) were selected by system for the undertaking of intermediate and rapid level determinations. These levels of assessment are described as follows:

- (i) **Intermediate** – mouth state, water quality at three sites which includes both in-situ physico-chemical parameters (GPS position, depth, temperature, pH, salinity, dissolved oxygen and turbidity) as well as laboratory analysis for pathogens, nutrients (nitrates, nitrites, ammonia and phosphates) and chlorophyll *a* concentrations to assess microalgal, high level botanical survey used to cross check against existing botanical importance rating scores, benthic macroinvertebrates, aquatic birds.
- (ii) **Rapid** – mouth state, water quality at 1-3 sites (depending on accessibility) which includes both in-situ physico-chemical parameters (GPS position, depth, temperature, pH, salinity, dissolved oxygen and turbidity) as well as laboratory analysis for pathogens, nutrients (nitrates, nitrites, ammonia and phosphates) and chlorophyll *a* concentrations to assess microalgal, physical habitat descriptions with impacting activities noted and aquatic bird survey.

2.1 Site visit

The estuarine field survey for this study was conducted from the 19 October 2022 to undertake the Intermediate and Rapid level assessments at the identified priority RUs throughout the Keiskamma, Fish to Tsitsikamma catchment areas. Refer to Appendix A for the field survey programme which was followed. Two of the RUs chosen for rapid assessment were inaccessible as part of this survey, viz Elands and Groot East and one additional site was included viz Morgan's Estuary as the estuary was a good candidate for an additional rapid survey.

3. PRIORITY RESOURCE UNITS AND RESERVE LEVEL ASSESSMENT CONDUCTED DURING THE FIELD SURVEY

Refer to Table 3-1 and

Figure 3-1 **Error! Reference source not found.** for the list of priority RUs identified for the study and a map respectively. The table includes information regarding the proposed Reserve level and quaternary catchments, coupled with their newly assessed Reserve level and quaternary catchments following site selection. Comments are further provided as to the reason behind downgrades or upgrades of the Reserve level.

In addition, refer to **Error! Reference source not found.** for those supplementary sites where field verifications were undertaken. This included measuring the *in situ* water quality, obtaining a diatom sample and running the Index of habitat Integrity (IHI) for additional information regarding the catchments.

Table 3-1: Estuary Sites per IUA

IUA	IUA Description	RU No.	Estuary	Quaternary catchment	Proposed Reserve Level	Following site selection		
						Surveyed Quaternary catchment	Upgrade and downgrade of Reserve Level	Reason
IUA_T04	Xora	E_RU14	Xora	T80D	Rapid	T80D	Rapid	No Change
IUA_T02	Mbashe	E_RU13	uMbashe	T13E	Rapid	T13E	Rapid	No Change
IUA_SO3	Great Kei	E_RU12	Great Kei	S70F	Intermediate	S70F	Intermediate	High flow freshette came through on the morning of our proposed sampling.
	Morgans		Morgan's	R30A	Not originally a priority RU	R30A	Rapid	Loss of Papkuils and pickup an estuary which is small, very tidal, at a tourism node with potential impacting activities
IUA_R01	Gxulu	E_RU11	Gxulu	R40A	Rapid	R40A	Rapid	No Change
	Keiskamma	E_RU10	Keiskamma	R10M	Rapid	R10M	Rapid with increased bird surveys during second field verification	Significant intertidal habitats, sandbanks and salt marsh provide a high quality feeding area for Palearctic wading birds which had begun to arrive during this survey. End of summer survey proposed.
IUA_N01	Sundays	E_RU09	Sundays	N40F	Intermediate	N40F	Intermediate	No change
IUA_M01	Swartkops	E_RU08	Swartkops	M10D	Rapid	M10D	Rapid	No change
	Papkuilsrivier	E_RU07	Papkuils	M20A	Rapid	M20A	Field Verification	This is no longer an estuary but an artificial drainage channel out to the sea.

IUA	IUA Description	RU No.	Estuary	Quaternary catchment	Proposed Reserve Level	Following site selection		
						Surveyed Quaternary catchment	Upgrade and downgrade of Reserve Level	Reason
IUA_P	Bushmans	E_RU06	Bushmans	P10G	Rapid	P10G	Intermediate	This is an important estuary system with a very good stakeholder network. High recreational use and dynamic processes which result in environmental and user conflict. High socio-economic importance with a number of estuary issues including mouth dynamics, dune stabilisation, proposals for dredging and desalination with both abstraction of water and discharge of brine. Also adds value to balance the loss of the Papkuils system.
IUA_KL01	Kromme	E_RU05	Kromme	K90E	Rapid	K90E	Rapid	No change
	Kabeljous	E_RU04	Kabeljous	K90G	Rapid	K90G	Rapid	No change
	Gamtoos	E_RU03	Gamtoos	L90C	Intermediate	L90C	Intermediate	No change
IUA_K01	Elands	E_RU02	Elands	K80C	Rapid	K80C	Field verification	Estuary still unimpacted but indirect plantations to edges of steep cliffs
IUA_K01	Groot (Oos)	E_RU01	Groot (Oos)	K80D	Rapid	K80D	Field verification	Estuary still unimpacted but indirect plantations to edges of steep cliffs



Figure 3-1: The EWR sites for the estuarine field survey in October/November 2022

4. ESTUARY SURVEY TEAMS

Table 4-1 includes the list of specialists which conducted the survey, along with a team of DWS members for capacity building purposes.

Table 4-1: Estuary survey teams

Specialist team	DWS team	Additional capacity building colleagues
Nicolette Forbes (estuary scientist)	Lawrence Mulangaphuma	
Anthony Forbes (Prof) (estuary scientist)	Adaora Okonkwo	
Rachel Parker (MER Field Assist)		
Sphamandla Gabela (Bird specialist)		

5. ESTUARY SURVEY SITE DETAILS: INTERMEDIATE SITES

5.1 Great Kei

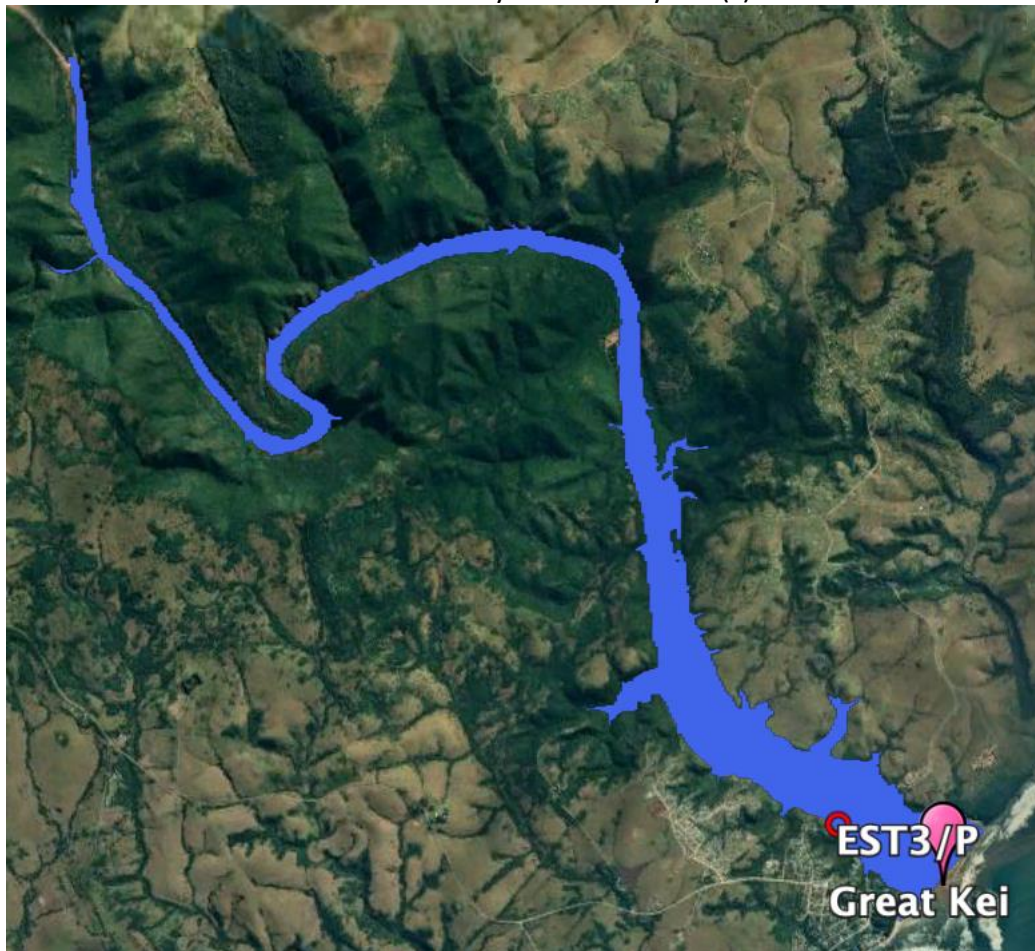
Site could not be surveyed owing to the river being in flood and further sampling will be undertaken in Survey 2.

Sample Date	24 October 2022	Reserve Level Assessment	Intermediate
Site Name	EST3/P	IUA	IUA_S03
Estuary	Great Kei	IUA description	Great Kei
Estuary type	Warm Temperate - Large Fluvially Dominated	Prioritised RU	E_RU12_I
Altitude (m.a.s.l.)	0	Quaternary catchment	S70F
Longitude	28.995188	Latitude	-32.159140
PES	C – Moderate	Conditions during sampling	100 mm of rainfall fell in Queenstown area the night before sampling resulting in a strong outflow from the river. No boating possible so intermediate sampling will need to occur in March
Components currently impacting PES	Hydrological score extremely low (E) and declining habitat health, microalgae, invertebrates and fish	Pressures	Hydrological modifications, alien fish and fishing pressure, WWTW from Keimond
Ecological Importance	High Importance with notable fish nursery and biodiversity		
Noted features	Fairly high turbidities during the freshette. EFZ largely intact.	Other potential impacting activities	Pont operates across the estuary linking the two areas on opposite banks. High recreational usage for fishing. High

			impact for estuarine fish populations.
--	--	--	--

Components sampled:
In Situ water quality, water quality (laboratory) for nutrients, pathogens. Chlorophyll-a for microalgal biomass, birds

EFZ delineation of estuary with survey site(s) indicated



Looking towards mouth



Looking upstream from pont harbour



Salt marshes flooded – Eurasian Whimbrel foraging in adjacent flooded grass area

Site Description:

A large estuary with minimal direct impacts within the EFZ. Large and important salt marsh areas exist and increase the functional importance of this estuary. Site on the flooding estuary was the Pont/Skiboat base area where a jetty allowed access to slightly deeper water than the margins.

Site impacts:

- Some bank interference at Pont site/skiboat launch and base.
- Jetty construction in the intertidal area
- WWTW discharge from Keimond

Preliminary Results

In situ water quality:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.30	23.14	8.07	0.13	8.59	102.7	281.2
0.57	23.1	8.04	0.13	8.6	102.8	280.5

Other comments:

This is a large system that will require much longer time allocated to sample in March to complete the intermediate level assessment.

5.2 Sundays

Sample Date	27 October 2022	Reserve Level Assessment	Intermediate
Site Name	EST8/2; EST8/3; EST8/4	IUA	IUA_N01
Estuary	Sundays	IUA description	Sundays downstream Darlington Dam
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU09_I
Altitude (m.a.s.l.)	0	Quaternary catchment	S70F
Longitude	25.832028	Latitude	-33.691772
PES	C – Moderate	Conditions during sampling	Clear weather, warm. Estuary with open mouth conditions.
Components currently impacting PES	The current state is being reduced by low water quality scores, microalgae, invertebrates and vegetation		
Ecological Importance	Important		
Noted features	<p><i>Krausillichirus kraussi</i> burrows obvious during sampling. Large mobile dunefields on the south bank and the reserve area upstream on the same side provide excellent estuary support habitats. South bank part of Addo protected area with important estuary support habitats including major dunefields (Alexandria) at the mouth</p> <p>Significant numbers of jetties from each private dwelling along the north bank accompanied by large revetments and bank stabilisation structures a negative aspect.</p>		

Components sampled: *In Situ* water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, benthic macroinvertebrates, waterbirds

EFZ delineation of estuary with survey site(s) indicated



Launch site to sample



Launch site and jetty north bank

<p>South bank with high quality habitat</p>	<p>South bank with high quality habitat</p>
<p>Extensive jetty and revetment Development significantly modifying marginal shallow habitats along the north bank</p>	<p>Revetments increasing along the estuary margins</p>
<p>Site Description: The estuary was accessed from the north bank launch site and sample sites were positioned upstream and downstream from this point towards the mouth and head of the estuary. The most obvious differences are the contrasts between land use on the north and south banks with Colchester village on the north and an extension of Addo National Park on the south. The banks along the developed margin are significantly modified with revetments, jettys and numerous other structures. Burrows of sandprawn were noted throughout the sampling reach. Water quality (in-situ) and sediment samples were taken at all three sites. Macroinvertebrate samples were taken from across the estuary width at all three sites. Birds were counted using standard methods but it was noted that abundance seemed low.</p>	
<p>Site impacts:</p> <ul style="list-style-type: none"> • High intensity modification of banks (northern) • Jetty construction in the intertidal area • WWTW discharge from Keimond 	

Preliminary Results						
<i>In situ</i> water quality EST8/2:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.1	23.79	8.15	21.31	6.16	60.1	11.62
1.61	21.77	8.07	30.16	5.05	49.9	59.46
<i>In situ</i> water quality EST8/3:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.13	23.07	8.09	26.44	7.21	71.4	12.32
0.71	22.63	8.07	27.08	7.06	69.7	12.27
<i>In situ</i> water quality EST8/4:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.03	24.01	8.18	15.79	5.62	53.2	11.96
2.01	22.41	8.09	23.54	3.39	32.6	161.2
Other comments:						

5.3 Gamtoos

Sample Date	31 October 2022	Reserve Level Assessment	Intermediate
Site Name	EST12/1; EST12/2; EST12/3	IUA	IUA_KL01
Estuary	Gamtoos	IUA description	Kromme from Kromme Dam to estuary and Gamtoos
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU03_I
Altitude (m.a.s.l.)	0	Quaternary catchment	L90C
Longitude	25.832028	Latitude	-33.691772
PES	B/C – Near Natural	Conditions during sampling	Slightly cloudy weather but warm. Estuary with open mouth conditions.
Components currently impacting PES	The current state is estimated to be near natural but examination of the loss of EFZ habitat suggests this score should be lower. The PES is pulled down by macrophytes, followed by water quality, hydrology, habitat health and microalgae.	Pressures	Increasing flow modification, pollution, major agricultural development and roads within the EFZ
Ecological Importance	High Importance	Importance increased by adjacent protected area in the lower EFZ and fish nursery significance, also an IBA	
Noted features	Disturbance of estuary margins with infrastructure, bridge crossings, intensive agriculture along canalised margins of estuary channel, contrast with more natural boundaries of lower estuary.		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, benthic macroinvertebrates, waterbirds			





EFZ delineation of estuary with survey site(s) indicated



Launch site to sample




Launch site and jetty north bank

	
<p style="text-align: center;">South bank in the lower estuary with high quality habitat</p>	<p style="text-align: center;">South bank in lower estuary with high quality habitat</p>
	
<p style="text-align: center;">Bridges and pipelines cross the estuary</p>	<p style="text-align: center;">Revetment along the estuary margins in the mid estuary</p>
<p>Site Description: The estuary was accessed from the ferry hotel launch site and sample sites were positioned downstream from this point towards the mouth of the estuary. Water quality (in-situ) and sediment samples were taken at all three sites. Benthic macroinvertebrate samples were taken from across the estuary width at all three sites. Birds were counted using standard methods but it was noted that abundance seemed low.</p>	
<p>Site impacts:</p> <ul style="list-style-type: none"> • Canalisation of estuary channel and elimination of large portions of EFZ from functional system through agricultural development • Bridges and some encroachment by private dwellings • Rubble along banks from road construction and stabilisation in mid-estuary 	

Preliminary Results						
<i>In situ</i> water quality EST12/1:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.18	20.71	8.1	34.94	7.65	71.8	3.93
2.47	17.93	8.19	35.56	7.74	69.4	5.87
<i>In situ</i> water quality EST12/2:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.23	21.4	8.11	33.74	7.78	73.4	4.55
1.61	20.67	8.14	35.04	7.69	72.2	7.08
<i>In situ</i> water quality EST12/3:						
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.23	21.4	8.11	33.74	7.78	73.4	4.55
1.61	20.67	8.14	35.04	7.69	72.2	7.08
Other comments:						

6. ESTUARY SURVEY SITE DETAILS: RAPID LEVEL

6.1 Xora Estuary

Sample Date	22 October 2022	Reserve Level Assessment	Rapid
Site Name	EST2/1	IUA	IUA_T04
Estuary	Xora	IUA description	Pondoland Coastal
Estuary type	Subtropical - Predominantly Open	Prioritised RU	E_RU14_R
Altitude (m.a.s.l.)	0	Quaternary catchment	T80D
Longitude	25.832028	Latitude	-33.691772
PES	A/B – Near Natural	Conditions during sampling	Sunny and warm. Estuary with open mouth conditions.
Components currently impacting PES	The current state is estimated to be near natural with a declining fish score	Pressures	Fishing pressure on estuary considered to have resulted in a degraded score of C.
Ecological Importance	Important	Fish nursery considered more important than the average	
Noted features	Mangroves dominated by <i>Avicennia marina</i> but also comprising <i>Bruguiera gymnorrhiza</i> and <i>Rhizophora mucronate</i> . African Oystercatcher using the mouth margins of the estuary and adjacent beaches.		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
View from sampling site of lower estuary			

EFZ delineation of estuary with survey site(s) indicated



Overview of Xora Estuary from south bank



Intertidal shoreline with mangrove fringe and island upstream of mouth



Abandoned development at the mouth of the Xora estuary

Site Description:

This is a beautiful estuary with natural surroundings and an intact EFZ. The site at the mouth provided a vista of the lower estuary with mangroves fringing the south bank and an intertidal island also comprised of mangroves just upstream of the mouth. An extremely clear system at the time of sampling. Very low intensity residential/holiday development on the south bank at the mouth. It was interesting to note that an attempt to develop a tourism facility just slightly back from the mouth had stalled (according to a local resident about three years prior).

Site impacts:

- Slight modifications of the south bank with jetties and skiboat launch site with lawn
- Skiboating/fishing in the low energy bay upstream of the mouth causing some wake erosion



Preliminary Results

In situ water quality EST2/1:

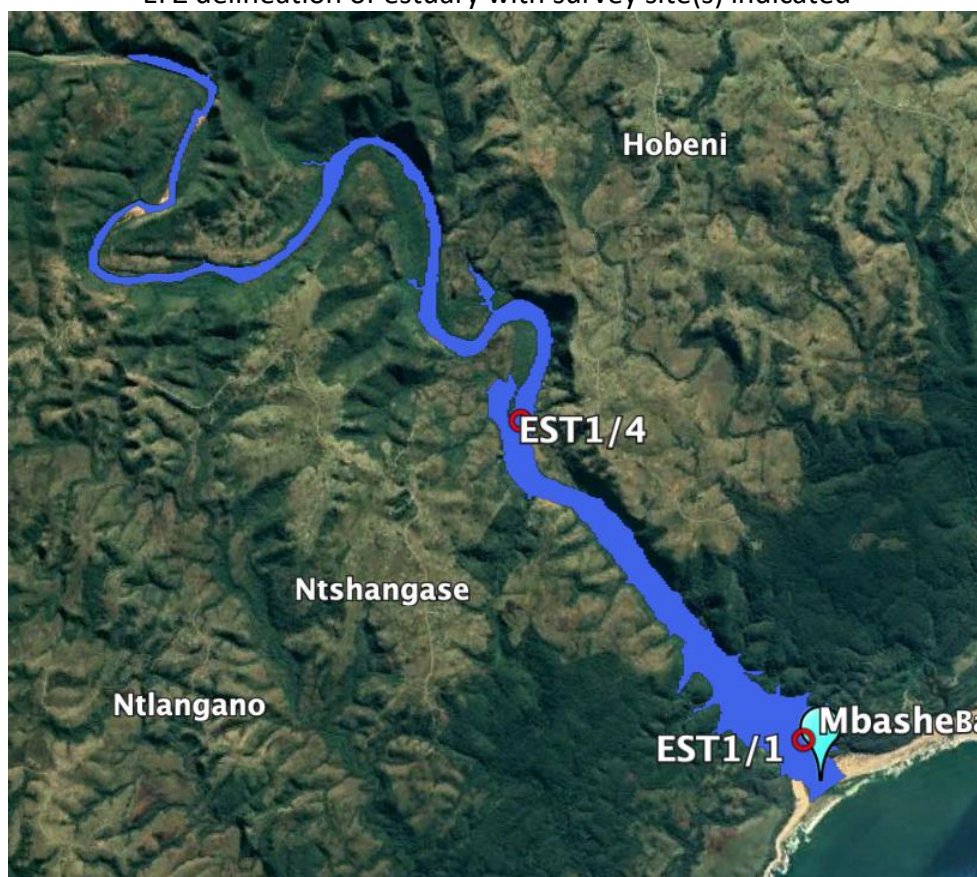
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.18	20.71	8.1	34.94	7.65	71.8	3.93
2.47	17.93	8.19	35.56	7.74	69.4	5.87

Other comments:

6.2 uMbashe Estuary

Sample Date	22 October 2022	Reserve Level Assessment	Rapid
Site Name	EST1/1; EST1/4	IUA	IUA_T02
Estuary	uMbashe	IUA description	Pondoland Coastal
Estuary type	Subtropical - Large Fluvially Dominated	Prioritised RU	E_RU13_R
Altitude (m.a.s.l.)	0	Quaternary catchment	T13E
Longitude	25.832028	Latitude	-33.691772
PES	B – Near Natural	Conditions during sampling	Sunny and warm. Estuary with open mouth conditions.
Components currently impacting PES	The current state is estimated to be near natural with a significantly depressed fish score	Pressures	Very high fishing pressure and the presence of alien fish species result in a significant drop in the fish health scores.
Ecological Importance	High Importance	In an MPA, with formal PA status on adjacent banks of the lower estuary as well as an IBA with a highly rated priority fish nursery function	
Noted features	Mangroves dominated by <i>Avicennia marina</i> but also comprising <i>Bruguiera gymnorrhiza</i> and <i>Rhizophora mucronate</i> . African Oystercatcher using the mouth margins of the estuary and adjacent beaches.		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
View towards lower estuary showing the significant coastal forest (Dwesa-Cwebe) surrounding the mouth area.		Surrounding forests of lower estuary showing the significant coastal forest reserve (Dwesa-Cwebe) surrounding the mouth and lower estuary.	



EFZ delineation of estuary with survey site(s) indicated





uMbashe Estuary lower sampling
site on north bank

Site Description:

The uMbashe estuary has always been considered a significant boundary between the sub-tropical and temperate estuaries. The estuary mouth area was accessed from the north bank which provided views from the mouth and upstream to the mangrove tree community. Sampling of water quality (*in situ* phys-chem and nutrient/pathogens) was undertaken as well as samples for microalgae (through measured Chlorophyll-a concentration) and birds were recorded. Observations around the mangroves indicated no young tree recruitment nor typical mangrove fauna usually associated with mangrove tree species.

						
<p>Mangrove stand with clumps of <i>Juncus kraussii</i> in the foreground.</p>	<p>Avicennia marina with <i>Sesarma</i> spp crab burrows in the foreground</p>					
<p>Site impacts:</p>						
<ul style="list-style-type: none"> • No obvious site impacts but noted that fishing effort intensifies during holiday seasons. • Community utilisation of the estuary was observed with fisherman using the mangroves to dig for bait and possibly harvesting wood for fishing poles 						
<p>Preliminary Results</p>						
<p><i>In situ</i> water quality EST2/1:</p>						
<p>Depth m</p>	<p>Temp °C</p>	<p>pH units</p>	<p>Salinity PSU</p>	<p>HDO mg/l</p>	<p>HDO %Sat</p>	<p>NTU</p>
<p>0.30</p>	<p>23.24</p>	<p>8.09</p>	<p>4.39</p>	<p>8.35</p>	<p>102.5</p>	<p>12.03</p>
<p>Other comments:</p>						

6.3 Morgan Estuary

Sample Date	24 October 2022	Reserve Level Assessment	Rapid
Site Name	EST4/1;	IUA	IUA_S03
Estuary	Morgan	IUA description	Lower Great Kei
Estuary type	Warm Temperate - Large Temporarily Closed	Prioritised RU	E_RUXX_R
Altitude (m.a.s.l.)	0	Quaternary catchment	R30A
Longitude	28.345150	Latitude	-32.706992
PES	B – Near Natural	Conditions during sampling	Sunny and warm. Estuary with open mouth conditions.
Components currently impacting PES	Invertebrate and fish scores decreasing overall score	Pressures	High fishing pressure and bait collection, some alien fish species noted.
Ecological Importance	Low to Average Importance	Adjacent to EBSA and a priority fish nursery area	
Noted features	Small waterfall at head of estuary; residential and holiday home development in the EFZ on the south bank; intertidal sandbanks with extensively worked and with remnant psuedofaeces, <i>Juncus kraussi</i> stands along margins of the estuary.		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
Residential/holiday development within the EFZ on the south bank.		Intertidal sandbank with psuedofaeces	

EFZ delineation of estuary with survey site(s) indicated



Site Description:

A very aesthetically pleasing estuary providing recreational space to the Morgan Bay holiday visitors and residents.. Area of sampling site is largely intact on the northern bank with some modification on the south bank. A road crossing at the head of the estuary passes a small waterfall which forces the abrupt end to estuary function.



View from site of intertidal and sub-tidal habitats and residential development.



Waterfall at head of estuary

Site impacts:

- Destruction of marginal vegetation and intertidal areas by infilling and modification for use by residence/caravan park on the south bank
- Likely septic tank impacts (nutrients and pathogens) at times from these dwellings



Preliminary Results

In situ water quality EST4/1:

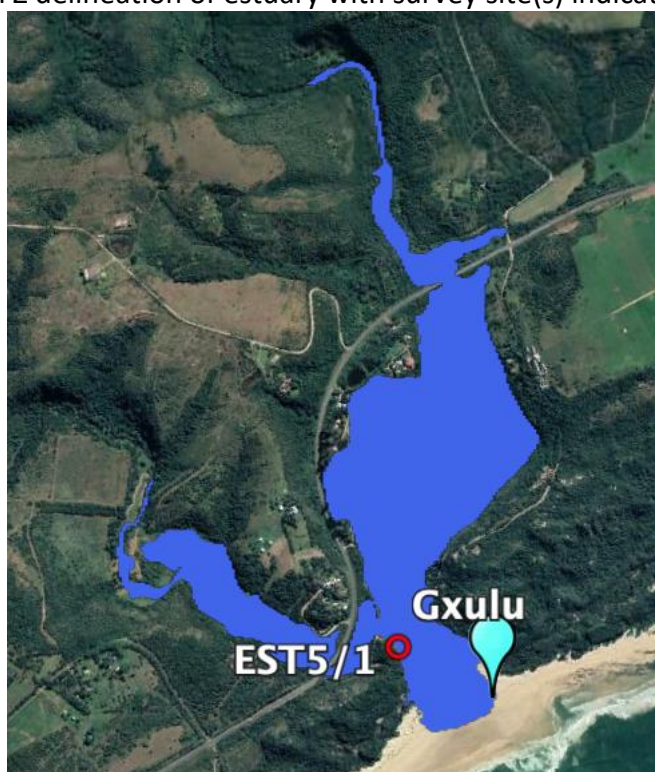
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.19	25.88	7.96	27.84	8.57	126.0	5.79
0.70	21.77	8.03	32.32	8.55	120.1	8.19

Other comments:

6.4 Gxulu Estuary

Sample Date	25 October 2022	Reserve Level Assessment	Rapid
Site Name	EST5/1;	IUA	IUA_R01
Estuary	Gxulu	IUA description	
Estuary type	Warm Temperate - Large Temporarily Closed	Prioritised RU	E_RU11_R
Altitude (m.a.s.l.)	0	Quaternary catchment	R40A
Longitude	27.728512	Latitude	-33.116520
PES	B/C – Near Natural	Conditions during sampling	Cloudy and Cool with estuary mouth closed.
Components currently impacting PES	Hydrodynamics, Physical habitat, vegetation, invertebrates, fish	Pressures	Low cumulative pressure but includes some pressure on habitat modification, pollution and flow modification
Ecological Importance	Low to Average Importance	Adjacent EBSA and PA and considered a priority fish nursery area.	
Noted features			
<p>Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.</p>			
			
<p>Site along mouth access road and view down towards mouth.</p>		<p>Site along mouth access road and view upstream of mouth.</p>	

EFZ delineation of estuary with survey site(s) indicated



Site slightly upstream of estuary mouth on the south bank

Site Description:

Site was accessed from the southern bank via an access road which crosses salt marsh and lies within the EFZ. This is an area where bait collectors were seen gathering live swim bait. Other than the roads and some low intensity development it is an attractive estuary with low turbidity. The estuary mouth was closed during sampling.



Site impacts:

- Bait collecting
- Road within the estuary to access the mouth
- Residential developments, again with septic tanks within the estuary.

Preliminary Results

In situ water quality EST4/1:



Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.14	24.07	7.81	28.06	7.54	107.7	2.18
0.50	24.07	7.83	28.16	7.11	101.6	9.05

Other comments:

Despite the protected area status inadequate processing of solid waste within the estuary boundary.



6.5 Keiskamma Estuary

Sample Date	25 October 2022	Reserve Level Assessment	Rapid
Site Name	EST6/2;	IUA	IUA_R01
Estuary	Keiskamma	IUA description	Keiskamma
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU10_R
Altitude (m.a.s.l.)	0	Quaternary catchment	R10M
Longitude	27.473074	Latitude	-33.283801
PES	B/C – Near Natural	Conditions during sampling	Cloudy and cool
Components currently impacting PES	Water quality and hydrodynamics, vegetation, invertebrates and particularly fish.	Pressures	Urban pollution, high fishing pressure and bait collection, habitat loss
Ecological Importance	High Importance	A priority system with linkages to MPA, EBSA and a highly rated fish nursery area. Its significance as a wader feeding ground needs to be added to this.	
Noted features	Good intertidal areas, with saltmarsh and sandbanks. Already a good selection and abundance of Palearctic waders – this needs further checking in early March		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
Upper estuary		Lower estuary with saltmarsh and intertidal sandbanks	



Site Description:

A large and impressive estuary. The sampling site was located slightly upstream of the mouth which was open. The sampling and observations were conducted over a low neap tide which exposed the intertidal sandbanks and saltmarsh habitats which cover large areas of the estuary. This provides very good habitat for migrant Palearctic waders which were just beginning to arrive during this survey. A jetty provided access to deeper water for water quality sampling.

Site impacts:

- A heavily fished system which has resulted in developments right along the south bank of the estuary
- Road development and bridge crossings within the EFZ

Preliminary Results

In situ water quality EST4/1:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.23	17.90	8.05	34.89	8.11	107.7	21.76
1.61	17.36	8.08	35.44	8.28	109.2	24.23

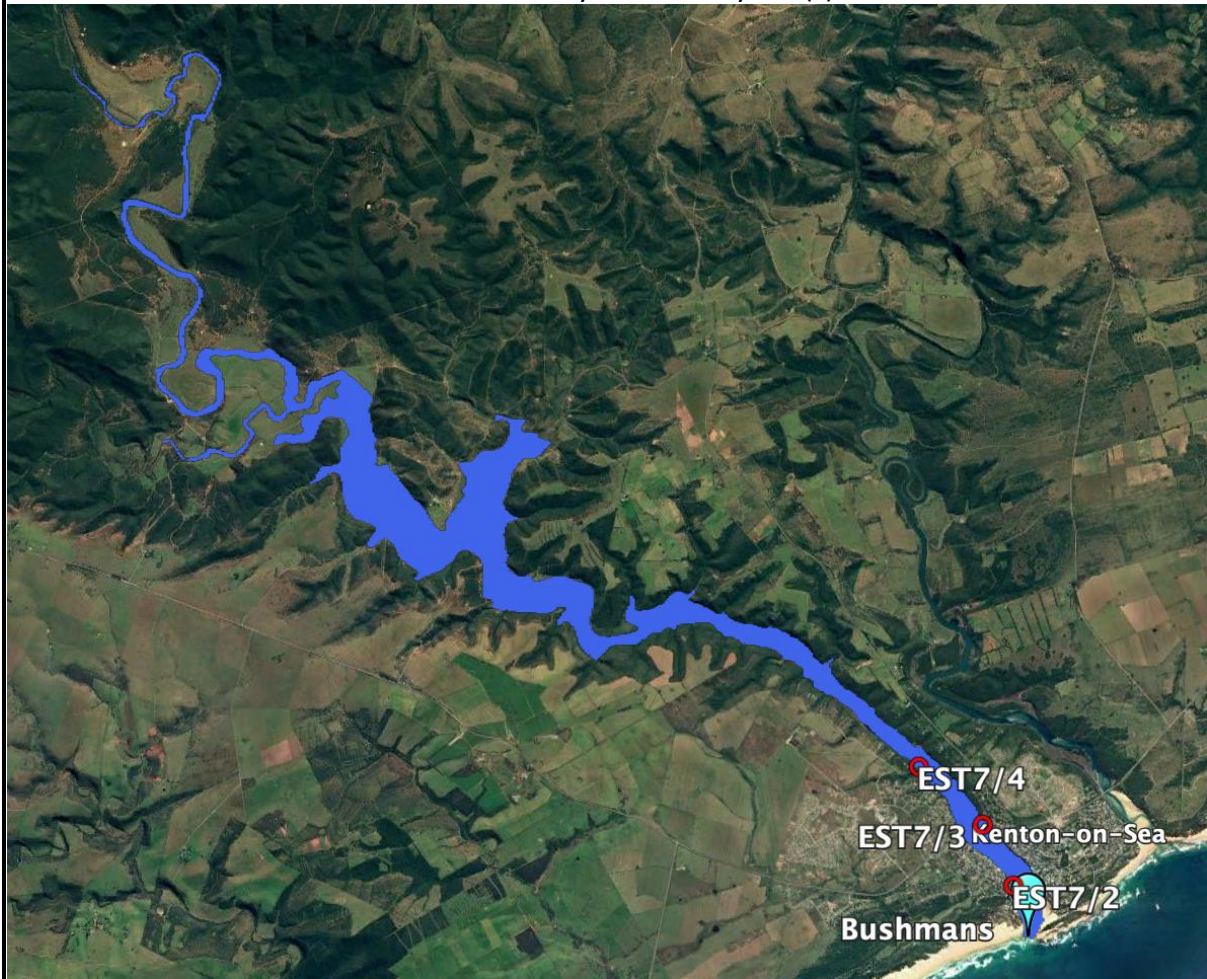
Other comments:

6.6 Bushmans Estuary

IUA_P	Bushmans	E_RU06	Bushmans	P10G	Rapid	P10G	Intermediate	
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Sample Date	26 October 2022	Reserve Level Assessment	Rapid
Site Name	EST7/2; EST7/3; EST7/4	IUA	IUA_P
Estuary	Bushmans	IUA description	
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU06_R
Altitude (m.a.s.l.)	0	Quaternary catchment	P10G
Longitude		Latitude	
PES	B/C – Near Natural	Conditions during sampling	
Components currently impacting PES	Water quality, macrophytes, microalgae and invertebrates	Pressures	Water abstraction and desalination, Noise pollution, Fishing pressure and alien species, along with loss of habitat
Ecological Importance	Important	A priority system linked to an MPA with a high rating as a functional fish nursery area.	
Noted features	Large mobile sand dunes at mouth, extensive tidal reach exceeding 20km – open mouth producing marine conditions throughout the mouth and middle reaches.		
Components sampled:			
<i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
This is an important estuary system with a very good stakeholder network. High recreational use and dynamic processes which result in environmental and user conflict. High socio-economic importance with a number of estuary issues including mouth dynamics, dune stabilisation, proposals for dredging and desalination with both abstraction of water and discharge of brine. Also adds value to balance the loss of the Papkuils system.			

EFZ delineation of estuary with survey site(s) indicated



The mouth area of the Bushmans estuary

Site Description:

The Bushmans estuary is an attractive large estuary. Three sites were sampled due to the availability of access points which results from the high utilisation of this system recreationally. A number of jetty's, a marina and a floating restaurant were all within the sampled reach. A fairly high level of development on both banks of the lower estuary but also some protected area from the Addo National Park extension and also a private reserve on the north bank alongside the mid to upper estuary.



The lower sampling site accessed from the launch site just upstream of the mouth

The upper sampling site with the floating restaurant

Site impacts:

- Water quality – septic tanks, desalination discharge
- Water quantity – flow modifications through upstream abstraction
- Habitat loss – interference with mouth dynamics
- Seasonal fishing and boating pressure

Preliminary Results

In situ water quality EST7/2:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.17	18.46	8.11	35.21	9.41	93.7	3.39
0.37	18.13	8.12	35.42	9.54	94.5	2.66

In situ water quality EST7/3:


Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.22	19.95	8.09	35.97	7.49	76.9	3.90
2.15	19.95	8.11	35.98	7.49	76.9	4.64

In situ water quality EST7/4:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.08	18.86	8.22	35.59	10.38	100.7	2.38
3.33	18.30	8.17	35.60	10.20	98.0	3.70

Other comments:

6.7 Swartkops Estuary

Sample Date	29 October 2022	Reserve Level Assessment	Rapid
Site Name	EST9/1; EST9/2; EST9/3	IUA	IUA_M01
Estuary	Swarkops	IUA description	M primary catchment
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU08_R
Altitude (m.a.s.l.)	0	Quaternary catchment	M10D
Longitude	25.631429	Latitude	-33.863503
PES	D – Heavily modified	Conditions during sampling	Warm and sunny with slight breeze, mouth open, ebbing tide
Components currently impacting PES	Hydrology, habitat health, water quality in combination with the biological factors of microalgae, macrophytes, invertebrates and fish.	Pressures	High utilisation, modification of EFZ, habitat loss, water quality from urban development, bridges
Ecological Importance	High Importance	Contributing to its importance is the protected area, MPA linkages and IBA status. This estuary is also considered a priority fish nursery.	
Noted features	The large size, intertidal sandbank habitat, heavy anthropogenic impact		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
EFZ delineation of estuary with survey site(s) indicated			



Sampling site at the mouth



Bluewater Bay developments in close Proximity to the mouth

Site Description:

The Swartkops is a highly urbanised and industrialised estuary and this is easily seen at a glance. The sites visited all indicated extensive modification to habitat with significant sources of pollution both point source and diffuse. Bait collection and fishing pressure is high. An estuary with highly valuable habitats which has suffered significant degradation. Degradation to such an extent that warnings regarding the consumption of fish and shellfish from the estuary have been posted by the municipality



Bait collectors

Fishing pressure on the estuary is high

Site impacts:

- Habitat loss through extensive modification
- Numerous bridge crossings
- Fishing and bait collection pressure
- Water quality from surrounding land use – point source and diffuse

Preliminary Results

In situ water quality EST9/1:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.08	19.19	8.12	35.44	7.68	101.2	3.91

In situ water quality EST9/2:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.12	19.55	8.14	35.51	7.72	71.3	3.68
0.42	19.53	8.14	35.54	7.70	71.1	3.85

In situ water quality EST9/3:



Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.19	21.03	8.02	32.46	7.18	66.8	31.14
0.24	21.09	8.02	32.71	7.06	65.9	38.87

Other comments:

Warnings regarding the consumption of fish and shellfish posted by the local municipality – these seem to be largely ignored.



6.8 Kabeljous Estuary

Sample Date	xx October 2022	Reserve Level Assessment	Rapid
Site Name	EST11/1;	IUA	IUA_KL01
Estuary	Kabeljous	IUA description	Kromme from Kromme Dam to estuary and Gamtoos
Estuary type	Warm Temperate - Large Temporarily Closed	Prioritised RU	E_RU04_R
Altitude (m.a.s.l.)	0	Quaternary catchment	K90G
Longitude		Latitude	
PES	C - Moderate	Conditions during sampling	Sunny and warm
Components currently impacting PES	All components both abiotic and biotic score a C with only the birds at a B.	Pressures	.
Ecological Importance	Important	A priority fish nursery area	
Noted features	Long shallow tidal flats with fringing salt marsh		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
Sampling site in the lower estuary looking towards mouth		Sampling site in the lower estuary looking upstream of mouth	
EFZ delineation of estuary with survey site(s) indicated			



Site Description:

The Kabeljous estuary is an unusually shaped system with the bulk of the EFZ running behind the coastal dunes in an east-west orientation. The long tidal and sub-tidal shallows stretch for a long distance from the bank making access to deeper water challenging.

Site impacts:

- Limited urban development on the western bank of the lower estuary
- Intensive agricultural development in the mid to upper estuary.
- Significant proposed development for the western bank will be potentially harmful to the EFZ if not planned in consultation with estuary specialists/



Preliminary Results

In situ water quality EST4/1:

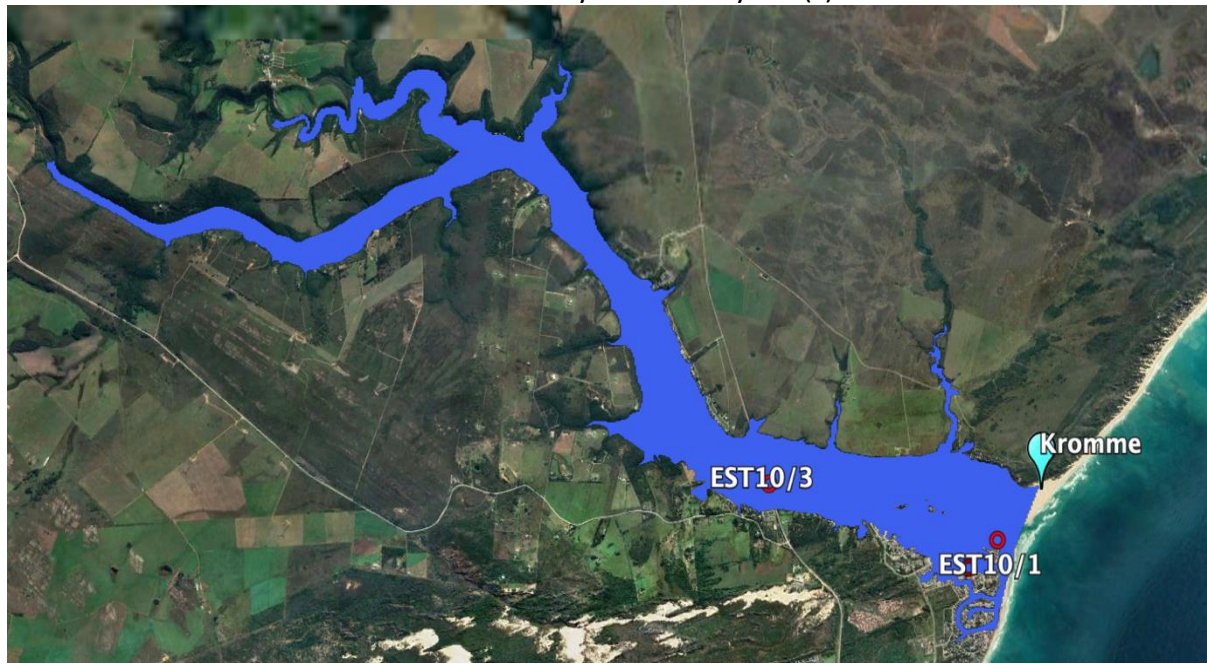
Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.19	19.28	7.77	37.70	7.70	71.6	3.25
0.24	19.31	7.84	37.63	6.54	60.8	6.44

Other comments:

6.9 Kromme Estuary

Sample Date	29 October 2022	Reserve Level Assessment	Rapid
Site Name	EST10/1; EST10/2; EST10/3	IUA	IUA_KL01
Estuary	Kromme	IUA description	Kromme from Kromme Dam to estuary and Gamtoos
Estuary type	Warm Temperate - Predominantly Open	Prioritised RU	E_RU05_R
Altitude (m.a.s.l.)	0	Quaternary catchment	K90E
Longitude	24.838138	Latitude	-34.145587
PES	D – Heavily modified	Conditions during sampling	Sunny and warm, estuary mouth open
Components currently impacting PES	Scores for hydrology and water quality exceptionally low and driving low scores for microalgae, macrophytes, invertebrates, fish and birds	Pressures	Significant flow modifications and habitat loss, high intensity bait collection and fishing pressure and the presence of alien fish species. Pollution from agriculture and the residential/ tourism development in the lower estuary.
Ecological Importance	High Importance	This estuary is a high priority fish nursery area	
Noted features	A large system which supports significant recreational use.		
Components sampled: <i>In Situ</i> water quality, water quality (laboratory) for nutrients, pathogens; sediments for particle size and organic content analysis, Chlorophyll-a to provide an indication of microalgal biomass, waterbirds.			
			
Upper site on the Kromme		Site used as an unofficial launch site into the estuary.	

EFZ delineation of estuary with survey site(s) indicated



Site Description:

The Kromme estuary is a large system which is heavily utilised. It is wide, deep enough for high speed boating and extends significantly inland (approximately 10 km). The Marina situated in the lower reaches is intensely developed and has water quality issues. Conflict occurs between different user groups around resource utilisation.



**High density residential development
 On the Cape St Francis marina
 in the lower estuary**

**Bait collection and fishing pressure
 are high throughout the estuary**

Site impacts:

- The well-established marina development has resulted in a significant loss of shallow subtidal and intertidal habitat within the lower EFZ
- Water quality issues
- Significant fishing effort and high recreational use

Preliminary Results

In situ water quality EST10/1

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.05	19.99	8.15	35.79	7.61	70.9	5.05
0.44	19.94	8.15	35.89	7.93	73.9	5.59

In situ water quality EST10/2

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.08	21.50	8.18	35.39	8.89	84.9	3.66
0.88	21.21	8.21	35.35	8.98	85.3	5.50

In situ water quality EST10/3:

Depth m	Temp °C	pH units	Salinity PSU	HDO mg/l	HDO %Sat	NTU
0.03	22.03	8.16	34.97	8.02	77.1	9.85
0.47	22.05	8.17	34.92	8.09	77.7	19.88

Other comments:

Significant beach and mouth area erosion as a result of interference with a natural sand bypass by development of the St Francis village and golf course. Sand bypass scheme in place (permitted?) and large rock wall constructed on west bank of mouth to prevent wave action and longshore drift. The impacts on the estuary will need evaluation.



7. ESTUARY SURVEY SITES: FIELD VERIFICATION

7.1 Papkuils Estuary


Sample Date	29 October 2022	Reserve Level Assessment	Field Verification
Site Name	-	IUA	IUA_M01
Estuary	Papkuilsrivier	IUA description	M primary catchment
Estuary type	Warm Temperate - Small Temporarily Closed	Prioritised RU	E_RU07
Altitude (m.a.s.l.)	0	Quaternary catchment	M20A
Longitude	25.614020	Latitude	-33.917253
PES	F – Severely to Critically modified	Conditions during sampling	N/A
Components currently impacting PES	Water quality, flow modification and complete habitat modification		

Components sampled: This estuary was assessed to be a bad candidate even for a rapid assessment and only field verification of the conditions was conducted.



The Papkuils estuary has been reduced to a drainage canal through major industrial areas.

7.2 Groot (Oos) Estuary

Sample Date	30 October 2022	Reserve Level Assessment	Field Verification
Site Name	-	IUA	IUA_K01
Estuary	Groot (Oos)	IUA description	Kromme from Kromme Dam to estuary and Gamtoos
Estuary type	Warm Temperate - Small Fluvially Dominated	Prioritised RU	E_RU01
Altitude (m.a.s.l.)	0	Quaternary catchment	K80D
Longitude	24.195026	Latitude	-34.059573
PES	A/B – Near Natural	Conditions during sampling	-
Components currently impacting PES	Water quality and fish	Pressures	Some pollution is noted to be affecting water quality and some bait collection is said to occur.
Ecological Importance	Low to Average Importance	Protected areas, MPA and EBSA add to importance	
Noted features	Estuary surrounded by rocky coast and high cliffs making it inaccessible. This has likely protected this system from development and resource utilisation.		
Components sampled: Field observation of estuary mouth and surrounding land use only. Access to the mouth area blocked by private estate for approximately 6km to the east.			
<p>EFZ delineation of estuary with survey site(s) indicated</p> 			
Site Description: Estuary still directly unimpacted but indirect impacts from plantations to edges of steep cliffs			



**Rugged, rocky coast surrounding
mouth of estuary**

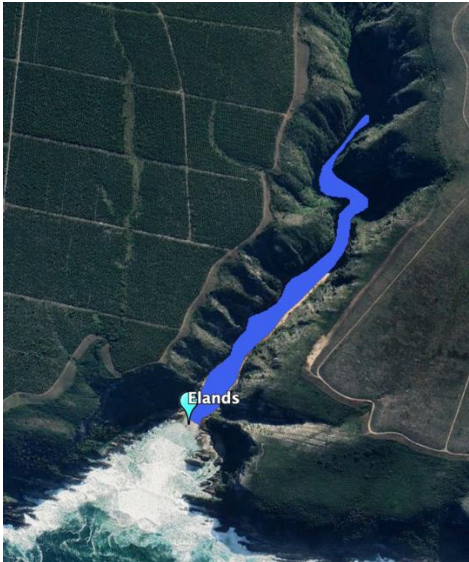


Approach to Groot (Oos) estuary

Site impacts:

- Plantations and agriculture surrounding land-use

7.3 Elands Estuary

Sample Date	xx October 2022	Reserve Level Assessment	Field verification
Site Name	-	IUA	IUA_K01
Estuary	Elands	IUA description	Kromme from Kromme Dam to estuary and Gamtoos
Estuary type	Warm Temperate - Small Fluvially Dominated	Prioritised RU	E_RU02
Altitude (m.a.s.l.)	0	Quaternary catchment	K80C
Longitude	24.078771	Latitude	-34.043987
PES	A - Natural	Conditions during sampling	-
Components currently impacting PES	Hydrological changes and fishing pressure through bait collection.	Pressures	Only changes to hydrology and fish considered to be driving score downwards
Ecological Importance	Low to Average Importance	Protected areas, MPA and EBSA add to importance	
Noted features	Scenic surroundings to EF		
Components sampled:			
Estuary surrounded by rocky coast and high cliffs making it inaccessible. This has likely protected this system from development and resource utilisation.			
EFZ delineation of estuary with survey site(s) indicated			
			

8. CAPACITY BUILDING

An unfortunate consequence of both author's illness prior to sampling was the slightly delayed trip and short notice which limited the numbers of DWS and others able to join the trip. We were fortunate to have Mr Lawrence and Ms Adaora Okonkwo of the Department of Water and Sanitation join us for the final systems which included the intermediate survey of the Gamtoos Estuary and visits to the Kromme and Kabeljous systems.

From an ecological perspective on the Gamtoos Estuary the DWS personnel were able to get a sense of some of the data collected for the intermediate assessment including the collection of in-situ physico-chemical water quality with the multi-parameter water quality probe as well as the laboratory samples for nutrients, pathogens and microalgal concentrations. They were also able to participate in the boating on the Gamtoos Estuary and the collection of sediment benthic macroinvertebrate samples including the associated methods and significance of each component

MER really enjoyed the opportunity to interact with DWS and the comments from both Lawrence and Adaora were that it was great to see the sampling and understand the methods and challenges posed by each. Some discussion regarding the proposed changes to some of the IUAs followed during the lunch before final departure.





9. RECOMMENDATIONS

A number of suggested changes and recommendations are possible resulting from lessons learned from the first low flow survey and these are as follows:

- There has to be a certain amount of flexibility built into the programme to allow for changes in timing due to flooding systems or quicker completion of sampling than scheduled.
- More time is required at the intermediate systems than allowed during Survey 1 as these are large systems. This will need to be scheduled into the Survey 2 programme.
- The Papkuilsrivier estuary has been moved from a rapid to a field verification system as it is no longer a relevant system to sample being highly modified (F) and now only exists as a canalised concrete drain to the sea.
- The Groot (Oos) Estuary and Elands Estuary are both impractical for this survey. Both are in excellent condition and have smaller catchments. They are virtually inaccessible and sampling using estuary methods will be virtually impossible.
- It is suggested that two additional systems, the Morgan Estuary and the Bushmans Estuary are added as a priority RU and upgraded to an intermediate assessment, respectively. The motivation for this as follows;
 - The Morgans which is suggest to be added as a rapid RU was sampled in anticipation of this during Survey 1 and is an accessible and small system providing a good contrast with the adjacent Great Kei.
 - It is also the Bushmans estuary is upgraded from a rapid to an intermediate assessment system as this is an important system with a very good stakeholder network. High recreational use and dynamic processes which result in environmental and user conflict. High socio-economic importance with a number of estuary issues including mouth dynamics, dune stabilisation, proposals for dredging and desalination with both abstraction of water and discharge of brine.

These recommendations and additions will be discussed with the river team and DWS prior to finalisation.

10. REFERENCES

Van Niekerk, L., Taljaard, S., Adams, J.B., Clark, B., Lamberth, S.J., MacKay, C.F. Weerts, S.P., & Whitfield, A.K 2019, 'Chapter 7: Condition of South Africa's estuarine ecosystems' in South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. South African National Biodiversity Institute, Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A

Van Niekerk, L., Adams, J.B, Lamberth, S.J., Taljaard, S., MaKay, F., Bashoo, S. and Parak, O. & Weerts, S. 2019. Chapter 6: Pressures on the Estuarine Realm in South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. South African National Biodiversity Institute, Pretoria. Report Number: SANBI/NAT/NBA2018/2019/Vol3/A

Van Niekerk, L., Turpie, J.K , Lamberth, S.J. 2019. Estuary Biodiversity Importance.

Appendix A: Estuary Survey Programme
