CRUZ ENVIRONMENTAL

Report No. 15

Fish & Benthic Invertebrate Fauna associated with Intertidal Mangroves and Sandflats in Transnet Capital Projects Richards Bay Port Expansion Project

A report prepared for AECOM SA (Pty) Ltd, Westville, Durban

by

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1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The Final Scoping Report (AECOM 2014) for the developments proposed by Transnet Capital Projects (TCP) for the Richards Bay Port Expansion project (Option 3A) identified that several specialist studies needed to be undertaken as part of the Environmental Impact Assessment for the proposed developments. These included elements of both Terrestrial and Aquatic Ecosystems present on the sites to be developed. In terms of the brief provided to CRUZ Environmental three areas required Specialist Studies as part of the Richards Bay Port Expansion project, the localities of these are shown on Figure 1.1 below.

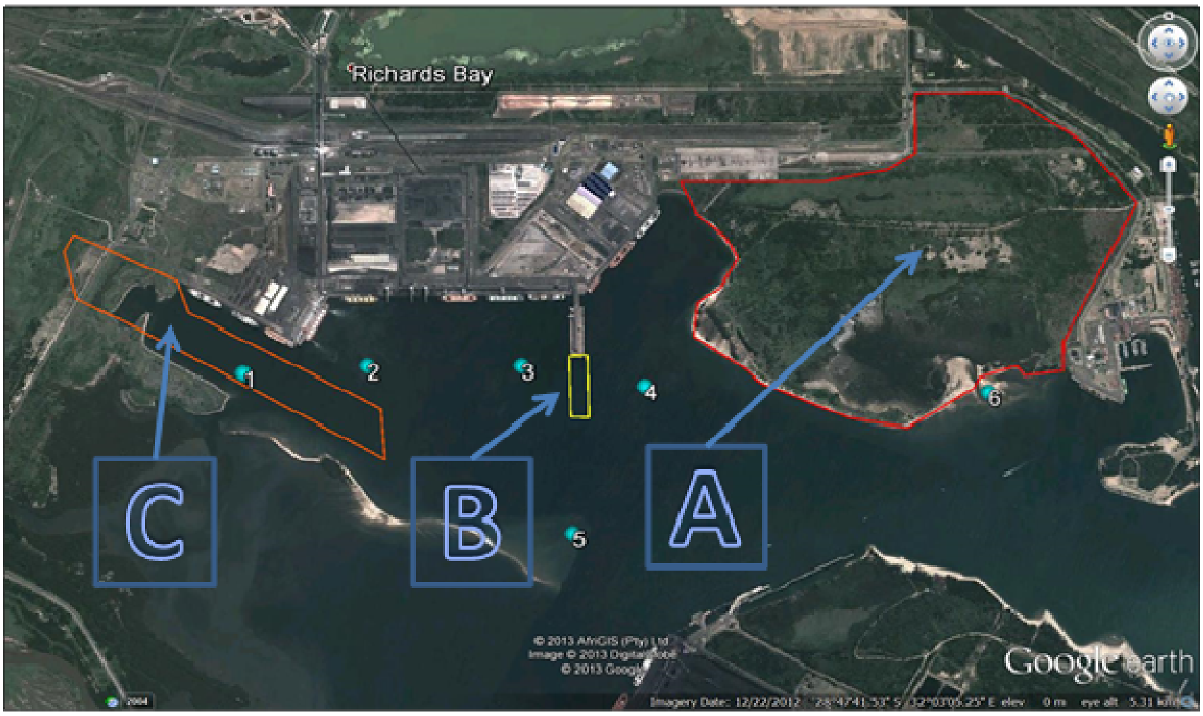

Figure 1.1 Sites associated with TCP Richards Bay Port Expansion Project, A = Rail Balloon, B = Finger Jetty Extension and C = Berth 600 Series Expansion.

The Intertidal Mangroves and adjacent Intertidal Sandflats associated with Site A, the Rail Balloon Area (Figure 1.2), were identified as potentially having important floral and faunal components as well as wetland habitats that would be lost through development of the TCP Richards Bay Port Expansion projec. The floral and wetland components formed a separate study (Mostert 2014) whilst this study focussed on the importance of the fauna associated with the intertidal habitats.

CRUZ Environmental (CRUZ-E) identified the fish and macrobenthic invertebrates as the two most important components of these intertidal areas. Initially the Intertidal Mangroves and Intertidal Sandflats were to form separate reports. However during fieldwork the interconnectivity of these two ecosystems manifested itself and as a result CRUZ- E decided that the two should be considered together in one report which is presented here. Historically the area that today comprises Richards Bay Harbour formed part of the Richards Bay Estuary which was classified as sub-tropical estuary of the Lagoon type by Millard & Harrison (1954) who undertook the first faunal investigations of the system. The construction of the harbour resulted in the northern section being cut off from the remaining part of the system which now known as the Mhlathuze Estuary (Begg 1978). Despite comprising mostly deep channels (>15m) the Richards Bay Harbours system functions as an estuarine system due to the undeveloped areas still being shallow in nature (Cyrus & Vivier 2009 & MER 2013).

Figure 1.2 The Intertidal Mangroves & Sandflats in the Balloon Rail area (Site A).

1.2 TERMS OF REFERENCE

The brief of the present study was to undertake a once off assessment of the fish and macrobenthic invertebrate fauna of the Intertidal Mangroves and Sandflats of the Rail Balloon area (Figure 1.2).

1.3 AIMS

The aim of the study was to determine the importance of the Intertidal Mangroves and Sandflats using the fish and macrobenthic fauna as indicators.

2. STUDY AREA

2.1 INTRODUCTION

By their very nature intertidal areas are exposed on a twice daily basis with considerable variability due to tidal ebb and flood. Both the Mangrove substrata and the Sandflats are covered with water and then almost entirely exposed as the tide recedes. This is clearly seen by comparing Figure 2.1, which was taken near high tide, with Figure 2.2 which was taken at low tide. Under the latter state large areas of sandflats are exposed and can be exploited by the wading birds for the food source it provides.

2.2 INTERTIDAL MANGROVES

2.2.1 Sampling Sites

2.2.1.2 Benthic Invertebrates

Samples of the macrobenthic invertebrate fauna were collected at two sites (IM1-IM2) in the intertidal zone adjacent to in the Mangroves (Figure 2.1).

2.2.1.2 Fish

The fish were sampled along the length of the Intertidal Mangrove interface (Figure 2.1).

2.3 INTERTIDAL SANDFLATS

2.3.1 Sampling Sites

2.3.1.2 Benthic Invertebrates

Samples of the Benthic invertebrate fauna were collected at four sites (ISF1-ISF4) in the intertidal zone adjacent to the beach (Figure 2.1).

2.3.1.2 Fish

The fish were sampled adjacent to the beach in the intertidal area (Figure 2.1).

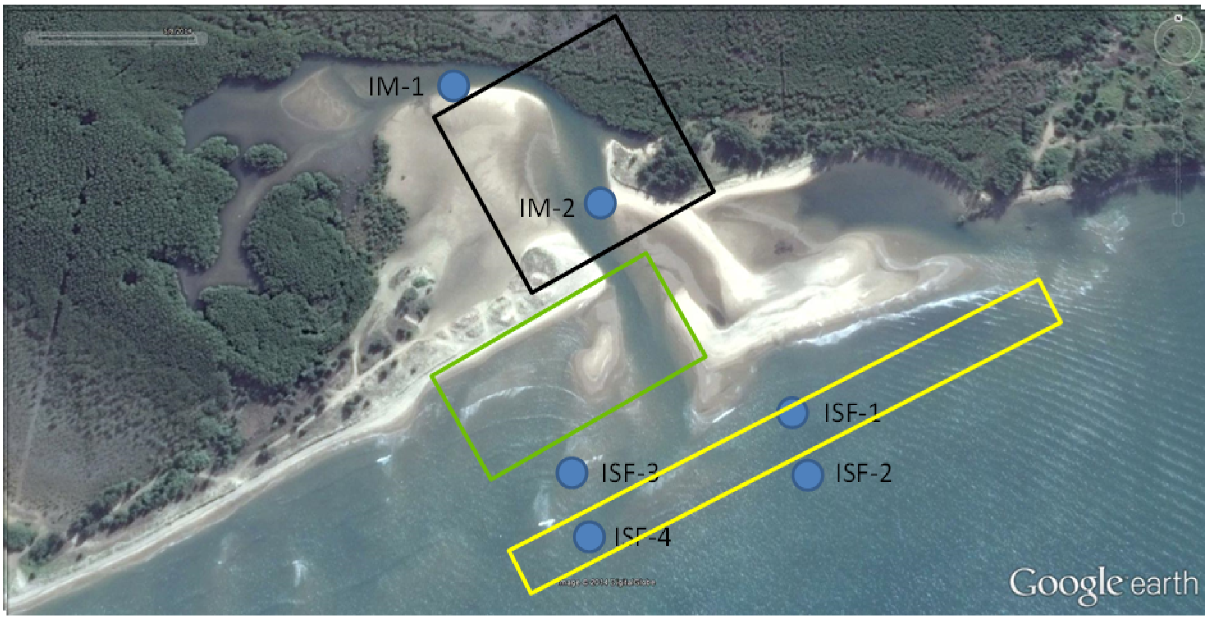

Figure 2.1 The intertidal areas of the Rail Balloon area covered by marine water at high tide (Google Earth 2014-05-08). Benthic sampling sites indicated as IM & ISF, Black Box demarcates fish sampling sites in the Mangrove Intertidal Zone, Green Box demarcates fish sampling sites in the Intertidal Sandflats Zone (Large and Small Seine used in both zones) & Yellow Box demarcates Beam Trawl sampling sites in the Intertidal.

Figure 2.2 The intertidal Zone of the Rail Balloon area exposed at low tide (Google Earth 2004-10-03).

3. METHODS

3.1 INTRODUCTION

Only a once-off sampling of two faunal groups was provided for in the brief. This created several constraints as there was insufficient time to obtain more detail on the systems. In addition Mangrove Zones by their very nature, having roots which stick upwards and out of the substrate, are difficult to sample. As a result all sampling was undertaken in the open intertidal area adjacent to the mangroves (see Figure 2.1).

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3.2 METHODS

3.2.1 Benthic Invertebrate Sampling

Samples of the benthic fauna were collected at two sites (IM1-IM2) in the intertidal zone adjacent to in the Mangroves and at four sites (ISF1-ISF4) in the intertidal Sandflats zone (Figure 2.1). A Zabalocki-type Eckman grab, which samples 0.0236 m^2 to a minimum depth of 50 mm, was used to collect five replicate benthic samples from each site, i.e. samples of the bottom substrate of the system. Samples were decanted five times through a 0.5 mm sieve to ensure extraction of at least 95% of the animals. Samples were preserved in a 10% formalin solution, and stained with the vital dye Phloxine B to aid sorting in the laboratory. Animals were identified to species level where possible, enumerated and densities calculated as no.m^{-2}. Sediment samples were also collected and analysed for grain size and organic content using standard techniques.

3.2.2 Fish Sampling

Fish were sampled using three types of sampling gear. A Small (10 m x 1.5 m, 6mm bar mesh) and Large Seine net (70 m x 1.5 m, 10mm bar mesh) were used to sample both the Intertidal Mangroves and Sand Flats. In addition a Beam Trawl (1.5m wide with 5mm stretch mesh bag) was used to sample the Intertidal Sandflats and this was aimed at sampling benthic macrocrustacea (prawns & crabs) and benthic associated fish species. All fish were measured to Standard Length (SL) and most were identified on site and returned to the water. In the laboratory identification of unknowns was undertaken and densities calculated as a Catch per Unit Effort (CPUE) where one net haul equals one unit of effort.

3.2.3 Sediment Grain Size & Organic Content

Bottom sediment was collected from each of the benthic sampling sites and sent to Environmental Management Service in Durban for Grain Size range and Organic Content determination.

3.2.4 Physico-chemical Parameters

Physical water quality parameters (water temperature, turbidity, salinity, pH, dissolved oxygen concentration, % oxygen saturation and depth) were measured at each site using a YSI 6920 Sonde (YSI Incorporated).

a) b)

Figure 3.1 a) The Zabalocki-Eckman Grab about to be deployed to sample benthic invertebrates, b) The YSI Data Sonde about to be deployed to measure Physco-chem parameters.

4. RESULTS

4.1 SEDIMENT ANALYSIS & PHYSICO-CHEMICAL WATER QUALITY

The physico-chemical water quality parameters and sediment characteristics recorded in the Intertidal Mangroves and adjacent Intertidal Sandflats associated with the Rail Balloon Area are presented in Table 4.1. Turbidity's in both areas were very low, reflecting inflow of relatively clear marine waters. Oxygen concentrations at the intertidal mangrove sites were relatively low, given the regular tidal inundation. Although very different habitat types in terms of wave exposure, water movement and proximity to mangroves, both areas were generally sandy, being characterised by medium to fine sand sediments that were moderately to well sorted. The relatively coarse sand at the intertidal mangrove was surprising given the close proximity to a well-developed mangrove stand. The percentage mud in the sediment of this area was similarly very low, ranging between 1.3-3.7%. The relatively coarse sediment was also reflected in the low organic content recorded at all sites, ranging between 0.1-0.4%.

Table 4.1: Physico-chemical water quality data and sediment characteristics at six sampling stations in the Intertidal Mangroves and Intertidal Sandflats in Richards Bay Harbour. See Figure 4.1 for sampling sites.

Site		Intertidal Mangroves				Intertidal Sandflats							
		IM 1		IM 2		ISF 1		ISF 2		ISF 3		ISF 4	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Temp (^oC)	(oC)	20.81	20.55	20.71	*	20.17	20.40	20.17	20.14	20.4	20.36	20.4	20.36
Conductivity	(mSm)	52.29	52.06	51.96	*	53.04	53.06	53.04	53.06	53.43	53.36	53.43	53.36
TDS	(mg/l)	33.96	33.84	33.78	*	34.48	34.49	34.48	34.49	34.47	34.48	34.47	34.48
Salinity		34.44	34.31	34.26	*	35.05	35.06	35.05	35.06	35.04	35.04	35.04	35.04
Dissolved Oxygen	(mg/l)	5.77	5.66	5.66	*	7.41	7.47	7.41	7.47	7.56	7.57	7.56	7.57
Oxygen Saturation	(%)	78.8	77	77.2	*	100.3	101.1	100.3	101.1	103.0	103.1	103.0	103.1
pH		7.56	7.52	7.63	*	7.86	7.86	7.86	7.86	7.92	7.89	7.91	7.89
Turbidity	(NTU)	3.4	3.5	4.4	*	3.2	6.0	3.2	6.0	3.1	4.1	3.1	4.1
Depth	(m)	-	1.0	-	0.5	-	1.0	-	1.4	-	0.9	-	1.0
Time		09h15		09h40		10h20		10h20		10h50		10h50	
Particle size	φ value	1.56		1.75		1.96		2.75		2.26		2.55	
	Category	medium sand		medium sand		medium sand		fine sand		fine sand		fine sand	
Sorting coefficient	Coefficient	0.53		0.55		0.51		0.36		0.43		0.34	
	Category	moderate		moderate		moderate		well sorted		well sorted		well sorted	
% Organic content	%	0.30		0.27		0.12		0.19		0.11		0.37	
	Category	very low		very low		very low		very low		very low		very low	

4.2 MACROBENTHIC INVERTEBRATE FAUNA

The zoobenthic macroinvertebrates recorded in the Intertidal Mangroves and adjacent Intertidal Sandflats associated with the Rail Balloon Area are presented in Table 4.2.

Table 4.2: Zoobenthic macroinvertebrate taxa CPUE, mean CPUE per area and percentage contribution per area as recorded in the Intertidal Mangroves and Intertidal Sandflats in Richards Bay Harbour. See Figure 4.1 for sampling sites. Dominant taxa (>4% of the total CPUE) are indicated in **bold**.

Taxa	Intertidal Mangroves				Intertidal Sandflats						Total CPUE	
	IM1	IM2	Mean	% Contr	ISF1	ISF2	ISF3	ISF4	Mean	% Contr	Total	% Contr
NEMERTEA						50.8		8.5	14.8	1.3	14.8	0.85
TURBULARIA		67.8	33.9	**5.6**							33.9	1.94
ANNELIDA												
Armandia intermedia					8.5			16.9	6.4	0.6	6.4	0.36
Ancistrocylis parva						110.2			27.5	2.4	27.5	1.58
Capitella capitata						8.5	8.5		4.2	0.4	4.2	0.24
Desdemona ornata	8.5	8.5	8.5	1.4							8.5	0.49
Euchone sp		8.5	4.2	0.7				8.5	2.1	0.2	6.4	0.36
Glycera subaena		25.4	12.7	2.1			8.5	25.4	8.5	0.7	21.2	1.22
Heteromastus filiformis		8.5	4.2	0.7							4.2	0.24
Lumbrinereis latrelli						8.5			2.1	0.2	2.1	0.12
Magelona cincta						50.8		16.9	16.9	1.5	16.9	0.97
Nephtyes sp					42.4		42.4	8.5	23.3	2.0	23.3	1.34
Nereid sp						16.9			4.2	0.4	4.2	0.24
Nephtys sphearocirrata						33.9		8.5	10.6	0.9	10.6	0.61
Owenia fusiformis					25.4	144.1	33.9	33.9	59.3	**5.2**	59.3	3.40
Polychaete sp1							8.5		2.1	0.2	2.1	0.12
Polychaete sp2					8.5				2.1	0.2	2.1	0.12
Polychaete sp3						8.5			2.1	0.2	2.1	0.12
Polychaete sp4						16.9			4.2	0.4	4.2	0.24
Prionospio sp							8.5		2.1	0.2	2.1	0.12
Prionospio sexoculata	8.5		4.2	0.7							4.2	0.24
Tharyx marioni	16.9	8.5	12.7	2.1							12.7	0.73
MOLLUSCA												
Dosinia hepatica	398.3	406.8	402.5	**66.4**	33.9		101.7	313.6	112.3	**9.9**	514.8	29.53
Eumarcia paupercula	25.4	76.3	50.8	**8.4**	16.9	33.9			12.7	1.1	63.6	3.65
Hiathula linulata	8.5		4.2	0.7							4.2	0.24
Assimnea ovata	50.8	8.5	29.7	**4.9**			8.5	25.4	8.5	0.7	38.1	2.19
Gastropod sp 1		8.5	4.2	0.7							4.2	0.24
CRUSTACEA												
Lyssianasidae sp					186.4	152.5			84.7	**7.4**	84.7	4.86
Cirolana sp							8.5		2.1	0.2	2.1	0.12
Ipinoe truncata	8.5	25.4	16.9	2.8		16.9		8.5	6.4	0.6	23.3	1.34
Mesopodopsis africanus							16.9	8.5	6.4	0.6	6.4	0.36
Urothoe		33.9	16.9	2.8			466.1	2381.4	711.9	**62.6**	728.8	41.80
Total CPUE	525.4	686.4	605.9		322.0	652.5	711.9	2864.4	1137.7		1743.6	
No of taxa	8	11	13		7	12	11	12	24		32	

A total of 32 zoobenthic taxa were recorded, 13 from the Intertidal Mangroves and 24 from the Intertidal Sandflats. Mean zoobenthic densities per site were generally low, being much lower in the Intertidal Mangroves (mean CPUE = 606 organisms per m^{-2}) compared to the Intertidal Sandflats (mean CPUE = 1138 organisms per m^{-2}). The intertidal mangrove area was dominated by the bivalves *Dosinia hepatica* and *Eumarcia paupercula*, with the two taxa comprising 75% of the zoobenthic organisms in this area. The intertidal sand flat area had a very different species composition and was dominated by amphipod crustaceans, notably *Urothoe* sp. These burrowing amphipods often form an important component of intertidal and shallow subtidal sandy areas. The abundance of the tube dwelling polychaete *Owenia fusiformis* in the intertidal sandy area also reflects the sandy substrate characteristic of this area, as these polychaetes generally avoid muddy or muddy sand areas.

4.3 MACROCRUSTACEA FAUNA

No species of macrocrustacea were caught during beam trawling or seine netting.

4.4 FISH FAUNA

A total of 486 individuals comprising 20 species were caught during sampling in the Intertidal areas of the Balloon Rail site (Table 4.3). The majority were caught in the Large Seine net. No fish or macrocrustacea were caught in the three Beam Trawl hauls that were undertaken.

By far the majority of the fish caught by seine netting were juveniles. Large and small seine catches in the Intertidal Zone adjacent to the mangroves (Figure 2.1) averaged between 17 and 28 fish per haul and comprised 19 species (Table 4.3). In the Intertidal Sandflats almost no fish were caught in the small seine (CPUE = 1.5), however one large seine haul netted 200 fish comprising 10 species.

Whitfield (1994) produced an estuary-association classification for the fishes of southern Africa which allows one to determine the origin of any group of fish caught in an estuary as well as the importance of the estuarine environment to the fish. This classification comprises five categories, with three of these being divided into subcategories (Table 4.4). Of the 20 fish species recorded in the Intertidal Mangroves and Sandflats, 15% are marine species which are not dependent on an estuarine environment for any specific part of their life cycle (Category III) and 75% are euryhaline marine species which breed at sea with their juveniles showing varying degrees of dependence on estuarine environments as part of their life cycle (Category II). Five percent are estuarine species which breed in these systems (Category I) and 5% euryhaline freshwater species some of which may breed in estuarine as well as freshwater (Category IV). No obligate catadromous species which use estuaries as transit routes between the marine and freshwater environments were recorded (Category V).

Table 4.3: Species, Numbers and Catch per Unit Effort of fish sampled at three localities within the TCP Capacity Expansion Option 3A (Mangrove = Intertidal Flats adjacent to the Mangroves, Sandflats = Intertidal Sandflats, Zostera = Intertidal *Zostera capensis* Beds within the Berth 600 Series Extension area & EDC = Estuarine Dependence Category based on Whitfield (1994).

		NUMBERS						CPUE				
		MANGROVE		SAND FLATS		ZOSTERA	Total	MANGROVE		SAND FLATS		ZOSTERA
EDC	SPECIES	SS	LS	SS	LS	SS		SS	LS	SS	LS	SS
IIa	*Acanthopagrus vagus*		13				13		0.04			
Ia	*Ambassis ambassis*					70	70					3.50
Ib	*Ambassis dussumieri*					83	83					4.15
Ib	*Ambassis natalensis*	110	2			67	179	1.38	0.01			3.35
III	*Amblyrhynchotes honckenii*	6	19	1	16		42	0.08	0.05	0.05	0.23	
III	*Arothron hispidus*		1				1		0.00			
IIb	*Gerres filamentosus*		1				1		0.003			
Ia	Goby Larvae					2	2					0.10
IIb	*Liza dumerilli*		8		106		114		0.02		1.51	
IIa	*Liza macrolepis*	15	73	2	45		135	0.19	0.21	0.10	0.64	
IIb	*Lutjanus argentimaculatus*	2					2	0.03				
IIa	*Monodactylus falciformes*					16	16					0.80
IIa	*Mugil cephalus*		5		7		12		0.01		0.10	
IIa	Mullet Larvae					1	1					0.05
IV	*Oreochromis mossambicus*		2				2		0.01			
IIc	*Platycephalus indicus*	1					1	0.01				
III	*Plectorhynchus gibbossus*		1				1		0.003			
IIa	*Pomadasys commersonnii*		2				2		0.01			
III	*Pseudorhombius arsius*					2	2					0.10
Ia	*Redigobius batteatops*					1	1					0.05
IIb	*Rhabdosargus sarba*					27	27					1.35
IIc	*Sillago sihama*	5			6		11	0.06			0.09	
IIc	*Sphyraena jello*		2				2		0.01			
IIc	*Strongylura leiura*				1		1				0.01	
IIa	*Terapon jarbua*	3	3		5		11	0.04	0.01		0.07	
IIc	*Valamugil buchanani*		6		3		9		0.02		0.04	
IIa	*Valamugil cunnesius*		2		8		10		0.01		0.11	
IIc	*Valamugil seheli*		1		3		4		0.003		0.04	
	Number of Hauls	x8	x5	x2	x1	x2		x8	x5	x2	x1	x2
	Number of Species	7	16	2	10	9	28	7	16	2	10	9
	Total	142	141	3	200	269	755	17.8	28.2	1.5	200.0	134.5

Whilst the overall contribution of species to each of these groups provides an indication of the dominance of the Category II species within the study area (Table 4.3), this needs to be interrogated further as these species all enter the estuary from the sea as post larvae or early juveniles and completion of their life cycle depends on getting into and surviving in an estuary. Richards Bay Harbour acts as a nursery area for members of this group providing numerous advantages for successful growth and survival (Blaber & Blaber, 1980; Wallace, 1975; Wallace & van der Elst, 1975). The Category II species may occur in extremely high numbers, to the extent that they dominate in terms of biomass. Of the 20 taxa occurring that fall into Category II, the juveniles of six are entirely dependent on Richards Bay Harbour as a nursery ground in order to complete their life cycle (Category IIa – Table 4.3), three occur as juveniles, mainly in estuaries which they utilize as a nursery but are also found at sea (Category IIb) and the remaining six species occur as juveniles in estuaries, again utilizing them as nurseries, but are usually more abundant at sea (Category IIc). Individuals from the bulk of species from all three sub-groups remain within the estuary until reaching sexual maturity for the first time, at which point they leave for the marine environment where they join the adult spawning stocks, with the majority never returning to the estuarine environment.

Figure 4.1 Bringing in the catch with the small seine in the intertidal area adjacent to the mangroves.

Figure 4.2 Juvenile barracuda (*Sphyraena* jello) caught in the large seine in the intertidal area adjacent to the mangroves.

Figure 4.3 Measuring fish caught in the large seine net.

Table 4.4: The major life cycle categories of fishes utilising southern African estuarine systems from Whitfield (1994).

Category	Description
I	Estuarine species which breed in estuaries: Ia Resident species which have not been recorded spawning in marine or freshwater environments. Ib Resident species which have been recorded spawning in marine or freshwater environments.
II	Euryhaline marine species which breed at sea but with juveniles that show varying degrees of dependence on estuaries: IIa Juveniles dependent on estuaries as nursery areas. IIb Juveniles occur mainly in estuaries but are also found at sea. IIc Juveniles occur in estuaries but are usually more abundant at sea.
III	Marine species which occur in estuaries in small numbers but are not dependent on these systems.
IV	Euryhaline freshwater species. Includes some species which may breed in both freshwater and estuarine environments.
V	Obligate catadromous species which use estuaries as transit routes between the marine and freshwater environments: Va Obligate catadromous species which require a freshwater phase for their development. Vb Facultative catadromous species which do not require a freshwater phase for their development.

 **Photo 1:** Water receding from the mangroves as the tide ebbs	 **Photo 2:** Mangrove roots becoming exposed as the tide recedes.
 **Photo 3:** Intertidal channel coming out of the mangrove (an important habitat for juvenile fish).	 **Photo 4:** Intertidal zone adjacent to the mangroves becoming exposed on the receding tide.
 **Photo 5:** Intertidal zone adjacent to the mangroves almost entirely exposed on the low tide.	 **Photo 6:** Intertidal Mangroves and adjacent area covered at high tide.

Photo 7: Intertidal Sandflats exposed at low tide, looking towards the Small Craft Harbour.

Photo 8: Intertidal Sandflats exposed at low tide, looking towards the Harbour entrance.

Photo 9: Intertidal Sandflats exposed at low tide, looking towards the area east of RBCT.

Photo 10: Intertidal Sandflats exposed at low tide, looking towards RBCT.

5. DISCUSSION & CONCLUSIONS

5.1 MACROBENTHIC INVERTEBRATE FAUNA

Intertidal mudflats, sandflats and mangroves in estuarine environments are generally characterised by high biological productivity and abundance of organisms, but relatively low diversity. Intertidal mudflats and mangroves are particularly productive, due to high input of nutrients and organic matter from adjacent mangrove and wetland stands, whereas exposed intertidal sandflats are less productive as they are both harsher environments and with lower levels of organic matter. Sandflat sediments in the protected upper reaches of the harbour are much finer and more organic, whereas those in the lower reaches generally are characterised by coarse, low organic sediment due to the influence of greater wave action and currents. The influence of the wave action and currents were apparent even in the relative sheltered intertidal mangrove area, where the sediment was coarse with a very low organic content. This is unusual for a sheltered intertidal area adjacent to mangroves.

Along the KwaZulu-Natal coastline, large sandflat and sandbank habitats only occur within the larger estuaries (St Lucia, Kosi Bay Mhlathuze and Durban & Richards Bay Harbours). Similar habitats that occur in smaller estuaries along the KwaZulu-Natal coastline are under continuous threat from development pressures in the catchments and this places greater importance on the need to conserve the large sandflat and sandbank habitats such as those found in Richards Bay. In Richards Bay, the total area occupied by this habitat is approximately 447 ha in size with the bulk of this habitat remaining subtidal, with only limited sections being intertidal (CSIR 2005). The largest part of this habitat occurs in the south-western region of the Port seaward of the mudflats.

Benthic macroinvertebrates are amongst the most sensitive biotic components of estuarine environments and are thus useful for assessing ecosystem integrity (Rosenburg and Resh 1993). Their close association with aquatic sediment, coupled with their limited mobility, mean that they are closely associated with most physico-chemical processes in the aquatic environment. Due to their sessile nature and relatively long life cycles, benthic invertebrates are representative of the location being sampled, which allows monitoring of temporal and spatial changes in response to perturbation in the aquatic environment. Macrobenthos also form a central element of estuarine food webs, being an important food resource for many larger crustaceans, fish and birds, and can profoundly influence the abundance and species composition of these tertiary consumers.

A combination of environmental factors usually affects the distribution of benthic organisms, of which salinity and sediment characteristics have been shown to be of most importance. Numerous studies have reported that the spatial distribution of macrobenthic invertebrates along an estuarine gradient is related to sediment composition and/or salinity (Teske and Wooldridge 2003). Suspension-feeders (e.g., bivalves) are usually more abundant in sandy areas in which tidal currents prevent accumulation of detritus on the bottom. In contrast, deposit-feeders such as polychaetes are usually more abundant in a muddy area in which the abundant organic matter provides an adequate source of nutrition for a large number of deposit-feeders. The sandy substrate and associated low organic content is regarded as the primary reason for the low benthic diversity in the study area.

The low zoobenthic diversity in the intertidal mangrove area was unexpected and needs to be seen in the light of the sediment composition recorded in the area. Macrofaunal communities in high and low intertidal mangroves are influenced by the inundation period, tidal range, availability of organic matter and sediment characteristics. Lower intertidal mangrove sediments (typically silt- or clay-dominated) provide substratum for growth of benthic microalgae and macroalgae. Frequent inundation in the low intertidal zone also favours the presence of filter and deposit feeders, whereas fauna in the high intertidal zone does not have frequent direct access to such food sources and other trophic groups therefore predominate there. In high intertidal mangroves, the substratum is often more sandy, and the reduced frequency of tidal inundation results in a drier more sandy environment which is less suitable for growth of micro- and macroalgae and macrobenthos.

5.2 MACROCRUSTACEA FAUNA

Despite three sets of Beam Trawl hauls having been undertaken across the Intertidal Sandflats not a single organism was caught, this could lead one to conclude that the fauna of the area is depauperate. There could be several reasons for this result but it is more likely that net avoidance due to the clarity of the water and the fact that the sampling was done during daylight hours rather than the fauna being depauperate. From a prawn perspective the sandy intertidal areas are the preferred habit of *Penaeus japonicus* (Weerts *et al.* 2003). This species feeds on the surface during the night and however remains buried in the sand during the day time. They are therefore difficult to catch as being buried allows them to avoid the beam trawls 'tickler' chain. It is therefore concluded that the beam trawl results are not representative of the status of the macrocrustacea fauna on the Intertidal Sandflats.

5.3 FISH FAUNA

This once-off survey has shown that the species diversity and density in the two intertidal areas are relatively high. The Catch per Unit Effort (Table 4.3) was above average when compared to those recently achieved at Mfolozi and St Lucia Estuaries (D.P.Cyrus *pers obs.*). An assessment of life cycle categories represented in the fauna sampled using the Whitfield (1994) classification clearly indicated the importance of the area for marine species which have a dependence on estuarine environments for part of their life cycle. This included six species which are totally dependent on finding an estuarine type environment to complete their life cycle. Despite being limited in nature the current survey has shown that the Intertidal Mangroves and Sandflats are an important habitat for estuarine associated fish which utilize them as feeding grounds during the high tide period. The mangroves in particular provide a sheltered environment with few predators.

5.4 OVERALL CONCLUSIONS

In terms of the fish fauna present in the Intertidal Mangrove & Sandflats of the Rail Balloon area (Site A - Figure 1.1) it is concluded as follows;

1. The loss of these Intertidal Mangrove and Sand Bank habitats (Figure 2.1) could potentially have a significant effect on the fish fauna as intertidal sand banks are limited in their occurrence in Richards Bay Harbour.
2. The loss of the Intertidal Mangroves will also have an impact on the fish fauna, however this habitat is of far greater significance in the broader sense of ecosystem functioning than just to the fish fauna.

In terms of the macrobenthic fauna present in the Intertidal Mangrove & Sandflats of the Rail Balloon area (Site A - Figure 1.1) it is concluded as follows;

1. The area is characterised by relatively low macrobenthic diversity which is related to the sandy substrate and low organic content in both areas.
2. The low macrobenthic diversity in the intertidal mangroves area was related to the unusually sandy, low organic content substrate in the area, which support primary suspension feeding macrobenthic organisms.
3. Despite the relatively low benthic diversity and other issues mentioned in 1 and 2 above, this habitat is ecologically important in an estuarine intertidal context and the loss of which will affect the functioning of intertidal habitat in Richards Bay Harbour.

The importance of Richards Bay Harbour as a functioning ecosystem has been highlighted on several occasions in the past (Cyrus & Forbes 1994 & 1996; Forbes *et al.* 1997) and more recently by CSIR (2005), Cyrus & Vivier (2009), Vivier & Cyrus (2009) and MER (2013). As a result all the issues raised in this report are discussed in more detail and assessed, in conjunction with results from the other components investigated in this study, in the Overall Findings and Assessment Report for the project (Cyrus & Vivier 2014).

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BSc (Zoology, Biochemistry)	**1987**
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Experience: Twenty two years experience in estuarine ecological research on KZN rivers, estuaries and coastal lakes - mostly on zoobenthos, fish & water quality. Current fields of research include biology and ecology of estuarine zoobenthos and fish, and sediment toxicity bioassay procedure development for nearshore, estuarine and marine sediment and water. Have participated in many co-operative and contract research projects i.e. environmental biotic studies of Richards Bay Harbour and adjacent estuarine and wetland areas, environmental reserve for coastal lakes and estuaries, instream flow requirements for rivers,strategic environmental scan with reference to biotic components of the Richards Bay area, deign and monitoring of fishways in KZN, survey of water quality and biota of the Bivane and Phongola Rivers, ecostatus of the Phongolo river floodplain.

Specialisations: Zoobenthic & fish community ecology and water quality assessment of coastal lakes and east coast estuaries. Estuarine water and sediment pollution/quality surveys, including use and development of sediment toxicity assessments and assays.

Presentation of Research Findings:

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Co-operative And Collaborative Research: Have participated in joint Unizul, Rhodes, UPE, CSIR & JLB Smith RDM projects on the Mhlathuze and Nhlabane Estuaries. Have collaborated with ORI scientists in a multi-disciplinary MCM funded survey of the drought related impacts on the fish community of St Lucia.

Membership of Scientific Societies: Member of the Southern African Society of Aquatic Scientists and the Consortium for Estuarine Research and Management.

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	MSc (*cum laude*) (Estuarine Ecology)	**1980**
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	Integrated Environmental Management - Theory & Practice	**1991**
	Offshore Marine Pollution	**1997**
	ISO 14001 Environmental Management Systems	**1998**
	Public Participation in EIA's – Theory & Practice	**2002**
Awards	**Southern African Society of Aquatic Scientists – Gold Medal**	**2011**

Academic Experience: Thirty three years' experience lecturing a wide range of Zoology related subjects as well a supervising numerous MSc and PhD students.

Research Experience: Forty years covering Estuarine, River, near-shore Marine and Coastal Lake environments. Have participated in numerous contract research projects such as the determination of the Environmental Reserve for Coastal Lakes and Estuaries, the effects of intrabasin transfer schemes in the area, A Strategic Environmental Scan with reference to Biotic components of the Richards Bay area and Instream Flow Requirements for Rivers. Involved with Freshwater Flow Requirements for Estuaries. Was part of the Scientific team that formulated the biological requirements for the South African Resource Directed Measures Legislation to determine Flow Allocations for Environmental Purposes for Estuaries & Rivers and the monitoring thereof.

Specialisations: Estuarine, River and Coastal Lakes Ecology. Flow Allocations for Environmental Purposes for Estuaries and Rivers based on Biotic component requirements. Fish Specialist. Also specialist in ornithological issues related to association of birds with Estuaries, Rivers and Coastal Lakes.

Environmentally Related Activities:	Have been involved in over 130 research projects concerned with Environmental Impact Assessments on the ecology of nearshore marine, estuarine and freshwater systems and project leader/senior author on some 90 of these. Fields include specialist biological surveys, ecological assessments, biomonitoring, specialist review consulting, Estuarine Flow Requirements and numerous studies on impacts of developments on aquatic environments. Have been involved with Reserve determinations for the Mkomaas, Mhlathuze, St Lucia, Siyaya and Nhlabane Systems as well as with the revision of the estuarine RDM Protocols, Thukela Intermediate EFR study and development of Estuarine Base line and long term Monitoring Protocols for RDM of Estuaries. Assessment of the Environmental Impacts of the development of the Port of Richards Bay over the next 40 years.
Presentation of Research Findings:	**Publications:** 146 Scientific Journal Publications (124 on Estuaries) 142 Environmental Project Reports **Conference Presentations:** 76 National Conferences 67 International Conferences
Co-operative and Collaborative Research:	Current and past involvement with the Universities of Natal (Durban & Pietermaritzburg) and Port Elizabeth, the SA Institute for Aquatic Biochemistry, KZN Wildlife, World Wildlife Fund - Conservation Division, National Ports Authority, Mondi Forests, Sappi Stanger Environmental Liaison Committee, CSIR, Institute for Natural Resources, Oceanographic Research Institute as well as three overseas based projects (University of Hull, UK & CSIRO, Australia).
Membership of Scientific Societies:	Southern African Society of Aquatic Scientists (SASAqS), Estuarine and Coastal Shelf Sciences Society (ECSA), Consortium for Estuarine Research and Management (CERM), Zoological Society of South Africa & Ornithological Society of South Africa (Bird Life SA).

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