CRUZ ENVIRONMENTAL

Report No. 17

Aquatic Vegetation & Fish associated with Berth 600 Series Extension 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.

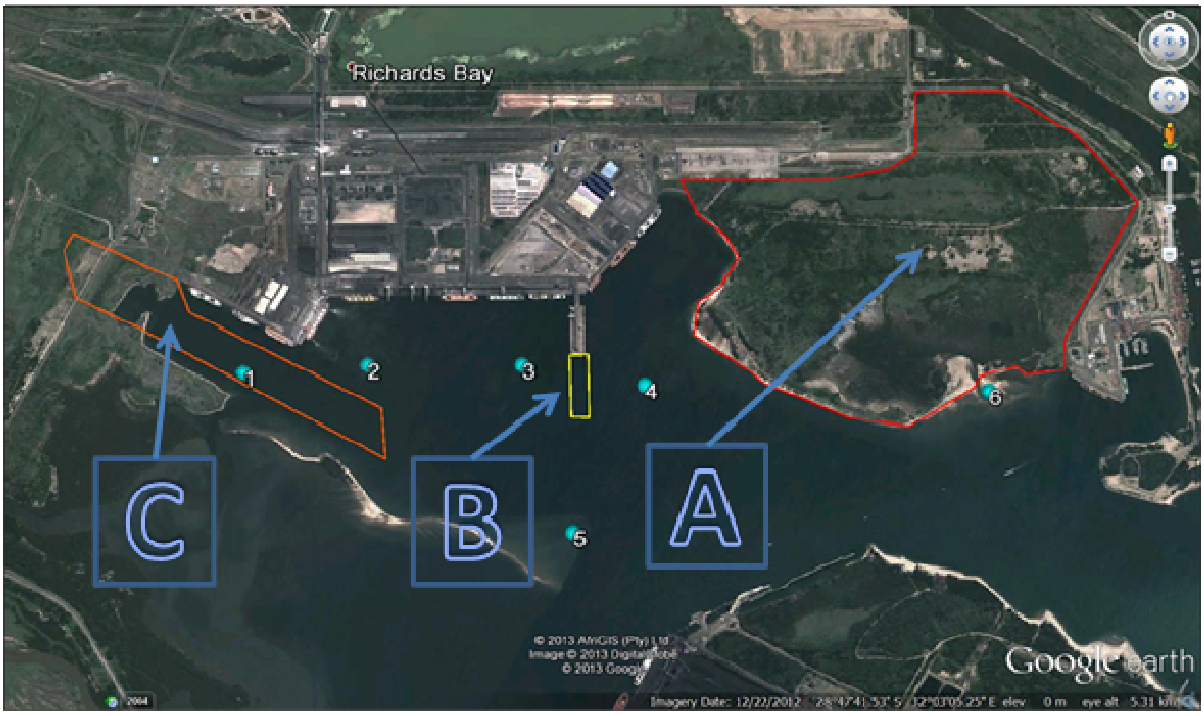

Figure 1.1 Sites associated with TCP Richards Bay Port Expansion project, A = Rail Balloon, B = Finger Jetty Extension and C = Berth 600 Series Expansion.

In terms of Site C (Berth 600 Series Extension) only the Vegetation, Wetlands and the Birds were identified for further investigation. The components brought forward in this report did not form part of the original brief, partly because they were not identified in the Final Scoping Report (AECOM 2014) or by CRUZ Environmental when we made additional recommendations for additional elements to be included in the specialist studies. We were not fully aware of the ecosystem that had developed within the Berth 600 Series Extension

site. During the course of the Vegetation and Wetland Delineation study (Mostert 2014), Dr Mostert informed us that he had observed large numbers of juvenile fish present in a partially enclosed intertidal section on the site as well as *Zostera capensis* (Marine Seagrass). It should be noted that *Zostera capensis* has recently been reclassified as *Nanozostera capensis* (Green & Short 2003) however the IUCN Red Data List specialists recommend that the original classification be retained until genetic investigations, which are currently underway, are completed (Short *et al.* 2010). Based on this the name *Zostera capensis* is used throughout this report and other reports associated with the Specialist studies for the TCP Richards Bay Port Expansion project.

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. They recorded large beds of *Z.capensis* within the system, particularly near the mouth at what was known as Mermaid's Folly (Figure 1.2) The construction of the habour in the 1970's resulted in the southern section of Richards Bay Estuary being cut off from the northern part of the system. The former now known as the Mhlathuze Estuary whilst the latter was developed into the Port of Richards Bay (Begg 1978). Since then *Z.capensis* has led a chequered existence within the two systems.

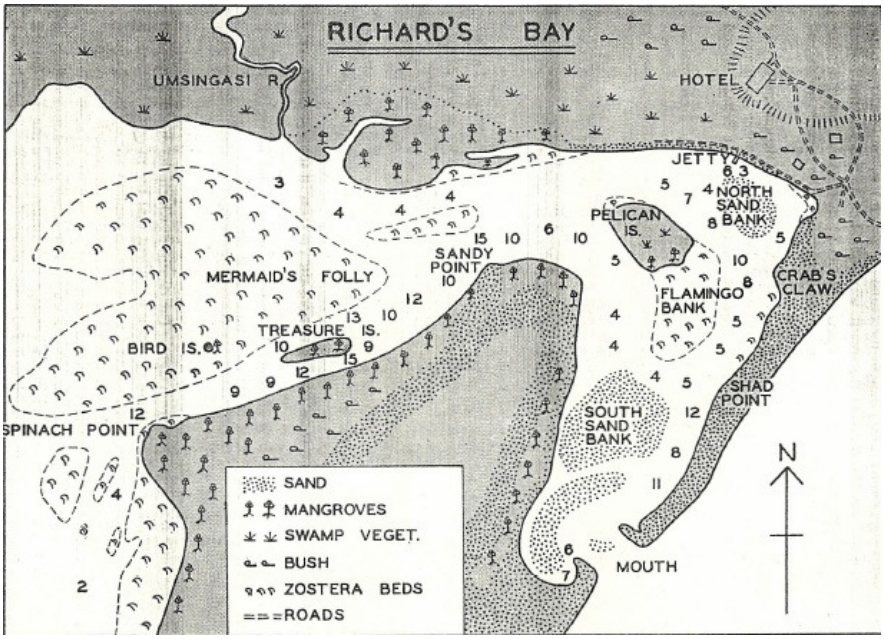

Figure 1.2 The distribution of *Zostera capensis* in the Richards Bay Estuary over the period 1948-1951 from Millard & Harrison (1954)

The importance of Richards Bay Harbour as a functioning estuarine 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). One of its main roles in this regard is providing nursery habitat for juveniles of estuarine dependent marine fish and prawns, a number of whom are unable to complete their life cycle if they do not get into an estuarine environment (Blaber & Blaber 1980; Whitfield 1994).

1.2 TERMS OF REFERENCE

No Terms of Reference were set for the study reported on here and nor was any budget allocated for the work. CRUZ Environmental undertook a short once-of assessment of the fish and aquatic floral of the shallow intertidal area within the Berth 600 Series Extension area (Figure 1.3).

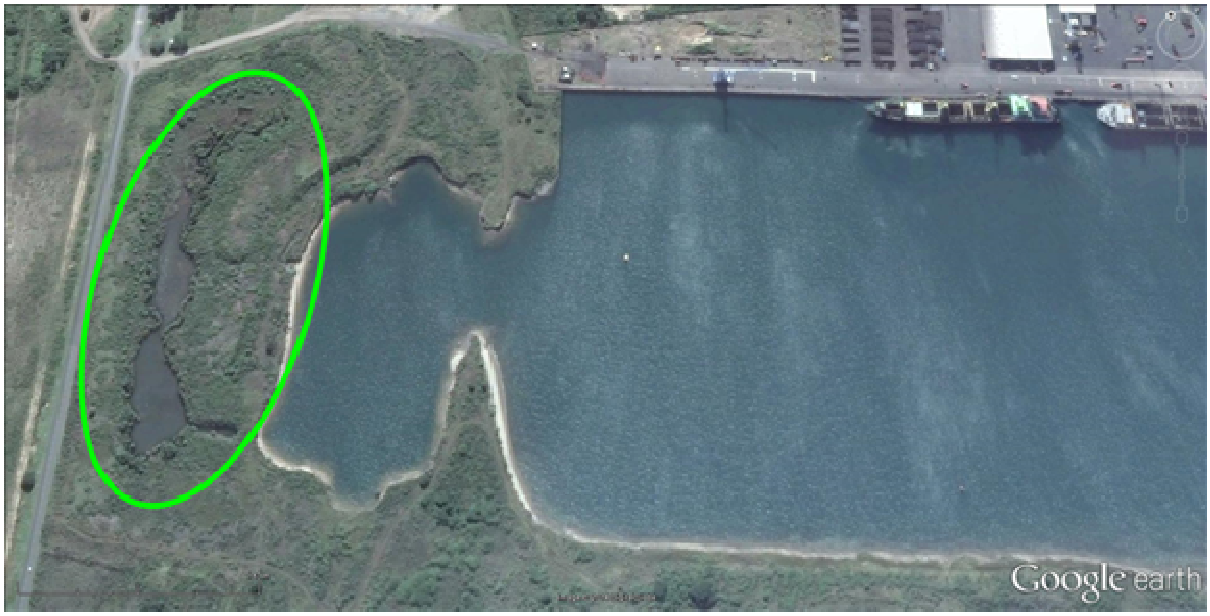

Figure 1.3 The Intertidal Shallows (enclosed in green) within the Berth 600 Series Extension area (Site C – Figure 1.1).

1.3 AIMS

The aim of the study was to determine the importance of the shallow intertidal area within the Berth 600 Series Extension area using the fish and *Z.capensis* 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 flood and ebb. Typically the study site is covered with water and then almost entirely exposed as the tide recedes.

2.2 SHALLOW INTERTIDAL AREA

2.2.1 Sampling Sites

2.2.1.2 Fish

The fish were sampled at one site along the shoreline which was accessible and did not comprise of deep muddy deposits

2.2.1.2 *Zostera capensis*

This included the total area of the Shallow Intertidal area.

3. METHODS

3.1 INTRODUCTION

A once-off sampling of the two groups was undertaken.

3.2 METHODS

3.2.1 Fish Sampling

Fish were sampled using Small Seine (10 m x 1.5 m, 6mm bar mesh), all fish were measure to Standard Length (SL), 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 *Zostera capensis*

A visual assessment was made of the extent and coverage of *Z.capensis* at the site using elevated points around the site as visual vantage points.

4. RESULTS

4.1 FISH FAUNA

It was only possible to undertake two small seine hauls in the area that the water could be accessed on 3rd October 2014 when the tide was almost at its highest. These yielded a total of 269 fish comprising nine species and reflecting a Catch per Unit Effort of 134 fish per haul (Table 4.1). By far the bulk of individuals caught were small juveniles within a size range of 10 to 30 mm SL, with a few individuals reaching 60 mm SL. One specimen identified as *Redigobius batteatops* appears to be a new record for South Africa which as far as is known has only previously been recorded as far south as Maputo Bay in Mozambique. The specimen will however have to be sent to the South African Institute for Biodiversity in Grahamstown for verification of the identification.

A second visit to the site on 22nd October 2014 when the tide was at its lowest revealed the Intertidal Shallow area as being almost totally drained of water. In contrast to the large number of small juvenile fish that were netted on the high tide visit upwards of 1,000 medium sized juvenile fish were noted at the pond end of the pipe (Photos 10 & 12). They appeared to have been trapped there on the falling tide when the water level dropped below the pipe level. Only visual observations were made and it was determined that there were at least eight species present, most ranging between 130 and 250 mm SL. The dominant species present included three mullet *Valamugil buchanani, Liza dummerilli & L.macrolepis* as well as *Terapon jarbua, Acanthopagrus berda, Himantura uarnak* and an Atherinid type filter feeder. There were several species present that could not be identified with certainty through the water. The bulk of the fish present were Whitfield (1994) Category II (see below), species whose juveniles are dependent on finding an estuarine type environment in order to be able to complete their life cycle. The size class of fish that were observed were too large and the fish too mobile for them to be have been caught in the small seine that was used for sampling the site previously.

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 4.2). Of the nine fish species recorded in the Shallow Intertidal area, 11% are marine species which are not dependent on an estuaries environment for any specific part of their life cycle (Category III)

and 33% are euryhaline marine species which breed at sea with their juveniles showing varying degrees of dependence on estuaries as part of their life cycle (Category II). Fifty six percent are estuarine species which breed in these systems (Category I). No euryhaline freshwater species, some of which may breed in estuaries as well as freshwater (Category IV), or obligate catadromous species, which use estuaries as transit routes between the marine and freshwater environments (Category V), were recorded.

The overall contribution of species to each of these groups provides an indication of the dominance of the Category I species within the study area (Table 4.1). However despite the fact that Category II species only made up 33% of the catch visual observations indicated that the Intertidal Shallows area is of greater importance to this group. Category II species enter estuarine environments from the sea as post larvae or early juveniles and their survival depends on them getting into such a habitat. Richards Bay Harbour acts as a nursery area for members of this latter group providing numerous advantages for successful growth and survival (Blaber & Blaber, 1980; Wallace, 1975; Wallace & van der Elst, 1975; Forbes *et al.* 1997). Individuals from the bulk of Category II species 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.

4.2 MACROCRUSTACEAN FAUNA

A large number of very small juvenile prawns (around 5 to 10 mm Carapace Length) were also netted when netting for fish was undertaken however neither the time nor the manpower required to identify and enumerate the specimens collected. In addition it was noted that the intertidal zone supported a well-established population of Fiddler Crabs.

4.3 *ZOSTERA CAPENSIS*

The stands of *Z.capensis* in the Shallow Intertidal area were well established and extensive covering approximately 40% of the surface area of this habitat. At high tide all stands were entirely submerged whilst at low tide the bulk were exposed as the water receded (see Photos 1 to 6). The Intertidal Shallows were fringed by a developing stand of mangroves which comprised two species, *Avicennia marina* and *Bruguiera gymnorrhiza* (see Photos 7 & 8).

4.4 STRUCTURE & DEVELOPMENT OF THE SHALLOW INTERTIDAL AREA

Without historical data at hand it is difficult to determine the history of the Shallow Intertidal area in Site C however historical Google Earth photos provide some clues. The oldest photo available (Figure 4.1a) was taken on the 4th of June 2004, it shows that the intertidal area was much larger than it is today and that there may have been a greater connection between it and what was developed into the 'Caisson' Basin when the caissons for the extension of the Coal Terminal Quay were constructed in 2006 (Figure 4.1b). It appears that tidal interchange had been restricted to a narrow connection via a large pipe to allow the construction of a dirt road, which followed the edge of the 'Caisson' Basin shoreline.

Table 4.1: 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, Sand Flats = Intertidal Sand Flats, Zostera = Intertidal *Zostera capensis* Beds within the Berth 600 Series Extension area, EDC = Estuarine Dependence Category based on Whitfield (1998), SS = Small Seine, LS = Large Seine & shaded species only caught in *Zostera beds*).

		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

During construction of the caissons, the area was severely impacted by what appears to be infilling of the Intertidal Shallows, this can clearly be seen from the Google Earth photo taken on 21st July 2006 (Figure 4.1b). By 21st November 2011 (Figure 4.1c) terrestrial vegetation had re-established itself across the area and the intertidal area appears to already have a fringing zone of mangrove trees, which are now well established as can be seen from the most recent photo taken on 8th May 2014 (Figure 4.1d). It was unfortunately not possible, from the historical photos, to determine if any *Z.capensis* was present at the time.

Currently the Intertidal Shallows are still linked to the main body of the harbour via a large pipe in the 'Caisson' Basin (Photo 11) through which the water moves when the tide rises (Photo 9) and falls (Photo 10). There is no doubt that this habitat is functioning as a typical intertidal estuarine habitat. The significance of this habitat in the context of Richards Bay Harbour as contributing to a functional ecosystem operating within its boundary is discussed under section 5.3.

Table 4.2: 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.

a)

b)

c)

d)

Figure 4.1 The Intertidal Shallows within the Berth 600 Series Extension area (Site C – Figure 1.1) from Google Earth photos, a) 4th June 2004, b) 21st July 2006, c) 21st November 2011 & d) 8th May 2014.

5. DISCUSSION & CONCLUSIONS

5.1 FISH FAUNA

Results from the limited scope of this study has clearly indicate that the Shallow Intertidal area present within the Berth 600 Series Extension area provides the necessary requirements for both small to medium sized juvenile fish of estuarine as well as estuarine associated marine species. The Catch per Unit Effort was above average when compared to those recently achieved at Mfolozi and St Lucia Estuaries (D.P.Cyrus *pers obs*.). The fact that a possibly new species for South Africa was recorded (verification pending) from the limited sampling that was undertaken, indicates possible further importance of this site. The attraction to this area is almost certainly the substrata but more importantly the habitat created by the presence of *Z.capensis* which is known to be an important habitat for a wide range of species, including fish and prawn and particularly for the nursery habitat it provides (Heck *et al.* 2003; Bloomfield and Gillanders 2005).

5.2 MACROCRUSTACEAN FAUNA

No direct sampling of this group was undertaken however the number of very small juvenile prawns, most likely of the genus *Penaeus*, is of significance. Members of this genus also have an obligatory requirement for an estuarine environment during their juvenile stage in order to complete their life cycle (Weerts *et al.* 2003). Forbes & Demetriades (2005) reported that Richards Bay Harbour and Lake St Lucia are the two most important nursery areas in South Africa for this group which are of economic importance as they are major contributors to the off shore commercial fisheries on the Thukela Banks.

5.3 *ZOSTERA CAPENSIS*

The discovery of a sustainable population of *Z.capensis* within Richards Bay Harbour is ecologically of great significance as this is the first record of its presences for more than 30 years. Koch *et al.* (2007) considered seagrasses as keystone species in many shallow lagoons and estuaries, where they provide complex habitats and high rates of primary production for ecologically and economically important higher consumers.

This species is now listed on the IUCN Red List of Threatened Species as Vulnerable which means it is considered to be facing a high risk of extinction in the wild (Short *et al.* 2010). C.F.MacKay of the Oceanographic Research Institute, Durban (*pers comm.*) believes that

prior to the recent discovery in Richards Bay Harbour that, in terms of KwaZulu-Natal, this species now only occurs in three systems, Amatikulu-Nyoni Estuary, Mhlathuze Estuary and the Lake St Lucia Estuarine System. *Zostera capensis* has not occurred in St Lucia over the past 10 years due to the extended hypersaline periods over this time (D.P.Cyrus *per obs.*).

Seagrass typically occurs in intertidal flats and lagoons with sandy or muddy bottom conditions and such conditions only occur in a few estuaries along the east coast of South Africa. Richards Bay was one of these and extensive *Z.capensis* beds were recorded in the system during the early estuarine surveys between 1948 and 1951 (Millard and Harrison 1954). Results from these surveys showed that these habitats supported a rich diversity of marine and estuarine fauna and they were believed to be vital to the nursery function of the estuary (Millard and Harrison 1954). MER (2013) reported that seagrass no longer occurs in Richards Bay but is still found within the adjacent Mhlathuze Estuary where these beds provide critical habitat for the migrant estuarine prawn, *Palaemon peringueyi*, an endemic species to southern Africa which is found to be strongly associated with *Z.capensis* beds (Forbes and Cilliers 1999).

Since the construction of the harbour in the 1970's *Zostera capensis* has had a chequered history in both Richards Bay Harbour and the Mhlathuze Estuary.

5.3.1 Richards Bay Harbour

Information gathered on the occurrence of *Z.capensis* in Richards Bay Harbour are detailed in Table 5.1.

Table 5.1: Historical information on the occurrence of *Zostera capensis* in Richards Bay Harbour subsequent to it first been reported in abundance in the Richards Bay Estuary by Millard & Harrison (1954).

1970's	*Zostera capensis* completely disappeared from the newly created harbour almost certainly due to increased sediment load in the water (L.Demont, past Deputy Port Engineer, *pers comm.*).
Late 1990's	*Zostera capensis* was collected from St Lucia and replanted in the 'Shark' Basin area to the south of the Richards Bay Coal Terminal. This replanting was not successful and the species disappeared from the harbour once again (L.Demont, past Deputy Port Engineer, *pers comm.*).
2014	Well established beds of *Z.capensis* discovered in the Shallow Intertidal area West of the Berth 600 Series (D.P.Cyrus, this report)

5.3.2 Mhlathuze Estuary

Information gathered on the occurrence of *Z.capensis* in the Mhlathuze Estuary is detailed in Table 5.2.

Table 5.2: Historical information on the occurrence of Zostera capensis in Richards Bay Harbour subsequent to it first been reported in abundance in the Richards Bay Estuary by Millard & Harrison (1954).

1970's	Construction of the harbour, the berm wall between it and the new mouth completely separated the Mhlatuze Estuary from Richards Bay Harbour. During this time *Z.capensis* completely disappeared from the newly created estuary (L.Demont, past Deputy Port Engineer, *pers comm.*).
±1991	*Zostera capensis* was collected from St Lucia and replanted in the estuary, this appears to have been successful (L.Demont, past Deputy Port Engineer, *pers comm.*).
03-1996	Well established stand of *Zostera* present in the South West corner of the estuary covering ±112 ha (Cyrus *et al.* 2008).
11-1996	Following Dredge Spoil disposal from quay development on the beach north of the estuary mouth the impact of an intrusion of fine sediments into the estuary resulted in the *Zostera* bed shrinking to ±26 ha (Cyrus *et al.* 2008).
06-1999	*Zostera capensis* beds recovered and expanded into the central area of the estuary comprising ±285 ha in extent (Cyrus *et al.* 2008).
12-2005	A decrease in spatial coverage was noted prior to dredging and spoil disposal for Berth 306 taking place (S.P.Weerts, CSIR *pers comm.*).
03-2006	Three stands of *Zostera* remained but these declined significantly during dredging for Berth 306 (S.P.Weerts, CSIR *pers comm.*).
07-2006	No living *Zostera* was present in the estuary, the total die off could not be fully attributed to the effect dredging alone (S.P.Weerts, CSIR *pers comm.*).
07-2009	A major recovery occurred with healthy stands noted in the central areas of the estuary (S.P.Weerts, CSIR *pers comm.*).
07-2010	It was noted that since July 2009 a significant and near total die off had taken place in the estuary (S.P.Weerts, CSIR *pers comm.*).
11-2011	A subsequent recovery of *Zostera* in the estuary was noted (S.P.Weerts, CSIR *pers comm.*).
10-2014	Inspection of Google Earth photos from May 2014 appears to indicate the presence of *Zostera* in the central part of the estuary but this is unconfirmed.

5.4 OVERALL CONCLUSIONS

The discovery of well-established stands of *Zostera capensis* in the Intertidal Shallows area, which is being extensively utilized by the fauna, is of great significance due to the contribution it is making in terms estuarine ecosystem functioning within Richards Bay Harbour. It is also significant due to this species having been absent from the harbour for more than 30 years and the fact that it is now on the IUCN Red List of Threatened Species and designated as Vulnerable.

In terms of the fauna and flora present in the Shallow Intertidal area of the Berth 600 Series Extension area (Site C - Figure 1.1) it is concluded as follows;

1. There is need for an in depth investigation of this ecosystem to more fully understand its current status and significance to the harbour ecosystem.
2. There is a need to establish if there are any other stands of *Z.capensis* that may have developed within Richards Bay Harbour and which remain as yet undiscovered.
3. There is a need to establish if there are any other comparable areas of this nature in the port which could be used for offset purposes.
4. There is a need to establish if *Z.capensis* has indeed made a recovery in the Mhlathuze Estuary and to what extent this has taken place.

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 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).

Photo 1: *Zostera capensis* covered by water at near high tide.

Photo 2: *Zostera capensis* covered by water at near high tide.

Photo 3: *Zostera capensis* exposed at low tide.

Photo 4: *Zostera capensis* exposed at low tide.

Photo 5: *Zostera capensis* covered at high tide and providing cover and a feeding ground for small juvenile fish.

Photo 6: *Zostera capensis* covered at high tide and providing cover and a feeding ground for small juvenile fish.

Photo 7: Mangroves fringing the Shallow Intertidal habitat near high tide at Site C.

Photo 8: Mangroves fringing the Shallow Intertidal habitat at low tide in Site C.

Photo 9: Near high tide at the point of entrance of pipe carrying tidal water into the Shallow Intertidal area at Site C.

Photo 10: Low tide at the point of entrance.

Photo 11: Inlet point of connection pipe in the 'Caisson' basin.

Photo 12: Large numbers of juvenile fish waiting for the tide to rise so they can access the Shallow Intertidal area.

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ABRIDGED CURRICULUM VITAE

PROF. DIGBY PAUL CYRUS

Occupation:	Senior Academic & Estuarine Ecologist		
Positions:	Head: Department of Zoology (1995 to June 2014) Research Fellow (July 2014 to date)		
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Place of Birth:	Pretoria, South Africa - South African Citizen		
Qualifications & Courses:	**BSc** (Zoology, Entomology)		**1977**
	BSc Hons (Hydrobiology)		**1978**
	MSc (*cum laude)* (Estuarine Ecology)		**1980**
	PhD (Estuarine Ecology)		**1984**
	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).

2014-11-10

ABRIDGED CURRICULUM VITAE

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Place Of Birth: Cape Town, South Africa - South African Citizen

Languages: English, Afrikaans

Qualifications:	**BSc** (Zoology, Biochemistry)	**1987**
	BSc Hons (Zoology)	**1988**
	MSc (Zoology)	**1992**
	PhD (Zoology)	**2010**

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.

	Publications:	**Conference Presentations:**
Presentation of Research Findings:	22 reviewed journal publications, co-author of 38 consultancy reports.	10 National Conferences 9 International Conferences

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.

2014-09-09