Adelaide Desalination Plant Intertidal Monitoring

Interim Report

July 2011

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Introduction

General operational and environmental monitoring objectives were outlined in the 2008 SA Water EIS for the construction of the Adelaide Desalination Plant project, which encompasses the implementation of environmental monitoring during the pre construction, construction and full operation phases (Proposed Adelaide Desalination Plant Environmental Impact Statement, available at URL: http://www.sawater.com.au/SAWater/WhatsNew/MajorProjects/EIS.htm; accessed 27-07-2011). Environmental monitoring of the rocky intertidal zone involved an assessment of invertebrate and algal communities. Rapid survey of the intertidal rocky shores was undertaken using the photoquadrat and video transect methods (Baring et al. 2010; Dutton & Benkendorff 2008; Benkendorff and Thomas, 2007).

The investigation was conducted to establish a baseline dataset for intertidal communities along the coastline of Gulf St. Vincent. This dataset will allow the evaluation of potential impacts associated with the operation of the Port Stanvac desalination plant with future monitoring. The data and analysis within this report is specific to the intertidal monitoring for the Summer period of 2010-2011 and also Autumn 2011. This report presents baseline data collected across the Port Stanvac Construction Zone and the North and South Control Zones during intertidal surveys prior to the launch of the desalination plant.

Methods

2.1 Sampling Locations and Sites

Sites along the Fleurieu Peninsula were selected according to comparable strata type and topography. Five locations within the Port Stanvac fenced area were sampled with reference locations located to the North at Marino Rocks and Hallett Cove and to the South at Carrickalinga, Second Valley and Fisheries Beach (Figure 1). Two 20 x 20 m plots were surveyed within the intertidal zone at each location, thus generating data from 20 specific sites. All sites for the Summer surveys were undertaken during low tides throughout February 2011 and Autumn surveys during April and May 2011 using each of the methods outlined in previous reports (Baring *et al.* 2010).

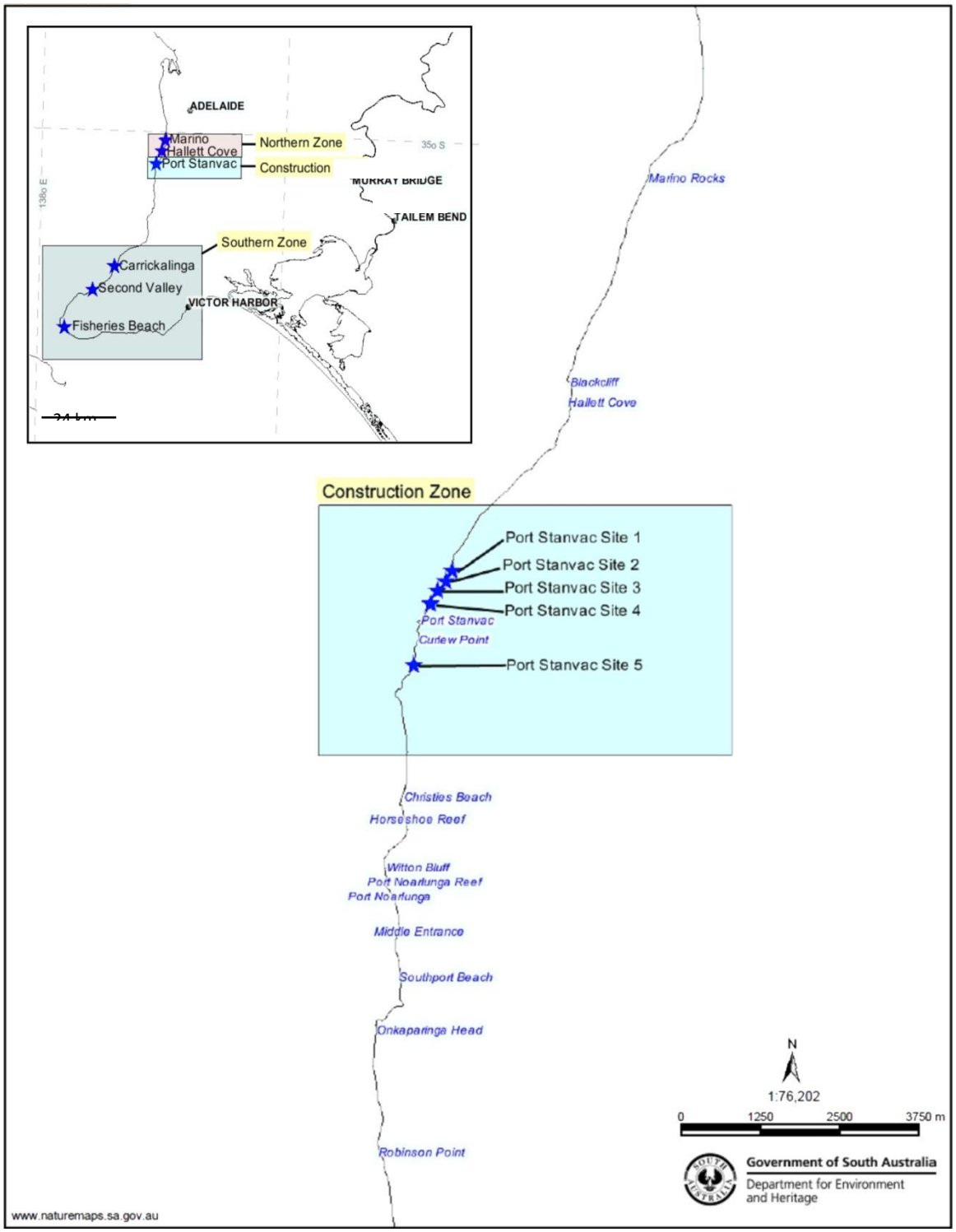

Figure 1: Intertidal sampling sites for the (a) Port Stanvac Construction Zone, Northern Reference Zone and Southern Reference Zone during Summer 2011 and Autumn 2011 (b) magnified snapshot of the five Sites

within the Construction Zone for the Summer 2011 and Autumn 2011. Maps adapted from Nature Maps, Department of Environment and Heritage, Government of South Australia, www.naturemaps.sa.gov.au

Table 1: Sampling dates and GPS co-ordinates for the intertidal study sites sampled during Summer 2011 and Autumn 2011.

	GPS Co-ordinates				
Location	**South**	**East**	**Season**	**Date**	**Tidal Height (m)**
Marino Rocks	S 35°02'45.6"	E 138°30'27.6"	Summer	3/02/2011	0.21
			Autumn	19/04 & 5/05/2011	0.57 & 0.56
Hallett Cove	S 35°05'06.2''	E 138°29'31.5"	Summer	3/02/2011	0.21
			Autumn	19/04/2011	0.57
Port Stanvac 1	S 35°06'48.8"	E 138°28'13.5"	Summer	22/02/2011	0.25
			Autumn	2/05/2011	0.59
Port Stanvac 2	S 35°06'28.4"	E 138°28'20.0"	Summer	15/02/2011	0.24
			Autumn	3/05/2011	0.58
Port Stanvac 3	S 35°06'15.4"	E 138°28'31.8"	Summer	16/02/2011	0.24
			Autumn	3/05/2011	0.58
Port Stanvac 4	S 35°06'12.4"	E 138°28'34.4"	Summer	17/02/2011	0.11
			Autumn	4/05/2011	0.57
Port Stanvac 5	S 35°06'25.7"	E 138°28'20.7"	Summer	10/02/2011	0.37
			Autumn	4/05/2011	0.57
Carrickalinga	S 35°25'09.0"	E 138°19'25.2"	Summer	9/02/2011	0.22
			Autumn	21/04/2011	0.52
Second Valley	S 35°30'36.3"	E 138°12'54.2"	Summer	1/02/2011	0.38
			Autumn	20/04/2011	0.55
Fisheries Beach	S 35°37'58.5"	E 138°06'49.4"	Summer	9/02/2011	0.22
			Autumn	20/04/2011	0.55

2.2 Invertebrate Abundance

Photoquadrats were used to assess invertebrate abundance, species diversity and species richness as this method can be rapidly applied in the field and provides a permanent record for future reference (Baring *et al.* 2010; Dutton and Benkendorff, 2008).

2.3 Percent Cover of Sessile Organisms

The line intercept transect method (e.g. Benkendorff and Thomas, 2007; Dutton and Benkendorff, 2008) was used to assess the percent cover of sessile invertebrates as well as percent algal cover from the low to high tide zones. Video footage was taken of each replicate transect using an Olympus Model Tough8000 digital camera (Baring *et al.* 2010). Algal identification was grouped into broad morphological categories (e.g. foliose, encrusting, and turfing) such as those used in Reef Watch surveys (Reef Watch, 2007). In regions where there was an overlap of sessile communities, 'mixed community' categories (e.g. mixed algal, mixed invertebrate) were established to represent and identify the presence of multiple species. Bare substrate and sediment cover was also noted along these transects.

2.4 Data Analyses

Data analyses were completed for the Summer and Autumn 2011 surveys. Three different methods of diversity indices were calculated to determine the diversity and evenness of invertebrate species Shannon-Wiener (H') and Simpson's Index and Pielou's measure evenness.

PERMANOVA was used to determine significant differences between Zones and Sites. PERMANOVA utilises permutations based on dissimilarities and does not assume a normal distribution for the original variables, making it a useful tool for analysing ecological community datasets (Anderson *et al*. 2008). Further pair-wise tests were also conducted to detect which group differences contributed to any significant result using PERMANOVA. Monte Carlo tests were undertaken in the pair-wise test function in PERMANOVA if low permutations were obtained. The Monte Carlo (*P)* value is better suited and more reliable when there are not enough possible permutations (i.e. < 100) for a rigorous statistical analysis (Anderson *et al*. 2008).

Analyses of invertebrate community composition of quadrat data and substrate structure of video transects for Summer were undertaken to determine if there were similarities between Sites and Zones. Principle Co-ordinates Analysis (PCO) was employed to provide a visual pattern of invertebrate community structure and substrate structure. In order to distinguish the dissimilarities between invertebrate communities and substrate structure a PERMANOVA design was used, incorporating the factors of Zone and Sites nested within Zone. All univariate and multivariate analyses were performed using the PRIMER version 6.0 with PERMANOVA + add on programme.

Results

3.1 Photoquadrats

3.1.1 Invertebrate Species Diversity – Summer 2011

The largest numbers of species were identified within the Northern Reference and Construction Zone, while species numbers were low across the Southern Reference Zone (Figure 2)[1]. PERMANOVA indicated a significant difference between zones for total species numbers (Pseudo – $F_{2, 2.3} = 15.6$; $P = 0.0007$). Pair-wise analysis revealed group differences between the Construction and Southern Reference zone (t = 4.72; $P = 0.0002$) as well as the Northern and Southern Reference zones (t = 4.52, $P = 0.0018$).

Fisheries Beach had the highest diversity (H' = 1.68) due to its relatively low total abundance of individuals (N) compared with the total number of species found (S) (Table 2). However, the greatest number of species and number of individuals recorded occurred within the Construction Zone, sites 1-5 (Table2).

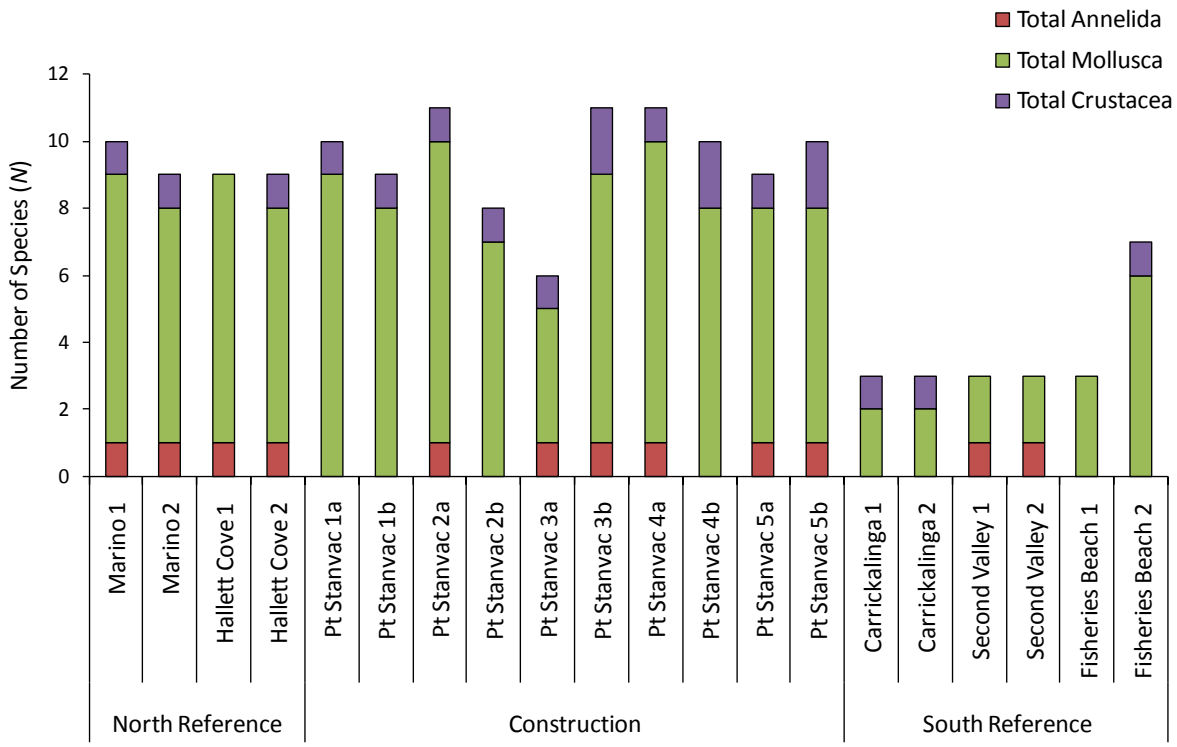

Figure 2: Total species number per phyla identified in quadrats for the Northern Reference Zone, Construction Zone and Southern Reference Zone in Summer 2011.

[1] *Refer to Appendix 1 for complete presence/absence list of species per site in Summer 2011

Table 2: Diversity indices for the Summer intertidal survey during 2011. *S* = number of taxa; *N* = total number of individuals from the two replicate plots per site.

Site	*S*	*N*	Shannon-Wiener	Pielou's evenness	Simpson
Marino	8	523	1.38	0.66	0.63
Hallett Cove	9	694	0.57	0.26	0.22
Port Stanvac 1	10	1064	1.30	0.56	0.66
Port Stanvac 2	11	1282	1.21	0.51	0.64
Port Stanvac 3	10	1505	1.28	0.56	0.64
Port Stanvac 4	11	1913	1.45	0.61	0.69
Port Stanvac 5	10	1398	1.20	0.52	0.62
Carrickalinga	4	370	0.58	0.42	0.33
Second Valley	3	32	0.66	0.60	0.37
Fisheries Beach	9	91	1.68	0.76	0.77

1.1.2 Invertebrate Species Diversity – Autumn 2011

The Construction Zone and one site of the Northern Reference had high numbers of species, while sites within the Southern Reference Zone had low species numbers (Figure 3)[2]. PERMANOVA indicated a significant difference between zones for total species numbers (Pseudo – F 2, 2.42 = 29.93; *P* = 0.0001). Pair-wise analysis revealed group differences between the Construction and Southern Reference zone (t = 8.15; *P* = 0. 0002) and between the Construction and Northern Reference Zone (t = 2.87; *P* = 0.02). Group differences were also obtained between the Northern and Southern Reference zones (t = 3.54, *P* = 0.02).

Highest diversity (H') and also species abundances were found within the Construction Zone. Although having the lowest species abundances within the Construction Zone, Port Stanvac 2 had the highest diversity (H' = 1.87) due to its relatively low total abundance of individuals (N) compared with the total number of species found (S) (Table 3).

[2] *Refer to Appendix 1 for complete presence/absence list of species per site in Autumn 2011

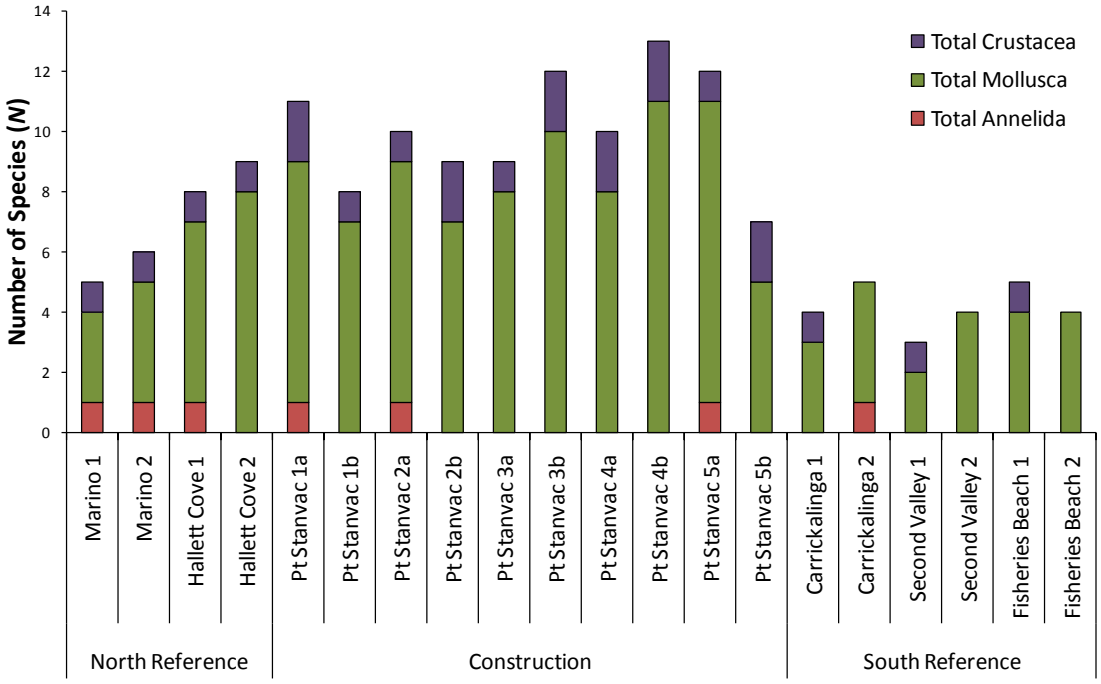

Figure 3: Total species number per phyla identified in quadrats for the Northern Reference Zone, Construction Zone and Southern Reference Zone in Autumn 2011.

Table 3: Diversity indices for the Autumn intertidal survey during 2011. *S* = number of taxa; *N* = total number of individuals from the two replicate plots per site.

Site	*S*	*N*	Pielou's evenness	Shannon-Wiener	Simpson
Marino	7	135	0.64	1.25	0.60
Hallett Cove	9	218	0.48	1.05	0.47
Port Stanvac 1	12	455	0.69	1.71	0.79
Port Stanvac 2	12	249	0.75	1.87	0.79
Port Stanvac 3	13	823	0.69	1.78	0.77
Port Stanvac 4	12	1570	0.66	1.63	0.74
Port Stanvac 5	14	1182	0.52	1.37	0.67
Carrickalinga	5	174	0.60	0.97	0.49
Second Valley	5	61	0.45	0.73	0.35
Fisheries Beach	6	45	0.74	1.32	0.68

3.1.3 Invertebrate Abundances – Summer 2011

During Summer, the average invertebrate abundance from the Construction Zone was 716.20 ± 385.51 standard deviation (SD) and significantly higher (Pseudo – $F_{2, 478.24} = 23.626$; $P = 0.0001$) compared to the other zones (Northern Reference: 304.25 ± 253.35 SD, Southern Reference Zone 82.17 ± 132.14 SD) (Figure 4a). There was no significant difference in abundances between Sites nested within Zones (Pseudo –$F_{7, 12.78} = 0.632$; $P = 0.738$).

Mollusca were most abundant throughout the Construction and Northern Reference Zone with a distinct drop in average abundance within the Southern Reference Zone (Figure 4b). A two-factor univariate PERMANOVA on mollusc abundance found significant differences between Zones (Pseudo – $F_{2, 237.17} = 18.877$; $P = 0.0001$), but not between Sites(Zones) (Pseudo – $F_{7, 8.687} = 0.691$; $P =$

0.6809). A pair-wise analysis for Zone revealed significant differences between the Northern and Southern Reference zones (t = 4.7964, *P* = 0.0001) and the Construction and Southern Zone (t = 6.295, P = 0.0001), but not between the Northern Reference and Construction Zone (t = 1.1106, P = 0.2672).

The largest number of Crustacea were found within the Construction Zone (average abundance of 335.7 ± SD 337.03), compared to the Northern (19.00 ± SD 29.5) and Southern (51.50 ± SD 119.87) Reference Zone (Figure 4c). Crustacea abundances were significantly different between Zones (Pseudo – $F_{2, 184.66}$ = 13.958; *P* = 0.0001), but not between Sites(Zones) (Pseudo – $F_{7, 8.2673}$ = 0.6249; *P* = 0.0001). A pair-wise analysis for Zone revealed significant differences between the Northern and Construction Zone (t = 3.4125, *P* = 0.0006) and the Construction and Southern Reference Zone (t = 4.2187, *P* = 0.0001). However, no significant difference was detected between the Northern and Southern Reference Zones (t = 0.40384, *P* = 0.7542).

1.1.4 Invertebrate Abundances – Autumn 2011

Highest abundances of all phyla occurred within the Construction Zone, whilst the lowest were found within the Southern Reference Zone (Figure 5a). Results from the Autumn PERMANOVA analysis revealed significant differences in abundances between Zones (Pseudo-$F_{2,217.04}$ = 21.459; *P* = 0.0001) as well as Sites nested within Zones (Pseudo-$F_{7,28.882}$ = 2.8556; *P* = 0.0077). A further pair-wise analysis on Zone identified significant differences between the Northern and Construction (t = 3.2471; P = 0.0021) as well as the Construction and Southern Zones (t = 5.7399; *P* = 0.001). However, no significant difference was detected between the Northern and Southern Zone (t = 3.6164; *P* = 0.0006).

Mollusca were identified at all Sites and Zones during Autumn (Figure 5b). A two-factor univariate PERMANOVA on mollusc abundance found significant differences between Zones (Pseudo-$F_{2,58.304}$ = 23.928; *P* = 0.0001) as well as between Sites(Zones) (Pseudo-$F_{7,9.8473}$ = 4.0413; *P* = 0.0004). A pair-wise analysis on Zone revealed significant differences between the Northern and Southern Reference zones (t = 3.7216; P = 0.0004), Construction and Southern Zone (t = 6.6781; *P* = 0.0001) and between the Northern Reference and Construction Zone (t = 2.3874; *P* = 0.0166).

Crustacea abundances were found to be significantly different between Zones (Pseudo-$F_{2,158.36}$ = 14.863; *P* = 0.0001), but not between Sites(Zones) (Pseudo-$F_{7,20.144}$ = 1.8906; *P* = 0.0667). A pair-wise analysis for Zone revealed significant differences between the Northern and Construction Zone (t = 3.4077; *P* = 0.0011) and the Construction and Southern Reference Zone (t = 4.2746; *P* = 0.0001). However, no significant difference was detected between the Northern and Southern Reference Zones (t = 0.619676; *P* = 0.5447).

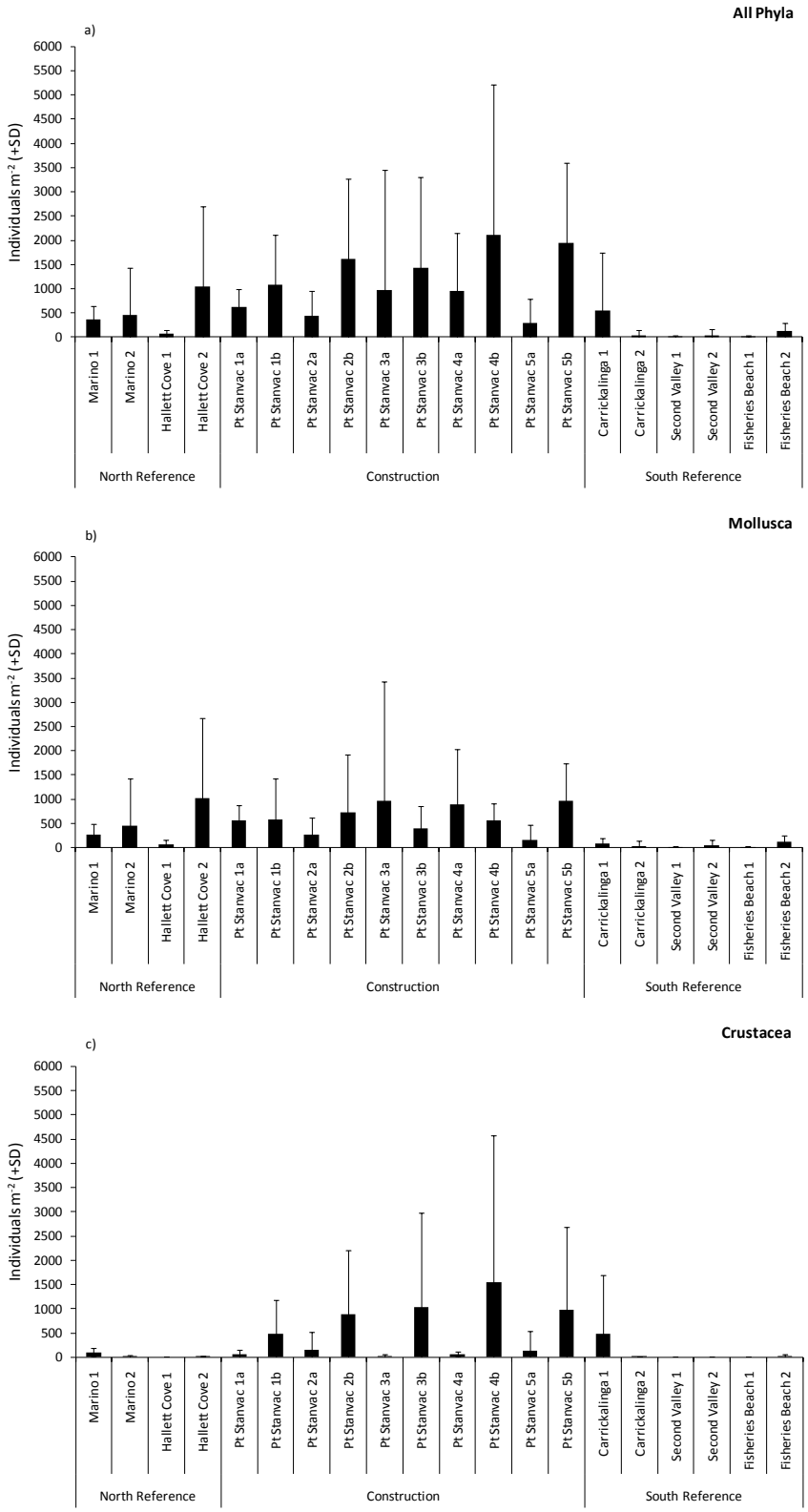

Figure 4: Mean abundances and standard deviations (SD) for (a) all phyla, (b) mollusca and (c) crustacea identified in photoquadrats (n=10) from the Summer 2011 survey at all sites encompassing three zones; Northern Reference Zone, Construction Zone and Southern Reference Zone.

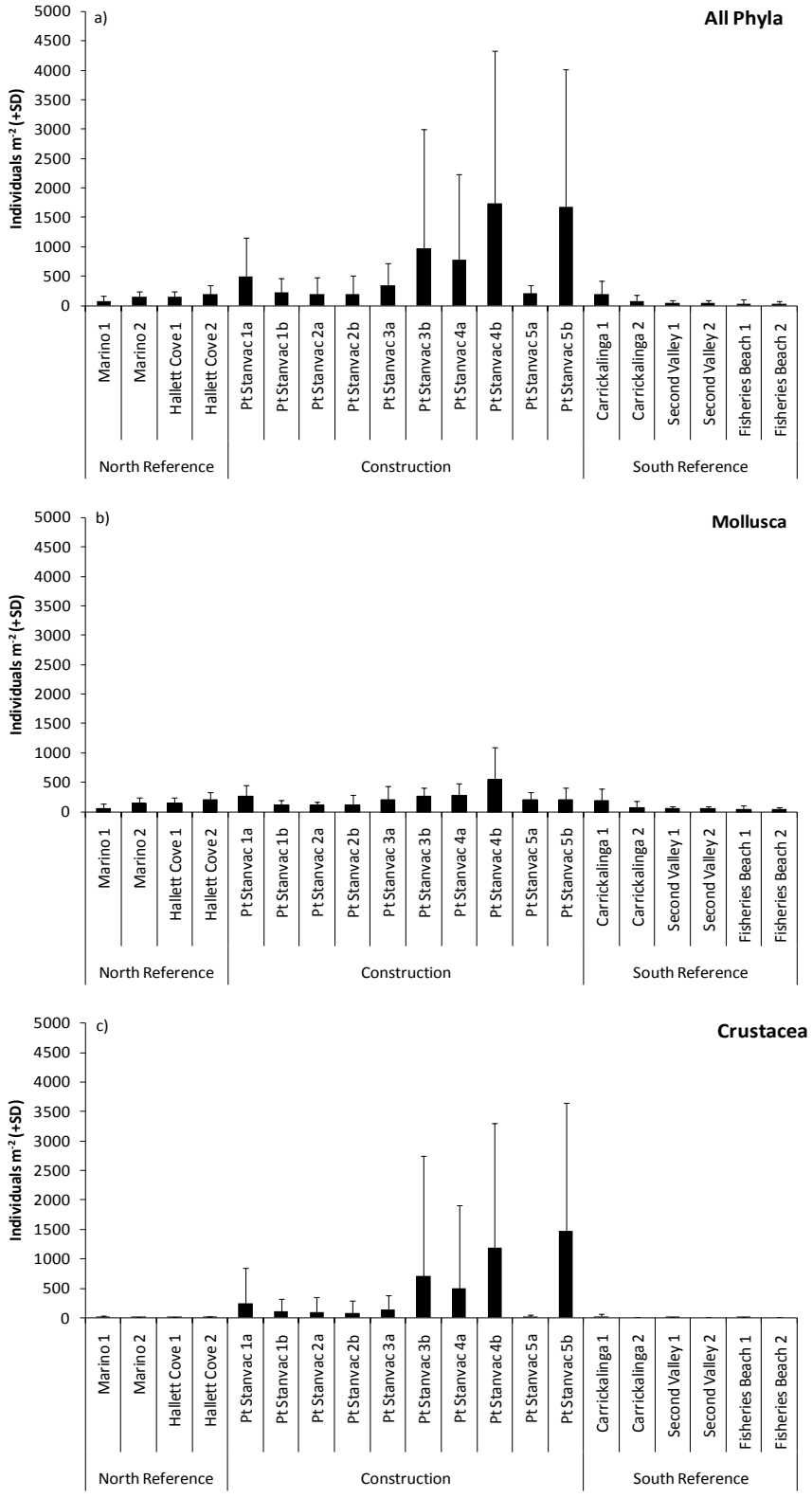

Figure 5: Mean abundances and standard deviations (SD) for (a) all phyla, (b) mollusca and (c) crustacea identified in photoquadrats (n=10) from the Autumn 2011 survey at all sites encompassing three zones; Northern Reference Zone, Construction Zone and Southern Reference Zone.

3.1.5 Percent Cover of Sessile Invertebrates – Summer 2011

The percent cover of sessile fauna was less than 6% for Polychaete tube worms and the bivalve *Limnoperna pulex* across the three separate zones. Polychaete tube worms were found in all three zones with no distinct pattern for Zone with the highest percent cover occurring at site Port Stanvac 5a (Figure 6a). *L. pulex* was detected in both the Construction and Northern Reference Zones, but was not found in quadrats within the Southern Reference Zone (Figure 6b).

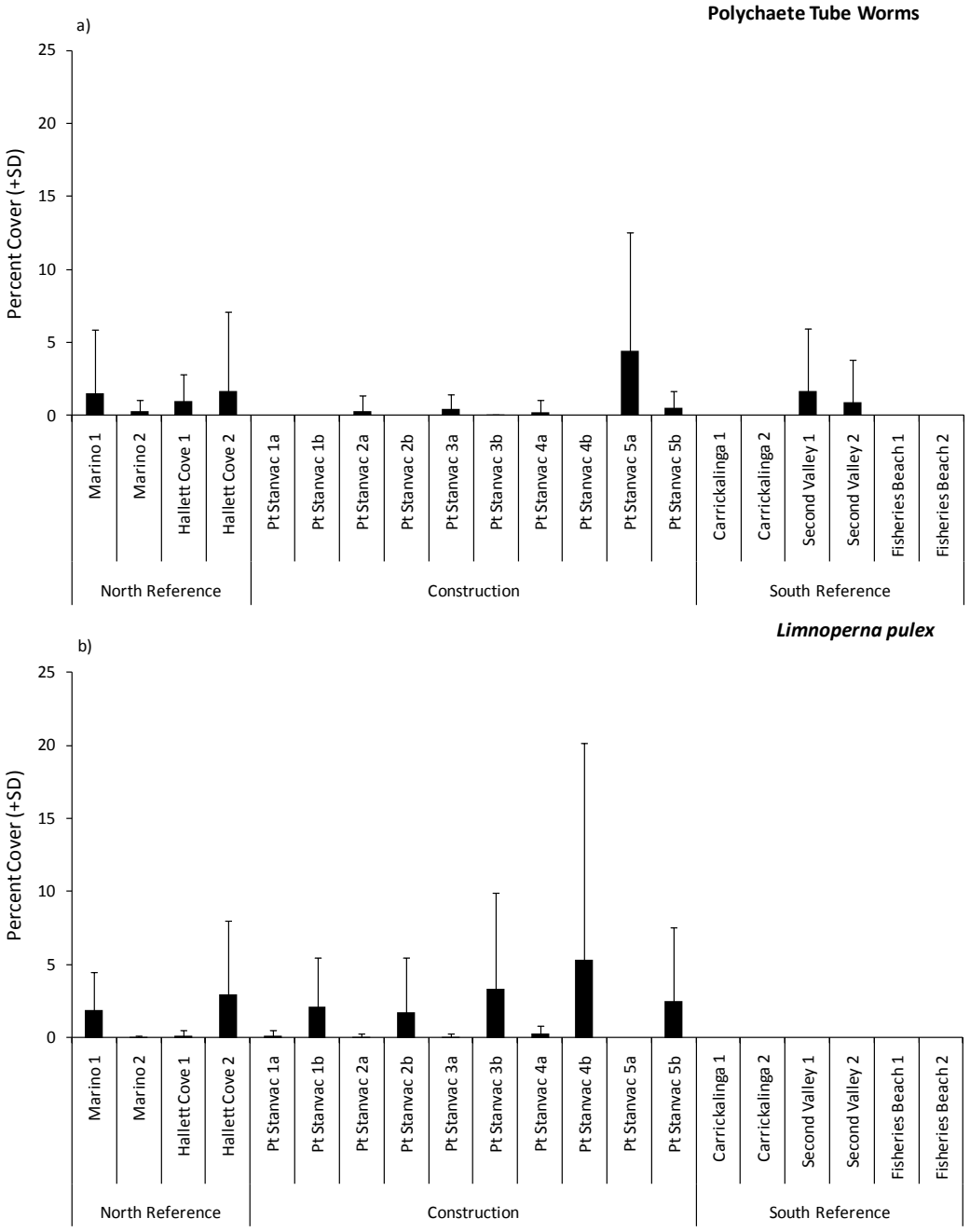

Figure 6: Mean percent cover and standard deviations (SD) for (a) polychaete tubeworms (b) the mollusc *Limnoperna pulex* identified from photo quadrats (n=10) in the Summer 2011 survey at all sites encompassing three zones; Northern Reference Zone, Construction Zone and Southern Reference Zone.

1.1.6 Percent Cover of Sessile Invertebrates – Autumn 2011

During Autumn, polychaete tube worms were found to occur at single sites in all three zones. However, percent cover was less than 10% at each site where they occurred (Figure 7). The mussel, *Limnoperna pulex*, was not detected in the Northern or Southern Zone, only occurring at 1 site, Port Stanvac 4b, where it contributed to less than 1% cover.

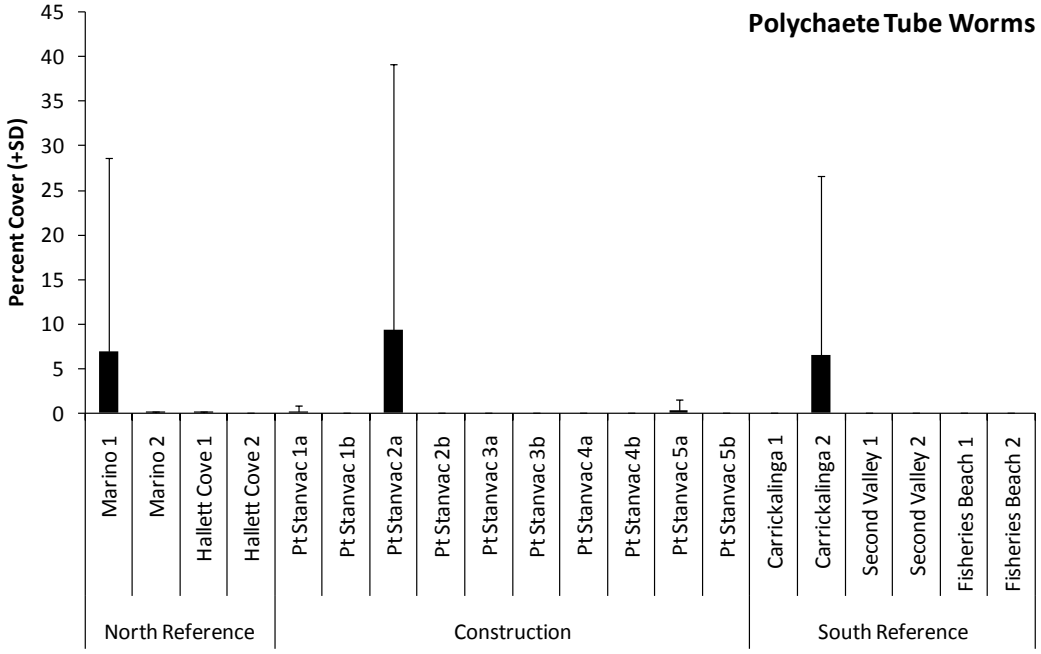

Figure 7: Mean percent cover and standard deviations (SD) for polychaete tubeworms identified from photo quadrats (n=10) in the Autumn 2011 survey at all sites encompassing three zones; Northern Reference Zone, Construction Zone and Southern Reference Zone.

3.1.7 Community Structure of Rocky Shore Invertebrates – Summer 2011

There were distinct differences in rocky shore invertebrate communities for each zone during Summer (Figure 8). Two factor PERMANOVA for Zones and Sites (Zone) revealed a significant difference between Zones (Pseudo – $F_{2, 9057.2} = 5.0929$; $P = 0.0003$) but not for Sites (Zone) (Pseudo – $F_{7, 1708.5} = 0.9607$; $P = 0.5672$). The Construction and Northern Reference Zones had a more distinct community structure with less variability between sites than what was found to occur within the Southern Reference Zone, which displayed more variable assemblages (Figure 8). Pair-wise tests indicated group differences between the Northern Reference and Construction Zone (t = 2.0142; P = 0.0199) and between the Construction and Southern Reference Zone (t = 2.6; P (MC) = 0.0004). Significant differences were also found between the Northern and Southern Reference Zone (t = 1.92; P = 0.0168).

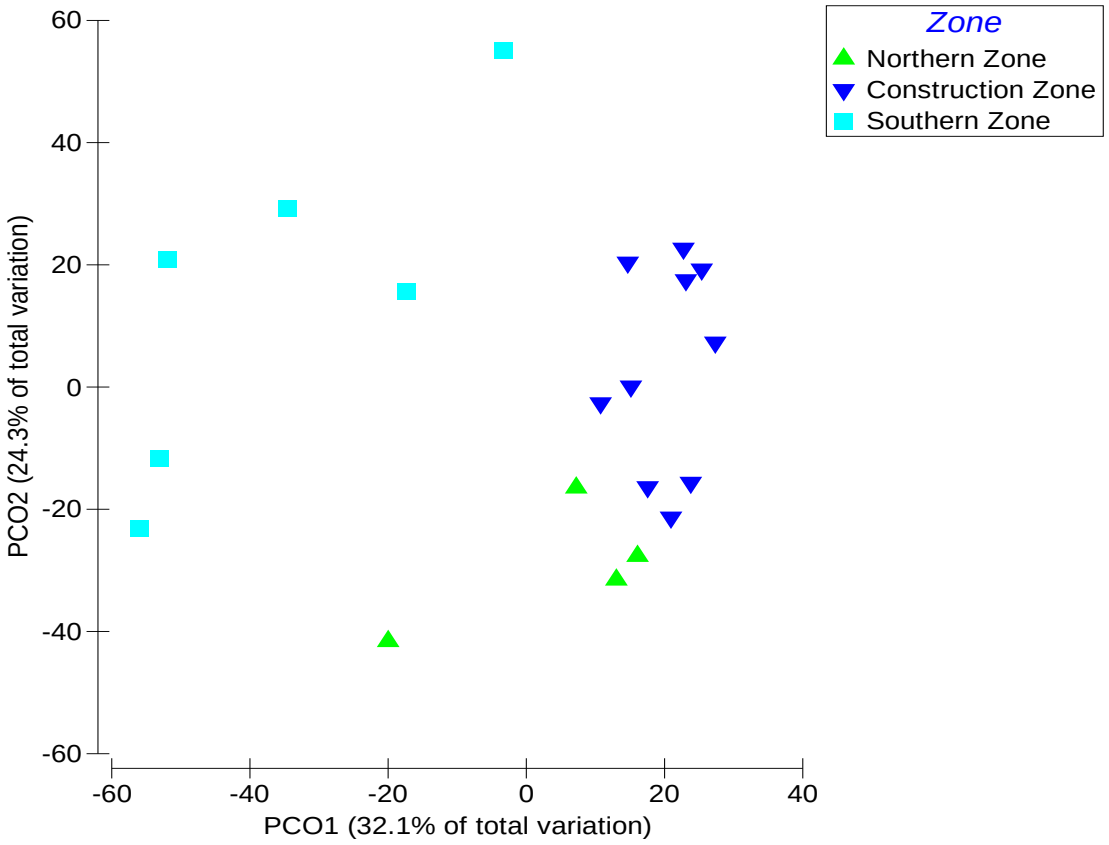

Figure 8: Principle Co-Ordinates (PCO) plot of invertebrate communities for the Summer 2011 survey for the sampling Zones using Bray-Curtis resemblance matrices.

3.1.8 Community Structure of Rocky Shore Invertebrates – Autumn 2011

There were distinct differences in rocky shore invertebrate communities for each zone during Autumn (Figure 9). Two factor PERMANOVA for Zones and Sites (Zone) revealed a significant difference between Zones (Pseudo-$F_{2,26028}$ = 15.864; P = 0.0001) as well as between Sites (Zone) (Pseudo-$F_{7,7959}$ = 4.8511; P = 0.0001). The Construction Zone had a more distinct community structure with less variability between sites than what was found to occur within the Northern and Southern Reference Zones, which displayed more variable assemblages (Figure 8). Pair-wise tests indicated group differences between the Northern Reference and Construction Zone (t = 2.9591; P = 0.0001) and between the Construction and Southern Reference Zone (t = 50.297; P = 0.0001). Significant differences were also found between the Northern and Southern Reference Zone (t = 3.1814; P = 0.0001).

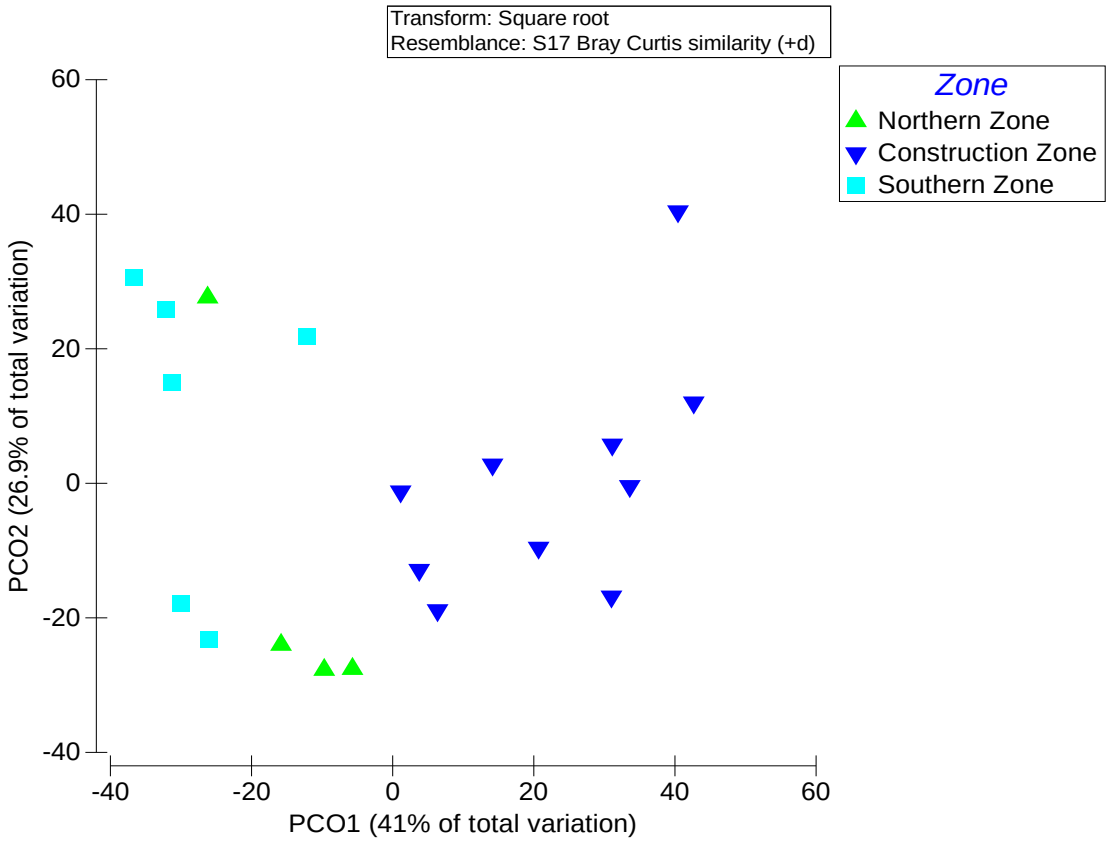

Figure 9: Principle Co-Ordinates (PCO) plot of invertebrate communities for the Autumn 2011 survey for the sampling Zones using Bray-Curtis resemblance matrices.

3.2 Video Transects

3.2.1 Percent of Substrate Cover – Summer 2011

During Summer, the highest proportion of bare rock occurred within the Southern Reference Zone with an average of 95% bare rock. In comparison, the Construction Zone had less than 67% rock cover. Sand cover was very low, only occurring within the Southern Reference Zone at Carrickalinga 2 and Fisheries Beach 2 (Figure 10a). Sand cover only occurred at 4 sites across all Zones, PS5b, CC1, CC2 and FB2 (cover ranged between 0.08 % to 4.14 %). Overall algal and sessile fauna cover was highest within the Construction Zone, particularly at sites PS5b, PS1a and PS1b (Figure 10b).

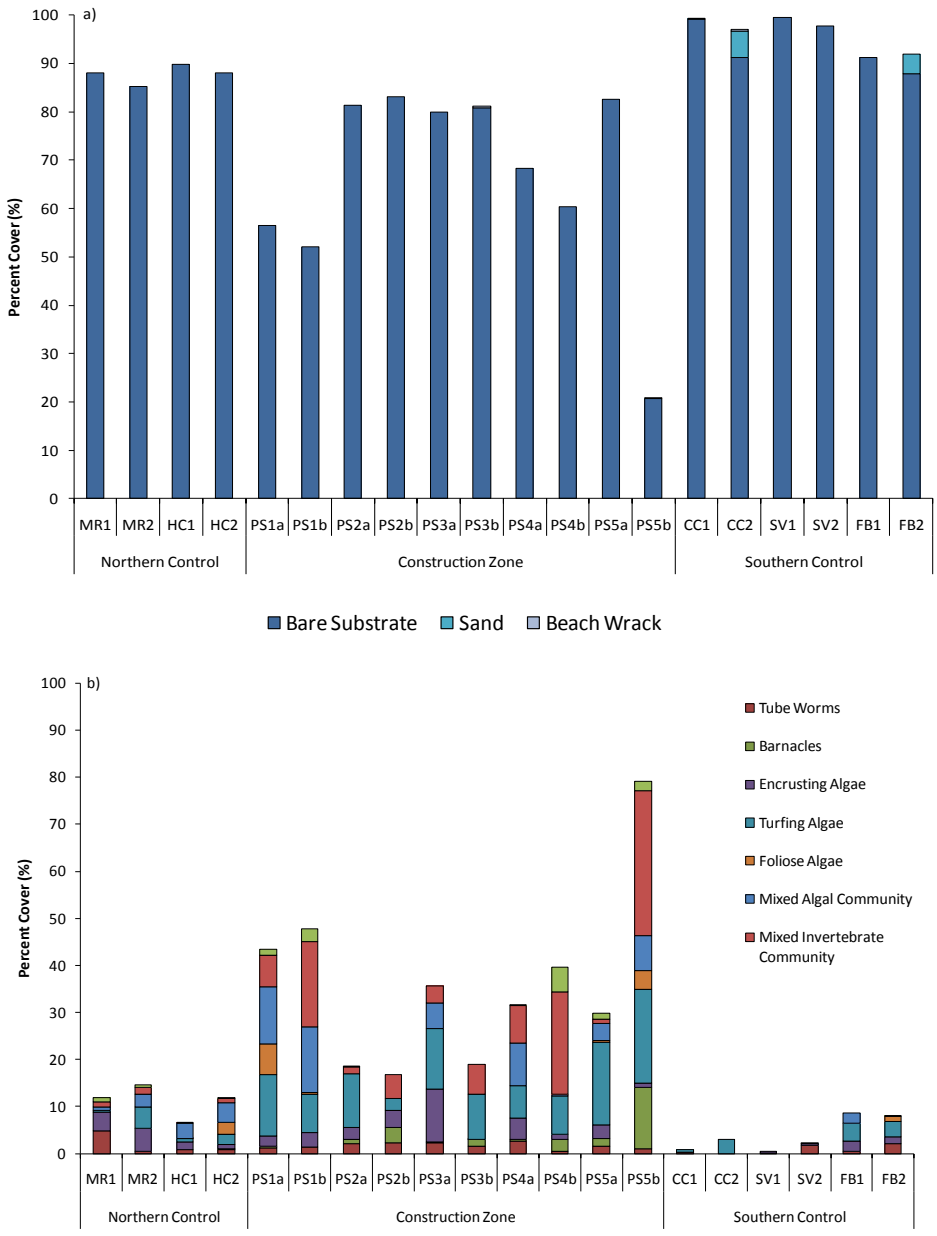

Figure 10: Mean percent cover of intertidal reefs, split into (a) bare substrate and sand and (b) algal and fauna quantified from transects. Based on intertidal reefs at all sites, across three Zones; Northern Reference Zone, Construction Zone and Southern Reference Zone during the Summer 2011 survey.

3.2.2 Percent of Substrate Cover – Autumn 2011

The Southern Reference Zone contained the highest proportion of bare rock followed by the Northern Reference Zone and then Construction Zone (Figure 11a). Sand cover and beach wrack were only observed within the Southern Reference Zone at Carrickalinga and Fisheries Beach. Algal and sessile fauna cover was more prevalent within the Construction Zone, particularly at sites PS1a, PS1b, PS3b and PS4b (Figure 11b).

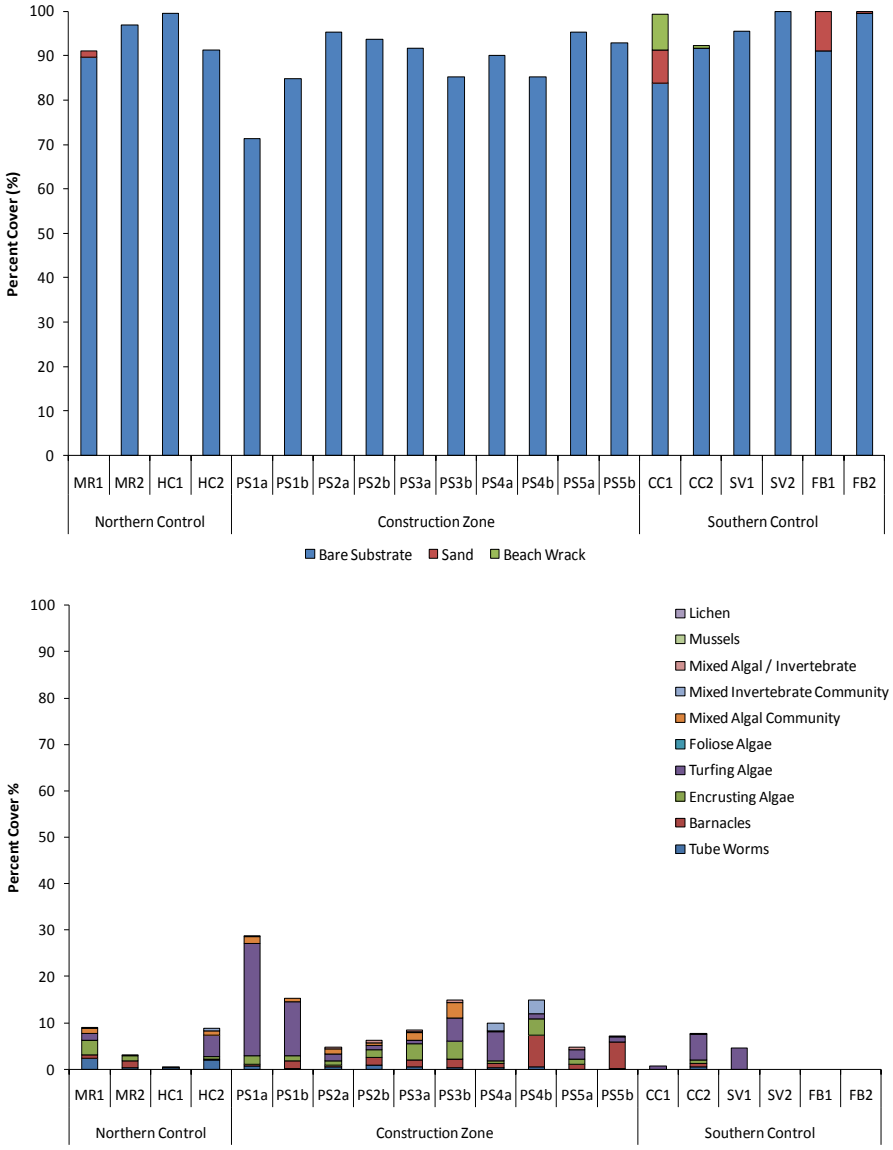

Figure 11: Mean percent cover of intertidal reefs, split into (a) bare substrate and sand and (b) algal and fauna quantified from transects. Based on intertidal reefs at all sites, across three Zones; Northern Reference Zone, Construction Zone and Southern Reference Zone during the Autumn 2011 survey.

3.2.3 Video Transects – Community Structure – Summer 2011

Based on the video transects, the assessment for rocky shores revealed significantly different communities between zones (PERMANOVA, Pseudo-$F_{2, 33173}$ = 36.096; P = 0.0001). Pair-wise tests indicated significant differences between the Northern Reference Zone and the Construction Zone (t = 4.9069; P = 0.0001), and the Southern Reference Zone and Construction Zone (t = 7.6138; P = 0.0001). Significant differences were also detected between the Northern and Southern Reference Zones (t =4.3545; P = 0.0001) (Figure 12).

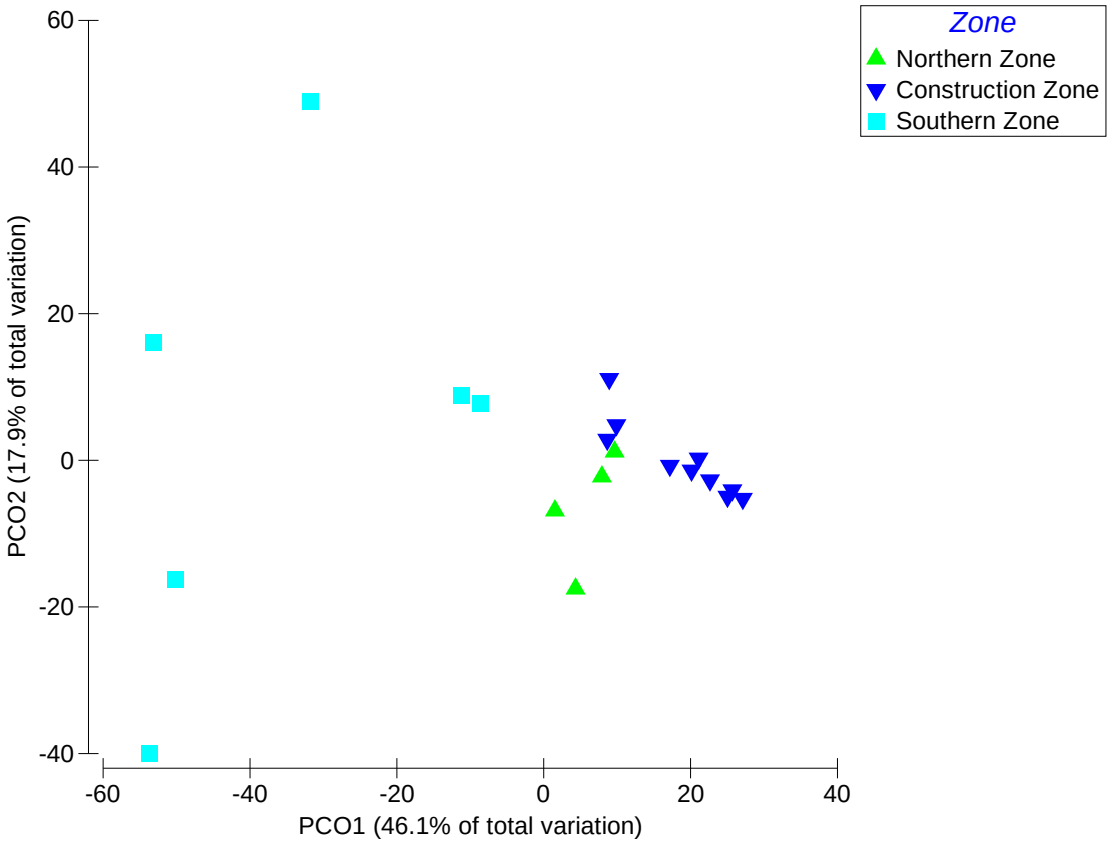

Figure 12: Principle Co-ordinates (PCO) plot of substrate structure obtained via video transect in Summer 2011 for Zones using Bray-Curtis resemblance matrices.

3.2.4 Video Transects – Community Structure – Autumn 2011

An assessment for rocky shores in Autumn 2011 revealed significantly different communities between zones (PERMANOVA, Pseudo-$F_{2, 3596}$ = 23.31; P = 0.0001). Pair-wise tests indicated significant differences between the Northern Reference Zone and the Construction Zone (t = 2.3895; P = 0.0006), and the Southern Reference Zone and Construction Zone (t = 6.2391; P = 0.0001). Significant differences were also detected between the Northern and Southern Reference Zones (t =4.8894; P = 0.0001) (Figure 13). PERMANOVA also revealed significant differences between Sites(zones) (Pseudo-$F_{17, 889.02}$ = 5.76; P = 0.0001).

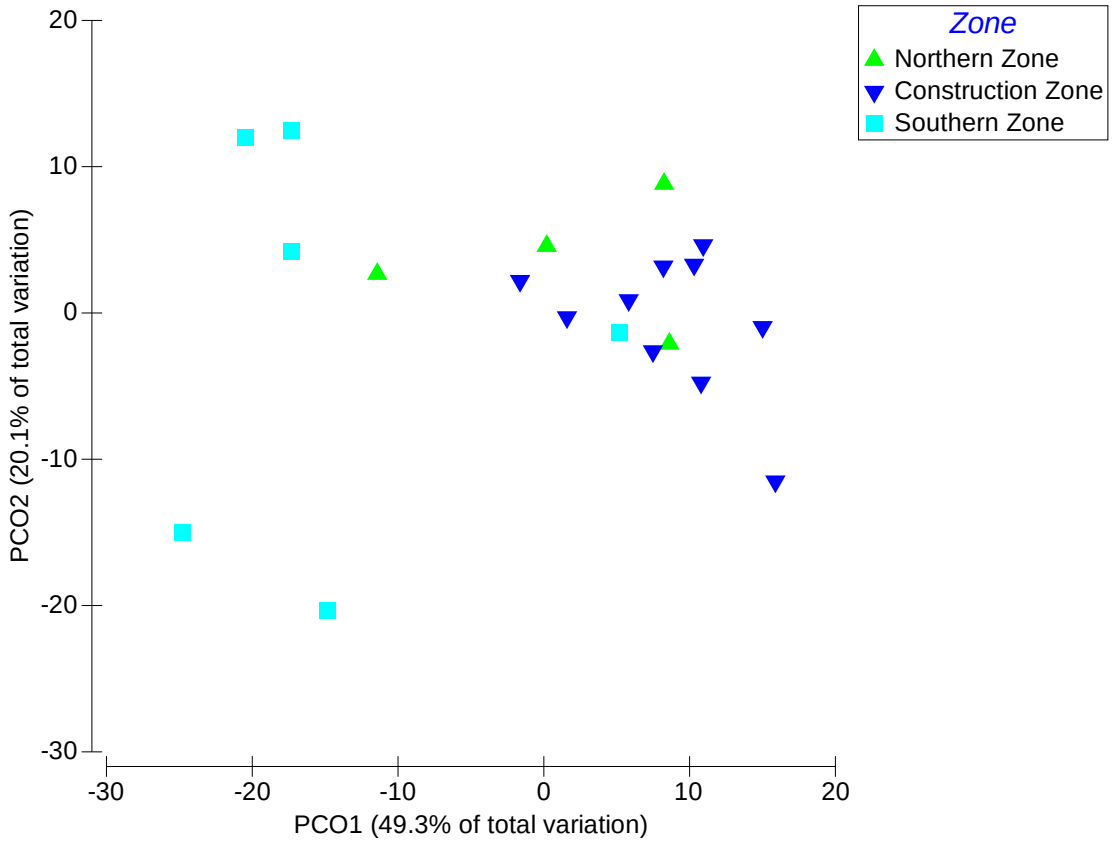

Figure 13: Principle Co-ordinates (PCO) plot of substrate structure obtained via video transect in Autumn 2011 for Zones using Bray-Curtis resemblance matrices.

Summary of Key Results

4.1 Summer 2011

- Fisheries Beach had the highest diversity. However, sites within the Construction Zone had the greatest number of species and total individual abundances.
- Diversity indices calculated for invertebrate species at all sites in Summer 2011 revealed that Fisheries Beach had the highest species diversity (H'), with the lowest found at Hallett Cove.
- Crustacea (barnacles) were the dominant taxa within the quadrats with highest abundances occurring within the Construction Zone.
- Across all three zones sessile cover was dominated by the bivalve *Limnoperna pulex*.
- Community structure of rocky shores was distinctively different between the Construction Zone and the Northern Reference Zone as well as between the Northern and Southern Reference Zones.
- The Southern Reference Zone had the least amount of flora and fauna coverage averaging at approximately 5% across the zone compared to 12.2% in the Northern Reference Zone and 33.5% in the Construction Zone.

- Results from the Summer surveys indicate that there is high variability in species abundances and densities between the three Zones.

4.2 Autumn 2011

- Port Stanvac 4 had the highest individual abundances yet Port Stanvac 5 was found to contain the greatest number of species (n = 14).
- Densities of Crustacea were highest in the Construction Zone compared to the Northern and Southern Reference Zones.
- The Construction Zone generally contained higher species densities.
- Community structure of rocky shore invertebrate species was found to be different between all three zones during Autumn 2011 surveys.
- Algal and sessile fauna cover was more prevalent within the Construction Zone.
- Community structure of sessile fauna was also found to be different between all three zones during Autumn 2011 surveys.
- Autumn surveys showed a high variability in species abundances and densities across the sites surveyed at each Zone.

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Appendix 1

Presence of invertebrate species at each location according to zone for Summer 2011.

Photoquadrat Summer 2011		North Reference		Construction					South Reference		
Species		Marino	Hallett Cove	Port Stanvac 1	Port Stanvac 2	Port Stanvac 3	Port Stanvac 4	Port Stanvac 5	Carrickalinga	Second Valley	Fisheries Beach
Mollusca	*Notoacmea flammea*	✓	✓	✓	✓	✓	✓	✓			
	Patelloida latistrigata			✓	✓	✓	✓	✓			
	Patelloida spp.										
	Cellana tramoserica	✓	✓	✓	✓	✓	✓	✓			✓
	Cellana solida			✓	✓		✓				
	Nerita atramentosa	✓	✓	✓	✓	✓	✓	✓			✓
	Diloma concamerata				✓					✓	✓
	Austrocochlea rudis		✓				✓	✓			
	Austrocochlea constricta		✓	✓		✓					✓
	Austrolittorina unifasciata				✓	✓	✓	✓	✓		✓
	Bembicium nanum	✓	✓	✓	✓						✓
	Bembicium vittatum			✓	✓	✓	✓	✓	✓	✓	✓
	Siphonaria diemenensis	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Siphonaria zelandica	✓	✓								✓
	Limnoperna pulex	✓	✓	✓	✓	✓	✓	✓			
Crustacea	*Tetraclitella purpurascens*										✓
	Chtalamus antennatus	✓	✓	✓	✓	✓	✓	✓	✓		
	Chamaesipho tasmanica					✓	✓	✓			
Annelida	*Polychaete Tube Worms*	✓	✓		✓	✓	✓	✓		✓	

Presence of invertebrate species at each location according to zone for Autumn 2011.

Quadrats Autumn 2011		North Reference		Construction					South Reference		
	Species	Marino	Hallett Cove	Port Stanvac 1	Port Stanvac 2	Port Stanvac 3	Port Stanvac 4	Port Stanvac 5	Carrickalinga	Second Valley	Fisheries Beach
Mollusca	*Limnoperna pulex* (%)						✓				
	Notoacmea flammea			✓	✓	✓	✓	✓			
	Notoacmea petterdi				✓						
	Notoacmea spp.							✓			
	Patelloida alticostata		✓			✓	✓	✓			
	Patelloida latistrigata				✓	✓	✓	✓			
	Cellana tramoserica	✓	✓	✓	✓	✓	✓	✓			
	Cellana solida			✓							
	Nerita atramentosa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Diloma concamerata	✓	✓			✓	✓	✓			✓
	Austrocochlea constricta			✓	✓	✓					
	Afrolittorina praetermissa							✓			
	Austrolittorina unifasciata	✓		✓	✓	✓	✓	✓	✓		✓
	Bembicium nanum	✓	✓	✓	✓	✓		✓	✓	✓	✓
	Bembicium vittatum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Siphonaria diemenensis		✓	✓	✓	✓	✓	✓		✓	
	Siphonaria zelandica		✓	✓			✓				
Crustacea	*Tetraclitella purpurascens*										
	Chtalamus antennatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Chamaesipho tasmanica			✓	✓	✓	✓	✓			
Annelida	Polychaete Tube Worms	✓	✓	✓	✓			✓	✓		