# Adelaide Aqua Desalination Plant Benthic Infauna Monitoring Survey 2023

## Final Report

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Flinders University acknowledges the Kaurna People as the Traditional Owners and Custodians of the lands and waters this research was undertaken on. We honour their Elders past, present and emerging.

# CONTENTS

Executive summary ........ 4
1. Introduction ........ 5
1.1 Background and Rationale ........ 5
1.2 Aims and Approach ........ 5
2. Methods ........ 6
2.1 Sampling sites ........ 6
2.2 Field methodology ........ 9
2.3 Laboratory processing ........ 10
2.4 Data analyses ........ 11
3. Results ........ 12
3.1 Sediment grain size ........ 12
3.2 Benthic meiofauna ........ 16
3.3 Benthic macrofauna ........ 24
4. Discussion ........ 33
5. Acknowledgements ........ 35
6. References ........ 35
7. Appendix ........ 36

# EXECUTIVE SUMMARY

The following report provides an assessment of sediment composition, benthic meiofauna and macrofauna associated with sediments as core components of the 2023 benthic monitoring program for the Adelaide Aqua Pty Ltd. desalination plant as required for EPA compliance (Licence 39143). The benthic infauna and sediment surveys conducted in autumn and spring 2023 were conducted within the vicinity of the Port Stanvac desalination plant and control locations to the north (Glenelg) and south (Port Noarlunga). Across the two surveys, a total of 400 sediment, meiofauna and macrofauna samples were obtained for analysis of benthic condition.

Overall, the 2023 survey identified that there were no significant differences in sediment condition or benthic meiofauna and macrofauna between zones and locations associated with the Port Stanvac desalination plant. There were site specific differences within locations and zones that were consistent with natural variation through this 2023 survey and previous surveys and not attributed to the desalination plant operations. Sediments across all seasons, zones and locations consisted of sand and some mud as observed in previous surveys. Meiofauna mainly consisted of particular taxa (i.e. Foraminifera, nematodes and ostracods), which was consistent with previous surveys across the years. Meiofauna communities varied across sites and between seasons as observed previously but had changed due to reduced diversity and abundances, which are likely due to changes in sediment structure across the Adelaide coastline, rather than any influence from the desalination plant. Macrofauna was quite diverse across all locations and consistently varied between sites within locations and between seasons during the 2023 survey. That pattern was similar to observations found in previous surveys and is most likely attributed to the natural response and variation of benthic macrofauna that reside in the dynamic sediments across the Adelaide metropolitan coastline.

Altogether, the sediment conditions and response of benthic meiofauna and macrofauna across seasons that were observed in the 2023 survey are consistent with the natural variation through time and space observed in surveys since 2010. Those responses are more aligned to the dynamic benthic condition along the Adelaide coastline and not due to any influence of the Port Stanvac desalination plant brine discharge. Benthic monitoring should progress forward in future surveys unchanged, but detailed assessment of all sediment and benthic meiofauna and macrofauna from previous surveys needs advanced analyses beyond the standard set of assessments that are currently used and we suggest some unique ways that this could be achieved.

# 1. Introduction

## 1.1 Background and Rationale

The Adelaide Aqua desalination plant, located at Port Stanvac on the Adelaide metropolitan coastline, began operation in 2012. Early baseline monitoring of benthic condition around the desalination plant infrastructure across subtidal soft sediments occurred during the construction and running-in phase (Ramsdale et al. 2011, Loo et al. 2014). In accordance with the Environmental Protection Agencies' licence requirements for the desalination plant's operation by Adelaide Aqua, benthic infauna assessments of the adjacent coastal environments are to be undertaken every three years for compliance, with two surveys in each survey year. This report presents the findings from the 2023 monitoring that encompasses one field survey in each of March/April (autumn) and September/October (spring).

Across the benthic monitoring years for the Adelaide Aqua desalination plant there have been changes to the methods used to capture infauna and sediment. From 2009 to 2011 and in 2017, Flinders University used box coring, dredges and suction sampling (Ramsdale et al. 2011, Dittmann et al. 2017); followed by a change to HAPS coring by SARDI Aquatic Sciences from 2012 to 2013 (Loo et al. 2014), and SCUBA divers with hand corers by J Diversity Pty Ltd. in 2020 (Loo et al. 2021). The box coring method was implemented again in 2023 so that comparisons in benthic fauna and sediment condition could be made with earlier surveys (2009 to 2011) and with a standardised area of macrofauna infauna calculated to individuals per $m^2$, comparisons can be made to surveys in 2012/13 and 2020. However, due to variation in methods and enumeration of the meiofauna assessment across the years, the data can only be reliably compared based on presence/absence of taxa as community data and species richness. For the 2023 benthic monitoring, areas at the Port Stanvac desalination plant location, which surrounds the plant infrastructure (i.e. intake pipeline and outflow diffuser) and the control locations at Glenelg and Port Noarlunga were surveyed according to site boundaries that have been implemented since 2017. Thus, the scientific evaluation of the 2023 Adelaide Aqua benthic monitoring will provide the conformance required for EPA licence conditions for compliance of desalination plant operations.

## 1.2 Aims and Approach

The overall aim of the 2023 benthic monitoring project was to assess the benthic condition of the coastal waters at the Port Stanvac desalination plant location, with comparison to northern and southern control locations at Glenelg and Port Noarlunga. The surveys consisted of assessing the benthic macrofauna and meiofauna, along with sediment condition at the desalination plant and control locations. Benthic condition monitoring based on assessment of infauna and sediment profiles is a core component of the Adelaide Aqua desalination plant environmental monitoring program as required by EPA licence conditions for plant operations. Findings from the autumn/spring 2023 assessments can be compared with summer/autumn baseline surveys conducted from 2009 to 2013 and the previous monitoring surveys completed in 2017 and 2020.

# 2. Methods

## 2.1 Sampling sites

Sampling was undertaken at three locations along the Adelaide metropolitan coastline in Gulf St. Vincent, South Australia, in autumn (March and April) and spring (September/October) 2023. Locations consisted of the Adelaide Aqua Desalination Plant inlet and outlet pipe near Port Stanvac (PSDP; 35°05'S, 138°28'E), a Northern Control (NC) location at Glenelg (34°59'S, 138°26'E) and a Southern Control (SC) location at Port Noarlunga (35°09'S, 138°26'E) (Figure 1).

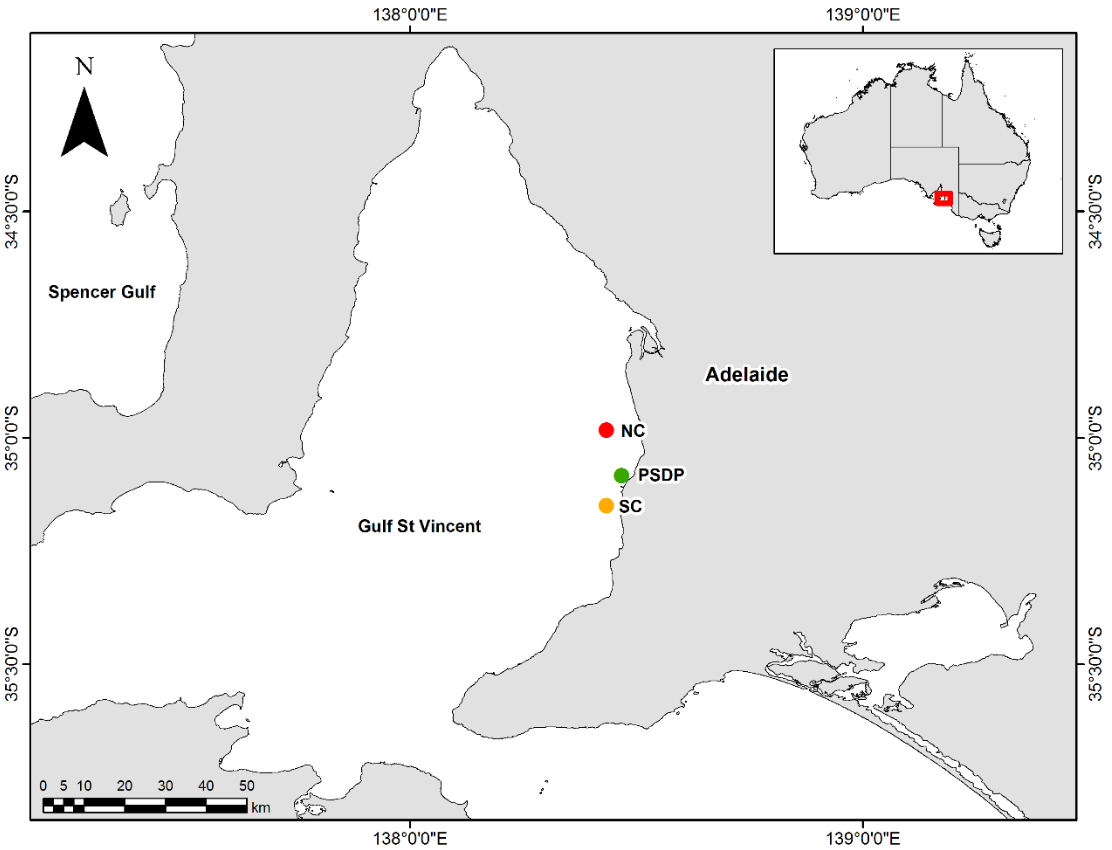
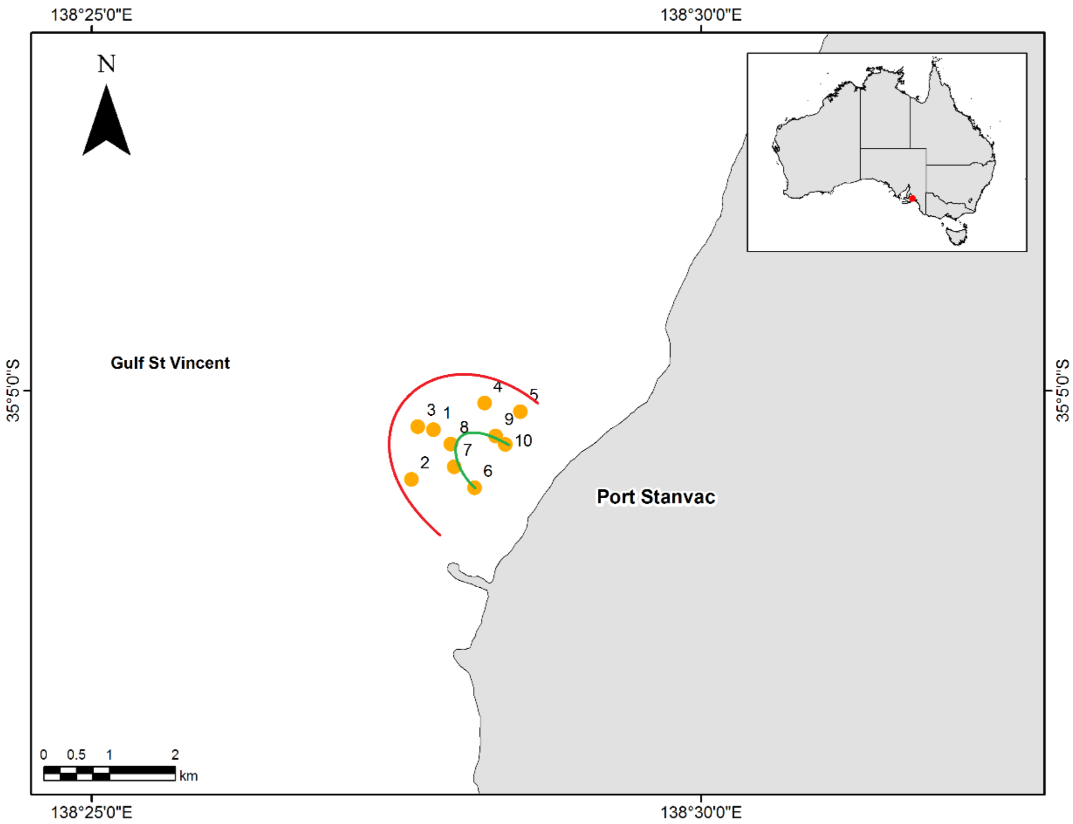


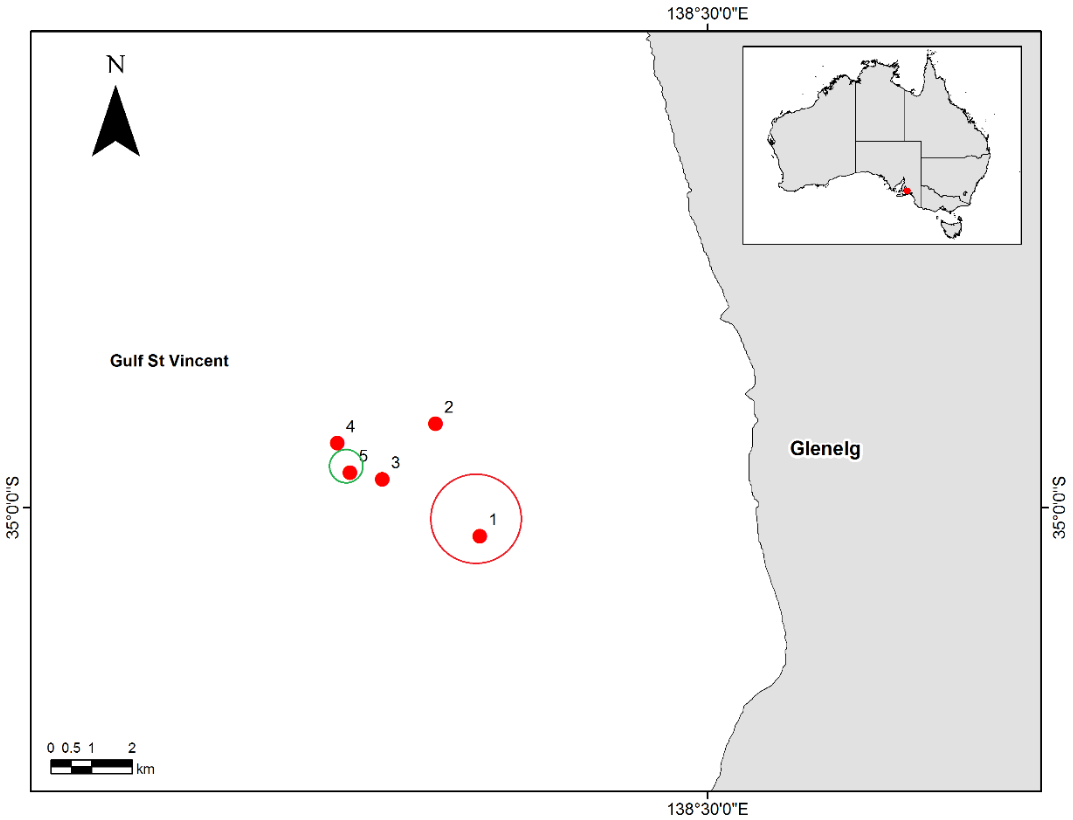

**Figure 1: Map of the Port Stanvac Desalination Plant (PSDP), North Control (NC) and South Control (SC) infauna monitoring locations during autumn and spring surveys in 2023.**

The sites for the 2023 surveys were located within the complete site perimeters from all previous surveys undertaken between 2009 to 2020 at the Port Stanvac desalination plant and southern control locations (Figure 2). The northern control location sites were within the same boundary as the previous surveys completed in 2017 and 2020 (Figure 2). Water depths were similar across the three locations, but shallowest at Port Stanvac and deepest at Port Noarlunga (Table 1). All sampling of organisms occurred under a Marine Parks permit (MR00212-1) for the Port Noarlunga Southern Control location, which falls within the Encounter Bay Marine Park.

(a)


138°25'0"E
138°30'0"E
N
Gulf St Vincent
Port Stanvac
35°5'0"S
1
2
3
4
5
6
7
8
9
10
0 0.5 1 2
km

(b)


138°30'0"E
N
Gulf St Vincent
Glenelg
35°0'0"S
1
2
3
4
5
0 0.5 1 2
km

(c)

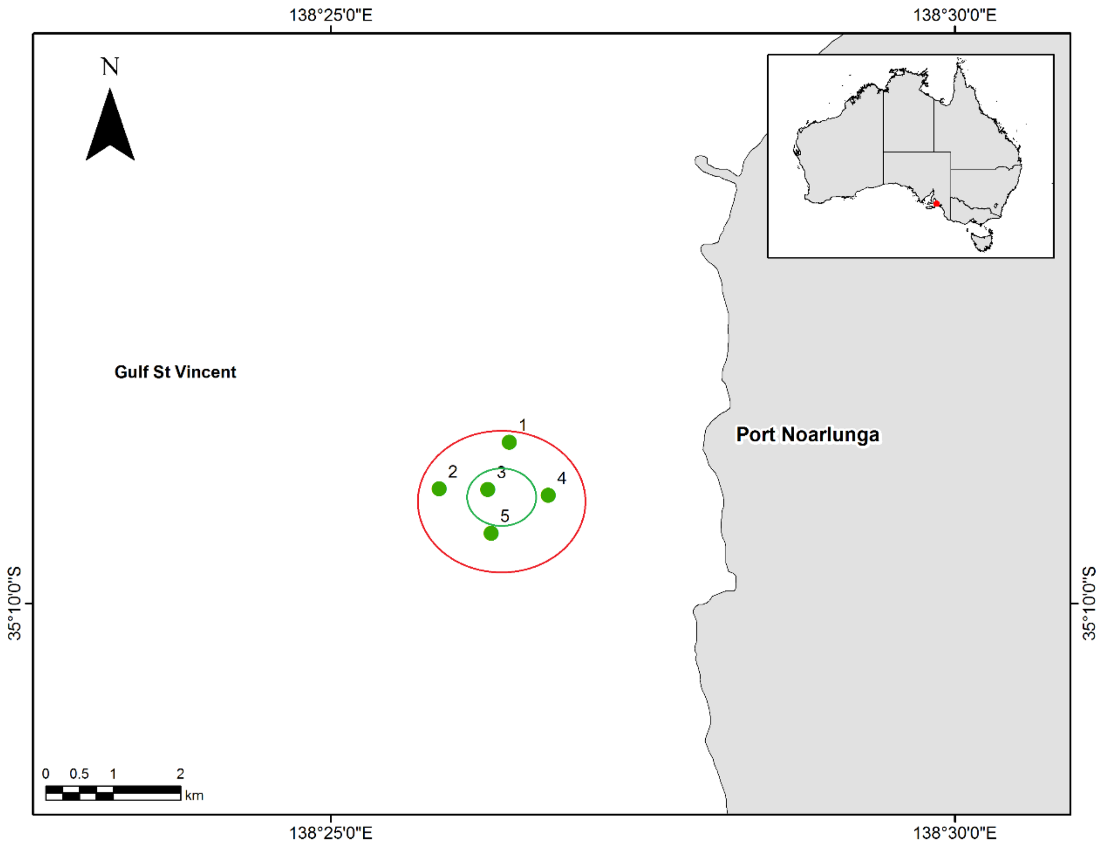



**Figure 1: Sites surveyed for benthic infauna monitoring within each of the (a) Port Stanvac Desalination Plant, PSDP; (b) North Control, NC and; South Control, SC locations during autumn and spring 2023.**

**Table 1: Locations and sites sampled during the autumn and spring 2023 infauna surveys. GPS locations and depth ranges are provided for each site within each of the three locations.**

| | | Date sampled | | | | |
|---|---|---|---|---|---|---|
| Location | Site | Autumn | Spring | Latitude | Longitude | Depth (m) |
| Port Noarlunga South Control (SC) | 1 | 10/3/23 | 01/09/2023 | 35°08.702' | 138°26.434' | 18 - 21 |
| | 2 | 10/3/23 | 01/09/2023 | 35°09.079' | 138°25.897' | 21 - 22 |
| | 3 | 14/3/23 | 01/09/2023 | 35°09.091' | 138°26.253' | 19 - 21 |
| | 4 | 14/3/23 | 01/09/2023 | 35°09.136' | 138°26.744' | 17 - 19 |
| | 5 | 14/3/23 | 28/09/2023 | 35°09.439' | 138°26.280' | 18 - 20 |
| Port Stanvac Desalination Plant (PSDP) | 1 | 15/3/23 | 28/09/2023 | 35°05.032' | 138°27.805' | 17 - 19 |
| | 2 | 15/3/23 | 28/09/2023 | 35°05.747' | 138°27.685' | 19 - 20 |
| | 3 | 15/3/23 | 28/09/2023 | 35°05.298' | 138°27.676' | 19 - 20 |
| | 4 | 15/3/23 | 29/09/2023 | 35°05.090' | 138°28.219' | 16 - 18 |
| | 5 | 21/3/23 | 29/09/2023 | 35°05.175' | 138°28.522' | 14 - 16 |
| | 6 | 21/3/23 | 29/09/2023 | 35°05.797' | 138°28.152' | 15 - 17 |
| | 7 | 22/3/23 | 29/09/2023 | 35°05.625' | 138°27.966' | 17 - 20 |
| | 8 | 22/3/23 | 2/10/2023 | 35°05.428' | 138°27.966' | 17 - 19 |
| | 9 | 3/4/23 | 2/10/2023 | 35°05.362' | 138°28.320' | 16 - 18 |
| | 10 | 3/4/23 | 2/10/2023 | 35°05.435' | 138°28.403' | 14 - 17 |
| Glenelg North Control (NC) | 1 | 30/3/23 | 2/10/2023 | 35°00.377' | 138°26.976' | 14 - 19 |
| | 2 | 30/3/23 | 10/10/2023 | 34°59.881' | 138°26.395' | 18 - 19 |
| | 3 | 31/3/23 | 10/10/2023 | 34°59.617' | 138°25.675' | 20 - 22 |
| | 4 | 13/4/23 | 10/10/2023 | 34°59.138' | 138°25.071' | 18 - 21 |
| | 5 | 13/4/23 | 10/10/2023 | 34°59.523' | 138°25.263' | 20 - 22 |

## 2.2 Field methodology

The surveys in 2023 used the original method of box coring (see 2009 to 2011 and 2017 surveys) to obtain sediments for macrofauna, meiofauna and sediment condition. At each of the sites within all three locations, benthic sediment samples were taken at approximately 20 metres apart from each other within each site. These points were randomly pre-selected during the 2017 surveys (Dittmann et al. 2017). Sediment samples were obtained using a box corer (Wildco®, model: 191-A12, internal dimensions: 0.15 x 0.15 x 0.23 m, surface area 225 $cm^2$), which was deployed and retrieved by electric winch from the Flinders University Research Vessel 'Tethys'. Penetration depths of the box corer varied depending on the bottom type but was within the range of 5 to 10 cm across all locations. Each sediment core obtained was carefully emptied into a plastic bin so that subsamples could be taken from the top horizon of the sediment for:

(a) sediment grain size characteristics (one subsample of 10 $cm^3$ volume), and;
(b) meiofauna (one subsample of 1.33 $cm^2$ sediment surface area to 1-2 cm depth).

The remaining sample was sieved with seawater through a 500 µm mesh and rinsed into a plastic zip-lock bag with 70 % ethanol solution for preservation of macrofauna.

This sampling procedure was an efficient process for obtaining the 200 samples overall (100 samples from the PSDP, and 50 samples each from the NC and SC control locations). Where core samples were too small to obtain enough sediment for proper analysis of all three components (i.e. sediment condition, meio- and macro-faunal analysis), the box corer was dropped at the same location again and the sediment was pooled to make one sample.

During each field survey day, all sediment and meiofauna samples were kept on ice and stored in a -20°C freezer upon return to Flinders University laboratories until further processing.

## 2.3 Laboratory processing

To keep consistency with early surveys (2009 to 2011; Ramsdale et al. 2011) and the 2017 survey (Dittmann et al. 2017), laboratory methods did not change at all for each of the sediment grain size, benthic meio- and macro-fauna.

### *2.3.1 Sediment grain size composition*

Sediment grain size was assessed for each site within each location across the autumn and spring 2023 surveys. Sediment samples were thawed and sediment grain sizes were determined by laser diffraction using a particle size analyser (Malvern Mastersizer 3000). To avoid blockage in the particle size analyser, sediment grain sizes with a fraction >1 mm were wet sieved off manually. The weights of the >1 mm fraction and the remaining sediment were determined and corrected so that the dataset could be normalised. Sediment data were then processed through a data analysis program (Gradistat) to determine median grain size and the sorting coefficient and categorized according to the parameters of 'geometric method of moments' (Blott & Pye 2001).

### *2.3.2 Benthic meiofauna*

Frozen meiofauna samples were thawed and extracted from sediments using the Ludox™ floatation method (Somerfield and Warwick 2013). Sediment was decanted in fresh water, first through a 500 µm mesh sieve and secondly with remaining supernatant poured through a finer 53 µm mesh sieve to separate the meiofauna and unicellular (ciliates) organisms from larger sediment particles. The meiofauna, unicellular organisms, fine sediments and detritus that remained were then processed with Ludox™ to float off and isolate the meiofauna from sediments and detritus. The extracted meiofauna samples were set onto glass slides with remaining moisture evaporated and meiofauna preserved with a 5 % pure glycerol and 70 % ethanol mixture. Cover slides were added to microscope slides and sealed with paraffin wax for identification and enumeration of individual taxa under compound microscope. Taxa were identified to higher taxonomic levels as ecological knowledge of meiofauna species, especially for Australian sediments, is limited (Bouwman 1987).

### *2.3.3 Benthic macrofauna*

In the laboratory, the preserved macrofauna samples were rinsed with freshwater through a 500 µm mesh sieve to remove any further fine sediment particles and residual ethanol. Samples were sorted under dissecting microscopes and all macrofauna was extracted, identified to the lowest possible taxonomic level and all individuals from each taxa were enumerated. All macrofauna specimens were preserved in vials of 70 % ethanol for storage and future reference.

## 2.4 Data analyses

Meiofauna and macrofauna data were analysed for differences between the factors of Time (random factor), Zone (fixed factor), Location nested in Zone (fixed factor), and Site nested in Location and Zone (random factor). For species diversity indices an experimental design that incorporated sites as replicates by pooling replicates within each site. For the sediment data, the sediment grain sizes were square root transformed and percent contribution of sediment fractions (e.g. sand, mud) were left untransformed. The sediment data were statistically analysed with univariate PERMANOVA based on Euclidean distances. Species richness and diversity indices (i.e. Pielou's evenness J', Shannon Weiner H' and Simpson's 1-λ') were calculated and left untransformed before univariate PERMANOVA analyses based on Euclidean distances. The total abundances of all meiofauna and macrofauna along with common taxa were square root transformed and analysed with univariate PERMANOVA based on Euclidean distances.

For the community structure of meiofauna and macrofauna, the square root transformed data were plotted using bootstrapped Metric Multidimensional Scaling (MDS) on Bray-Curtis similarities to visualise groupings between the factors of Time and Location. The same multi-factorial statistical design that included Time, Zone, Location and Site was used in multivariate PERMANOVA to identify if there were any significant differences in meiofauna and macrofauna community structure. Any significant differences identified in PERMANOVA main tests for fixed factors and interactions between factors were analysed further using pairwise tests. Identification of species that were contributing to significant differences between factors were discriminated using SIMilarity of PERcentages (SIMPER) (Clarke and Gorley 2015). Further analyses of sediment condition data relationships with meiofauna and macrofauana data were only conducted if there were significant differences for fixed factors in the separate sediment, and community structure analyses. Bootstrapped MDS plots were also conducted on meiofauna community data with Foraminifera excluded as the previous monitoring programs had either included (Ramsdale et al. 2011) or excluded (Loo et al. 2014) Foraminifera from meiobenthic assessments. Thus, we provide assessments of meiofauna including and excluding Foraminifera to provide easy comparisons between both previous surveys and the current one. All analyses were conducted using PRIMER/PERMANOVA+ (Version 7).

# 3. Results

## 3.1 Sediment grain size

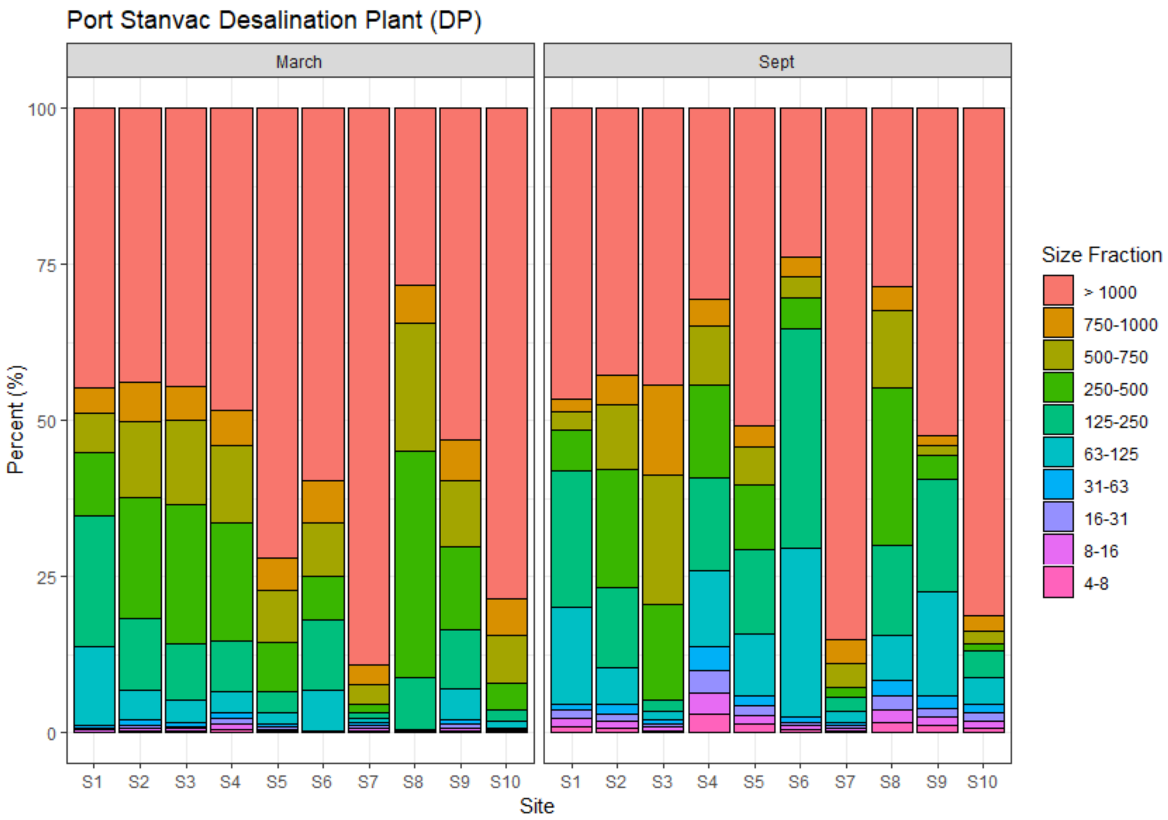
### *3.1.1 Sediment grain size – 2023 survey*

Sediment condition across all locations in both autumn and spring surveys mainly consisted of sand over mud/silt and were mostly poorly sorted, aside from the moderately sorted classification in autumn at the Glenelg North Control (NC) location (Table 2). Across all locations and during both autumn and spring surveys, sediment grain sizes were mainly coarse (> 500 μm) and were greatest at the Port Stanvac Desalination Plant (PSDP) location (Figure 2; Table 2). Median grain sizes were only significantly different between sites nested within locations (Table 3). Further, there were significant interactions for survey time by sites (zone and location) for the sand and mud classifications, which is indicative of natural site to site variation across seasons (Table 3).

**Table 2: Descriptions of grain size distributions and sorting co-efficients using geometric methods of moments (Blott and Pye, 2001) from each location averaged across sites, during the Autumn and Spring 2023 infauna survey.**

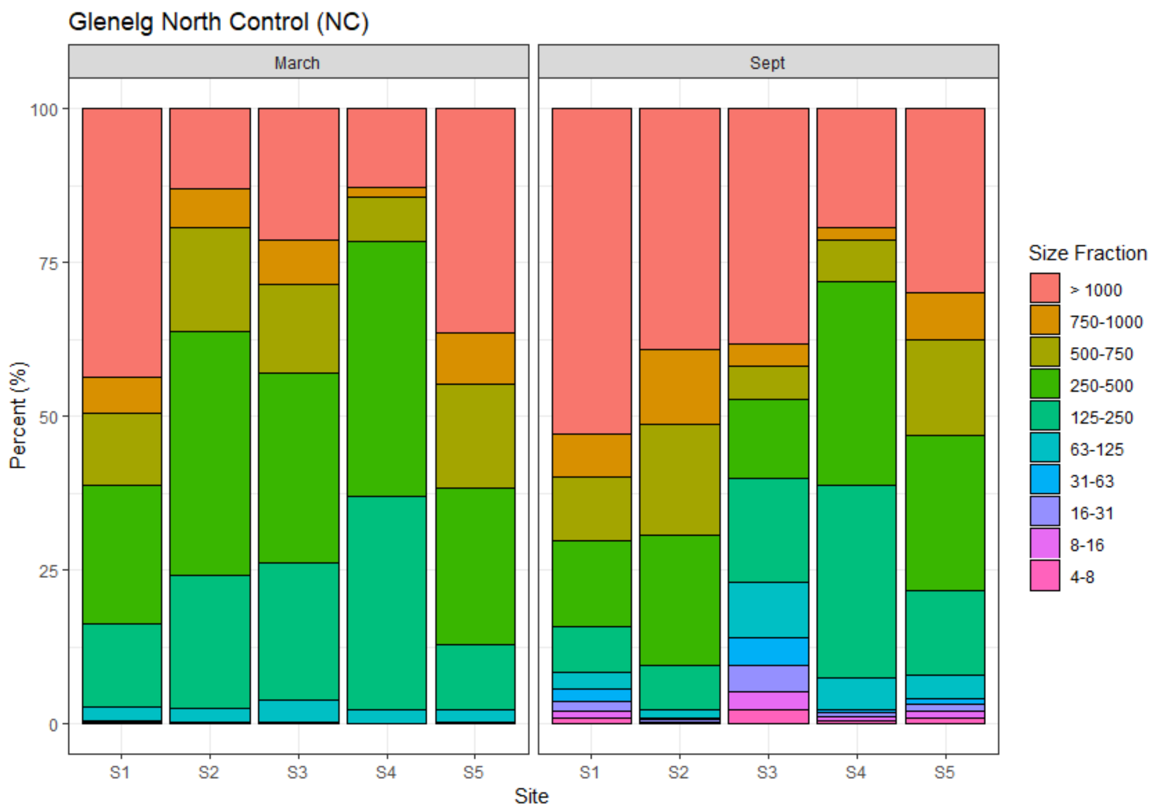
| Location | Sampling date | Mean (µm) | Median (µm) | Sorting | Sorting classification | Size classification | % Sand | % Mud |
|---|---|---|---|---|---|---|---|---|
| Port Stanvac Desalination Plant (PSDP) | Autumn | 808.60 | 951.81 | 2.22 | Poorly sorted | Sand | 0.99 | 0.01 |
| | Spring | 657.48 | 789.55 | 2.74 | Poorly sorted | Sand | 0.95 | 0.05 |
| Glenelg North Control (NC) | Autumn | 523.95 | 563.26 | 1.97 | Moderately sorted | Sand | 100 | 0 |
| | Spring | 567.31 | 670.30 | 2.60 | Poorly sorted | Sand | 0.95 | 0.05 |
| Port Noarlunga South Control (SC) | Autumn | 637.43 | 710.45 | 2.01 | Poorly sorted | Sand | 100 | 0 |
| | Spring | 597.32 | 678.08 | 2.21 | Poorly sorted | Sand | 0.98 | 0.02 |

(a)



Port Stanvac Desalination Plant (DP)
March
Sept
100
75
50
25
0
Percent (%)
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
Site
Size Fraction
> 1000
750-1000
500-750
250-500
125-250
63-125
31-63
16-31
8-16
4-8


(b)



Glenelg North Control (NC)
March
Sept
100
75
50
25
0
Percent (%)
S1
S2
S3
S4
S5
Site
Size Fraction
> 1000
750-1000
500-750
250-500
125-250
63-125
31-63
16-31
8-16
4-8

(c)

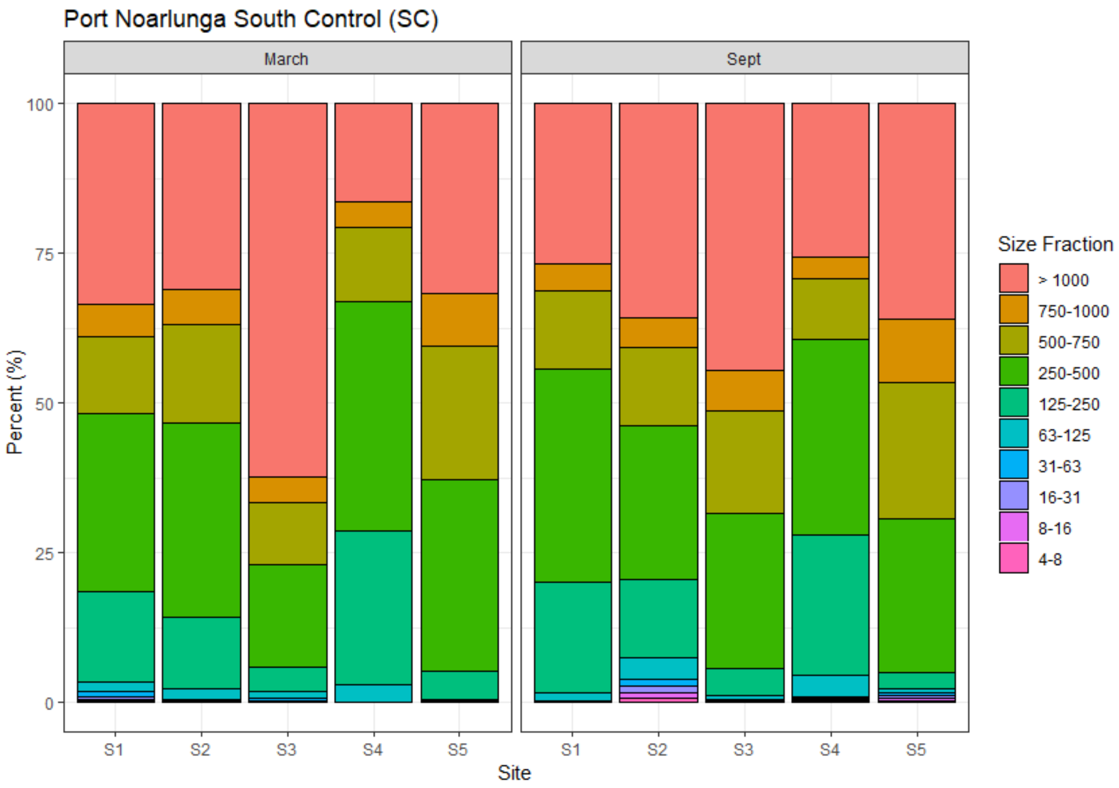



**Figure 2: Sediment grain size composition showing the percentages of sediments in size classes (µm) as stacked bar graphs for all Sites within Locations of (a) Port Stanvac Desalination Plant (DP), (b) Glenelg North Control (NC) and, (c) Port Noarlunga South Control from March/April (autumn) and September/October (spring) 2023 infauna surveys.**

**Table 3: Univariate PERMANOVA results for median sediment grain size, and composition of sand and mud fractions from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor and; Si (Zo and Lo), Site nested in Location and Zone factors. All significant differences are highlighted in bold text (P <0.05).**

| Source | df | Median grain size (g) | Sand (%) | Mud (%) |
|---|---|---|---|---|
| Zo | 1 | 0.28 | 0.25 | 0.26 |
| Ti | 1 | 0.39 | 0.38 | 0.36 |
| Lo (Zo) | 1 | 0.77 | 0.67 | 0.67 |
| Ti X Zo | 1 | 0.29 | 0.94 | 0.94 |
| Si (Lo(Zo)) | 17 | **0.001** | 0.31 | 0.31 |
| Mo X Lo (Zo) | 1 | 0.37 | 0.056 | 0.059 |
| Mo X Si (Lo(Zo) | 17 | 0.19 | **0.006** | **0.006** |
| Residual | 328 | | | |

#### *3.1.2 Sediment grain size comparison between years*

## 3.2 Benthic meiofauna

#### *3.2.1 Meiofauna taxa richness and diversity*

There was a total number of 1,333 individual meiofauna from 19 taxa identified in subtidal sediments across all locations in the autumn and spring 2023 surveys. The most common taxa identified across all locations and surveys were Foraminifera (38 %), Nematoda (18 %), Copepoda (20 %) and Ostracoda (12 %), with all other taxa each representing ≤ 1 % to total abundances (see appendix Figure A1). The total number of meiofauna taxa was greatest at the PDSP location in autumn and spring, and the NC location in spring (Figure 3). However, there were no significant differences between zones, surveys, locations, or sites for meiofauna taxa richness (Monte Carlo P > 0.05).

For the meiofauna diversity indices, Pielou's evenness and the Shannon Wiener index were similar across all locations in autumn and spring (Figure 4). The Simpson's index showed some changes in meiofauna across all locations in spring, particularly at the control locations, but there was large variation within each of those locations (Figure 4). Overall, there were no significant differences between zones, survey times, locations, or sites within locations for all three of the diversity indices measures for meiofauna (Table 4).

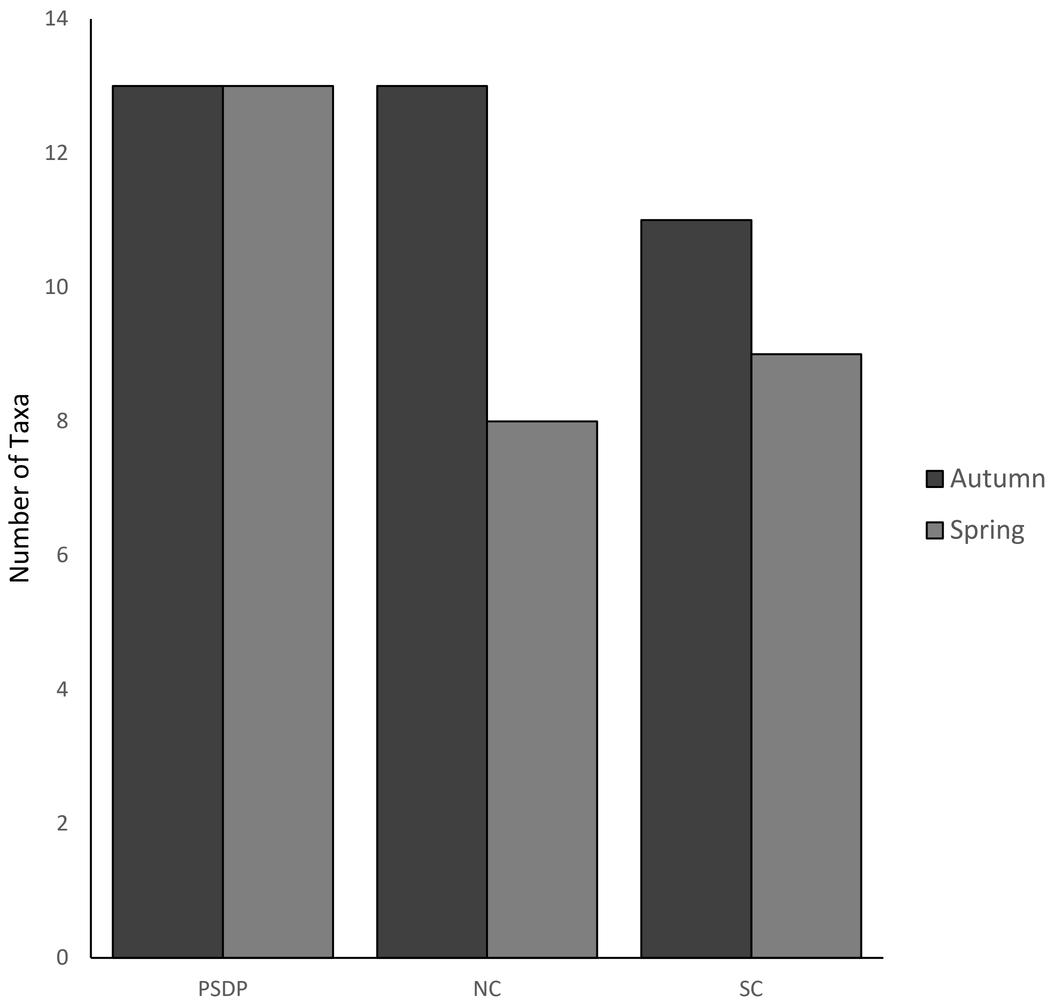



**Figure 3: Total number of taxa for benthic meiofauna at each of the Locations (all sites pooled) obtained from sediments in the Autumn and Spring 2023 surveys. Port Stanvac Desalination Plant (PSDP; 10 sites), North Control (NC; 5 sites), and South Control (SC; 5 sites).**

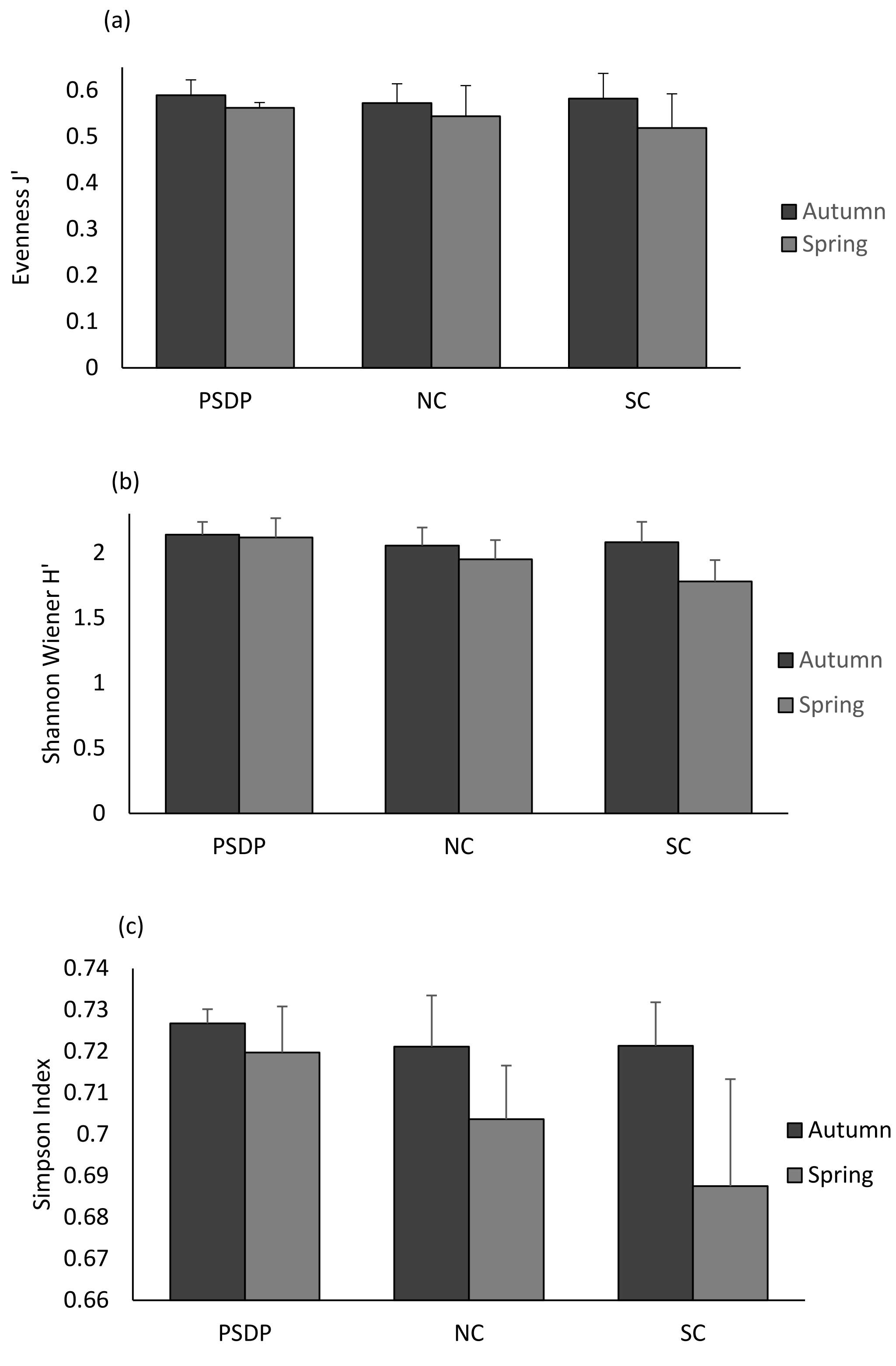



**Figure 4: Diversity values for meiofauna from the infauna surveys in Autumn and Spring 2023. Values are given for three diversity indices; (a) Pielou's evenness, (b) Shannon Wiener and (c) Simpsons Index. Note different ranges on Y axes across diversity indices.**

**Table 4: Univariate PERMANOVA (Monte Carlo) results for meiofauna species diversity indices of Pielou's (J') evenness, Shannon-Wiener (Log-e') and Simpson's index from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: All significant differences are highlighted in bold text. Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor. All significant differences are highlighted in bold text (P <0.05). Low species numbers for ability to statistically analyse indices is identified by 'Low'.**

| Source | df | Pielou's J' | Shannon-Wiener Log e' | Simpson's |
|---|---|---|---|---|
| Zo | 1 | Low | 0.90 | 0.60 |
| Ti | 1 | 0.32 | 0.44 | 0.07 |
| Lo (Zo) | 1 | 0.73 | 0.16 | 0.06 |
| Zo x Ti | 1 | 0.32 | 0.60 | 0.32 |
| Mo X Lo (Zo) | 1 | 0.68 | 0.60 | 0.76 |
| Residual | 34 | | | |

### *3.2.2 Meiofauna abundances*

The total abundances of meiofauna were greatest at the PSDP location in both seasons and lowest at the Glenelg control site in autumn (Figure 5). Particular taxa showed seasonal fluctuations, with greater abundances of Foraminifera at all locations in spring and greater abundances of copepods in autumn (Figure 5). Nematodes were only identified in the spring surveys at the PSDP and NC locations and Ostracods showed peaks in abundance at the NC location in autumn (Figure 5). However, there were no significant differences between the main factors of interest (i.e. Zone, Time or Location) (Table 5). The only significant differences identified was between sites within locations for total meiofauna, Foraminifera, nematodes, copepods, ostracods and bivalves (Table 5).

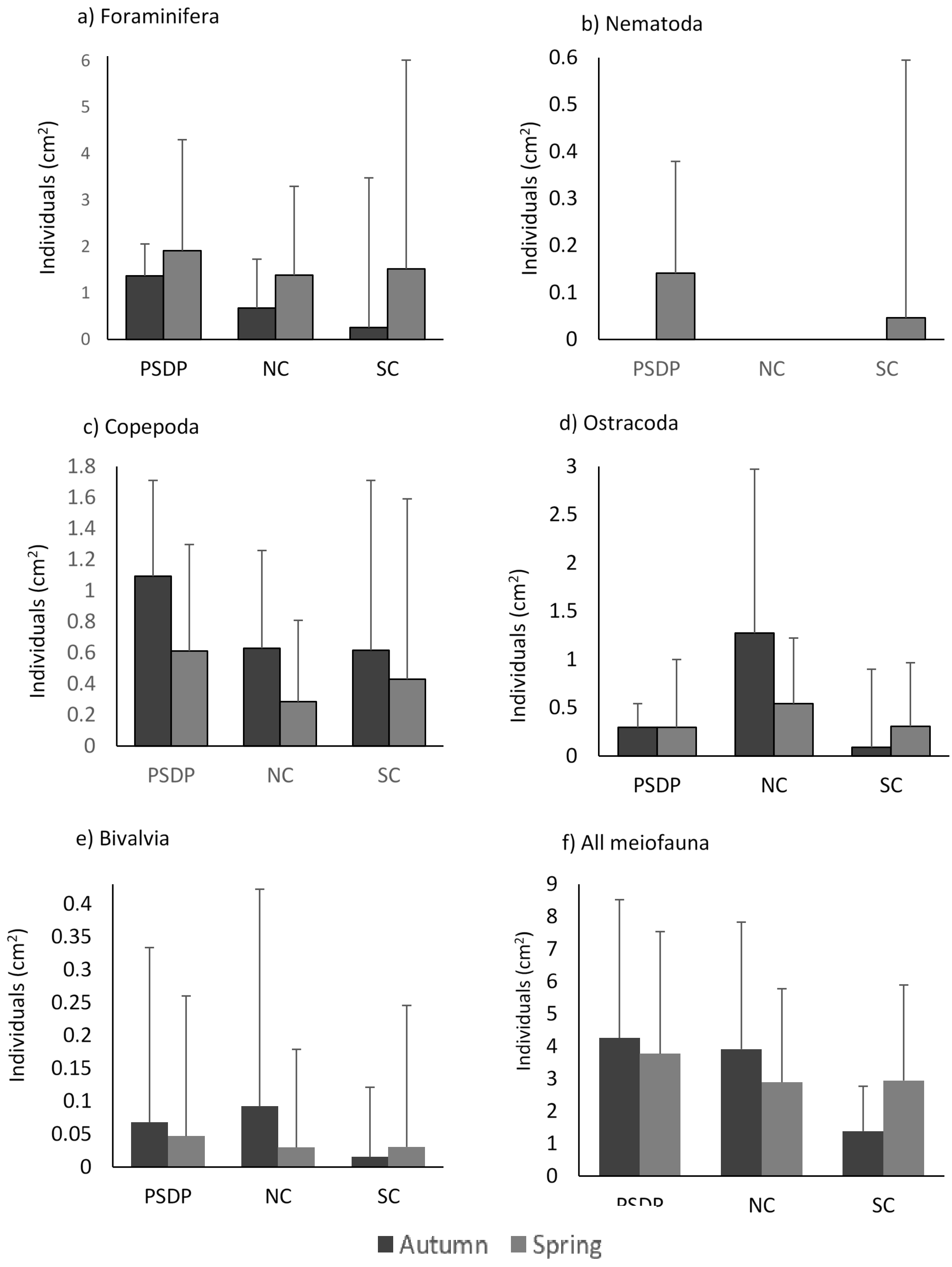



**Figure 5: Abundances (mean + SD) of common benthic meiofauna obtained from sediments in the 2023 surveys at the three Locations with sites pooled from; Port Stanvac Desalination Plant (PSDP; 10 sites), North Control (NC; 5 sites), and South Control (SC; 5 sites). Total abundances include the main taxa found as; a) Foraminifera, b) Nematoda, c) Copepoda, d) Ostracoda, e) Bivalvia and f) All benthic meiofauna combined as total abundances. Note different ranges in Individuals ($cm^2$) on Y axes across taxa.**

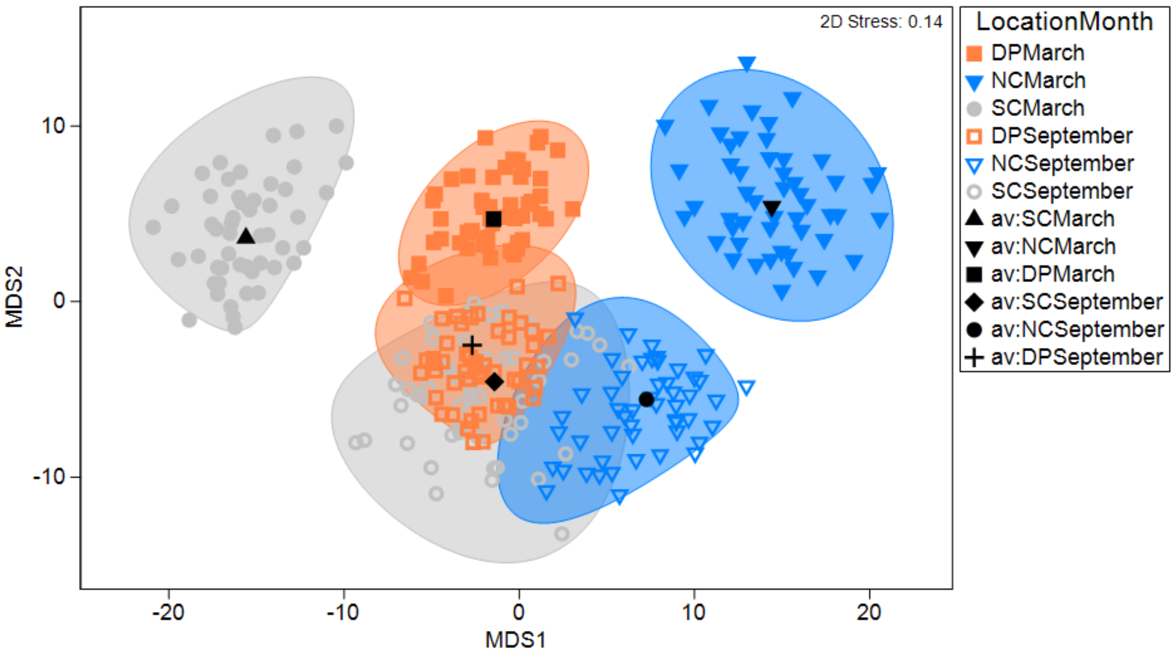
**Table 5: Univariate PERMANOVA results for key meiofauna taxa and total abundances from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor and; Si (Zo and Lo), Site nested in Location and Zone factors. All significant differences are highlighted in bold text (P<0.05).**

| Source | df | Foraminifera | Nematoda | Copepoda | Ostracoda | Bivalvia | Total abundance |
|---|---|---|---|---|---|---|---|
| Zo | 1 | 0.61 | 0.58 | 0.11 | 0.74 | 0.55 | 0.48 |
| Ti | 1 | 0.33 | 0.48 | 0.22 | 0.97 | 0.57 | 0.95 |
| Lo (Zo) | 1 | 0.50 | 0.59 | 0.46 | 0.07 | 0.37 | 0.51 |
| Zo x Ti | 1 | 0.40 | 0.56 | 0.46 | 0.92 | 0.74 | 0.89 |
| Si (Lo (Zo)) | 17 | 0.44 | 0.08 | 0.64 | 0.44 | 0.45 | 0.19 |
| Ti x Lo (Zo) | 1 | 0.52 | 0.27 | 0.64 | 0.07 | 0.44 | 0.12 |
| Mo X (Si (Zo)) | 17 | **0.0001** | **0.0005** | **0.04** | **0.0001** | 0.15 | **0.0001** |
| Residual | 353 | | | | | | |

### *3.2.3 Meiofauna community structure*

Benthic meiofauna communities with Foraminifera included mostly showed similar groupings for locations and across the autumn and spring seasons (Figure 6a). Two exceptions were the meiofauna communities that had unique groupings at the NC location and SC location in autumn and spring, respectively (Figure 6a). With Foraminifera excluded from the meiofauna community data, the NC location showed separation from the PSDP and SC locations (Figure 6b). Overall, there were only significant differences in meiofauna communities including Foraminifera between the autumn and spring surveys at the site level within locations (Table 6). With Foraminifera removed from the meiofauna data, there were significant differences between locations, nested within zones due to the separation of NC to other locations (Table 6). No further analyses was conducted to determine the taxa that contributed to significant differences as the meiofauna communities were similar for fixed factors (e.g. survey times and zones).

(a)




(b)

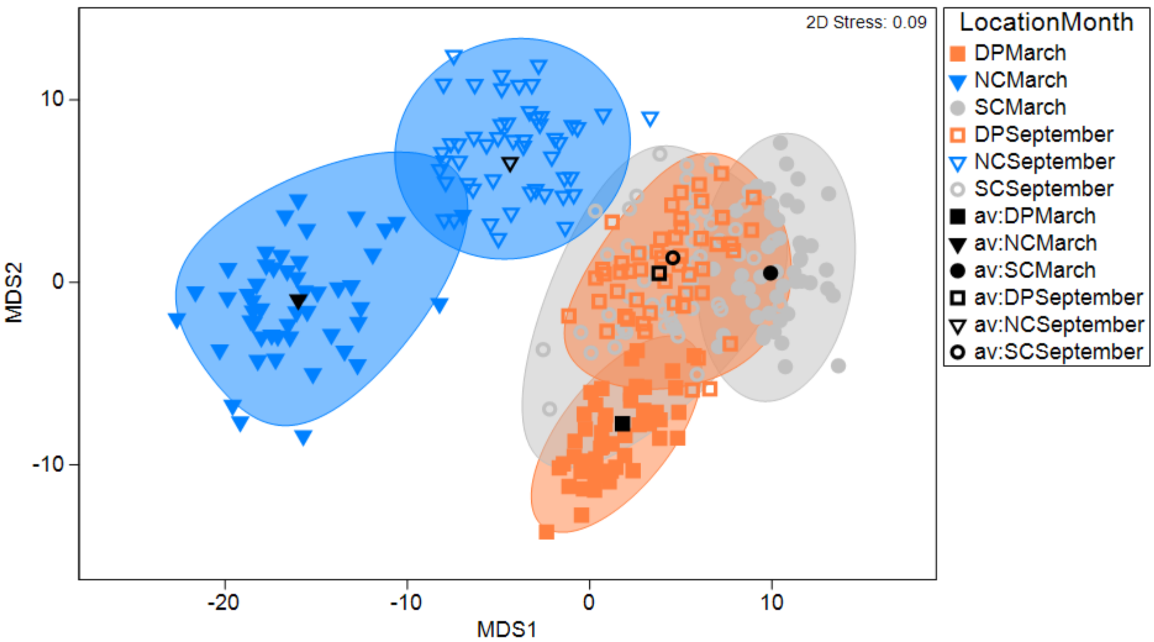



**Figure 6: Bootstrap multi-dimensional scaling (MDS) plots of (a) all meiofauna and (b) meiofauna excluding Foraminifera across infauna surveys at the PSDP (DP), North Control (NC) and South Control (SC) locations in Autumn and Spring 2023. Data visualisation based on square root transformations and Bray-Curtis similarity matrices.**

**Table 6: Multivariate PERMANOVA results for all meiofauna communities and meiofauna communities excluding Foraminifera from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor and; Si (Zo and Lo), Site nested in Location and Zone factors. All significant differences are highlighted in bold text (P<0.05).**

| Source | df | All meiofauna | Communities without Foraminifera |
|---|---|---|---|
| Zo | 1 | 0.85 | 0.82 |
| Ti | 1 | 0.52 | 0.58 |
| Lo (Zo) | 1 | 0.07 | **0.0476** |
| Zo x Ti | 1 | 0.67 | 0.88 |
| Si (Lo (Zo)) | 17 | 0.36 | 0.29 |
| Ti x Lo (Zo) | 1 | 0.23 | 0.21 |
| Ti X (Si (Zo)) | 17 | **0.0001** | **0.0001** |
| Residual | 353 | | |

## 3.3 Benthic macrofauna

### 3.3.1 Macrofauna taxa richness and diversity

There was a total number of 5,228 macrofauna from 200 separate taxa obtained from grab samples across all seasons and locations during the 2023 surveys. The main taxa that contributed to the macrofauna abundances across all surveys and locations consisted of Arthropoda (55 %), Annelida (21 %) and Mollusca (21 %), with all other taxa only contributing <3 % to total abundances. The greatest number of taxa overall was found at the PSDP location in autumn and comparable across all locations in spring (Figure 7). There were no significant differences in the number of macrofauna taxa between zone, survey times or locations (PERMANOVA P >0.05).

For the three diversity indices, there were similarities across both surveys and all locations (Figure 8). There was a significant differenced between survey times overall, but not specific to any zone or location (Table 7).

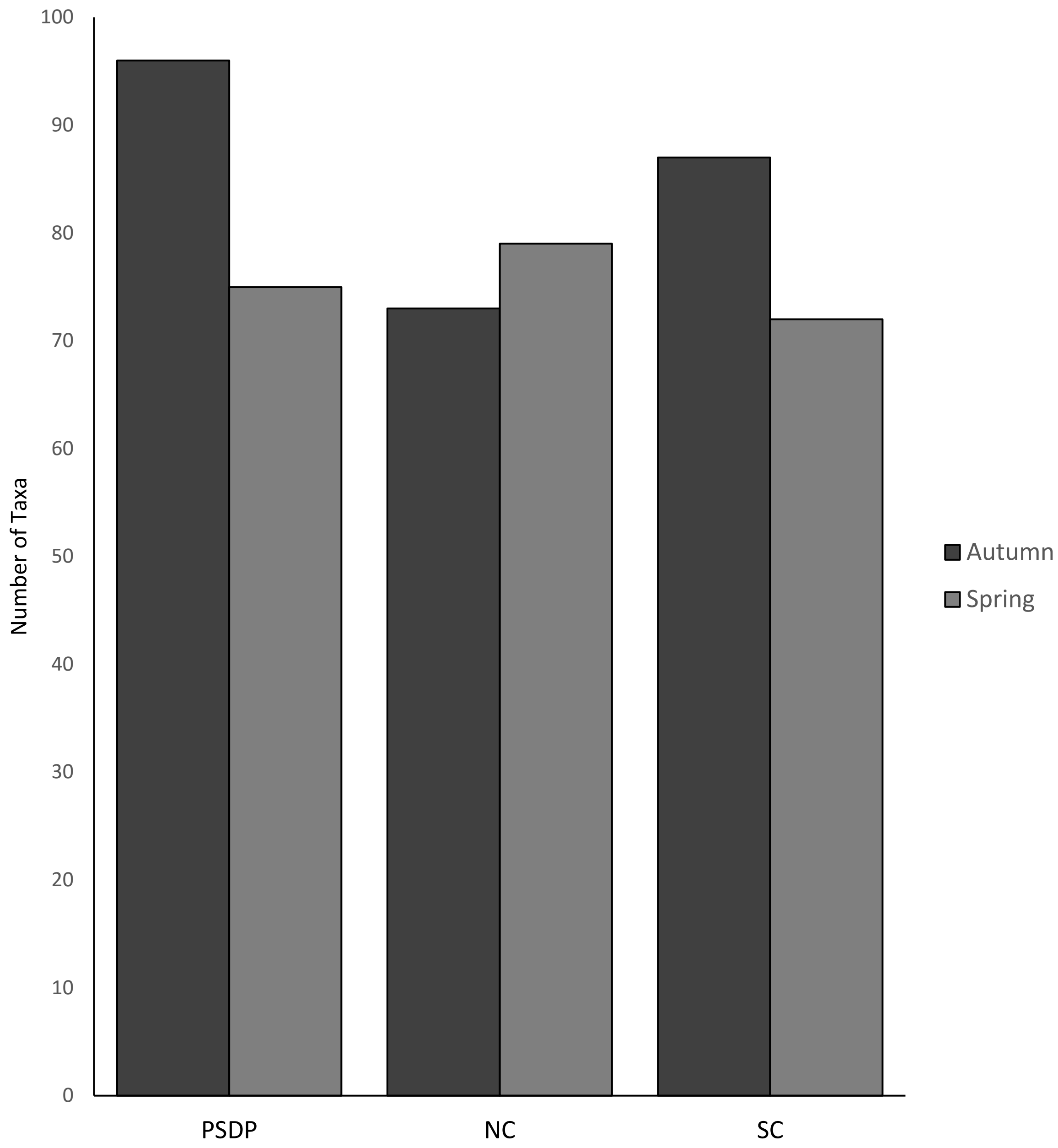



**Figure 7: Total number of taxa for benthic macrofauna at each of the Locations (all sites pooled) obtained from sediments in the Autumn and Spring 2023 surveys. Port Stanvac Desalination Plant (PSDP; 10 sites), North Control (NC; 5 sites), and South Control (SC; 5 sites).**

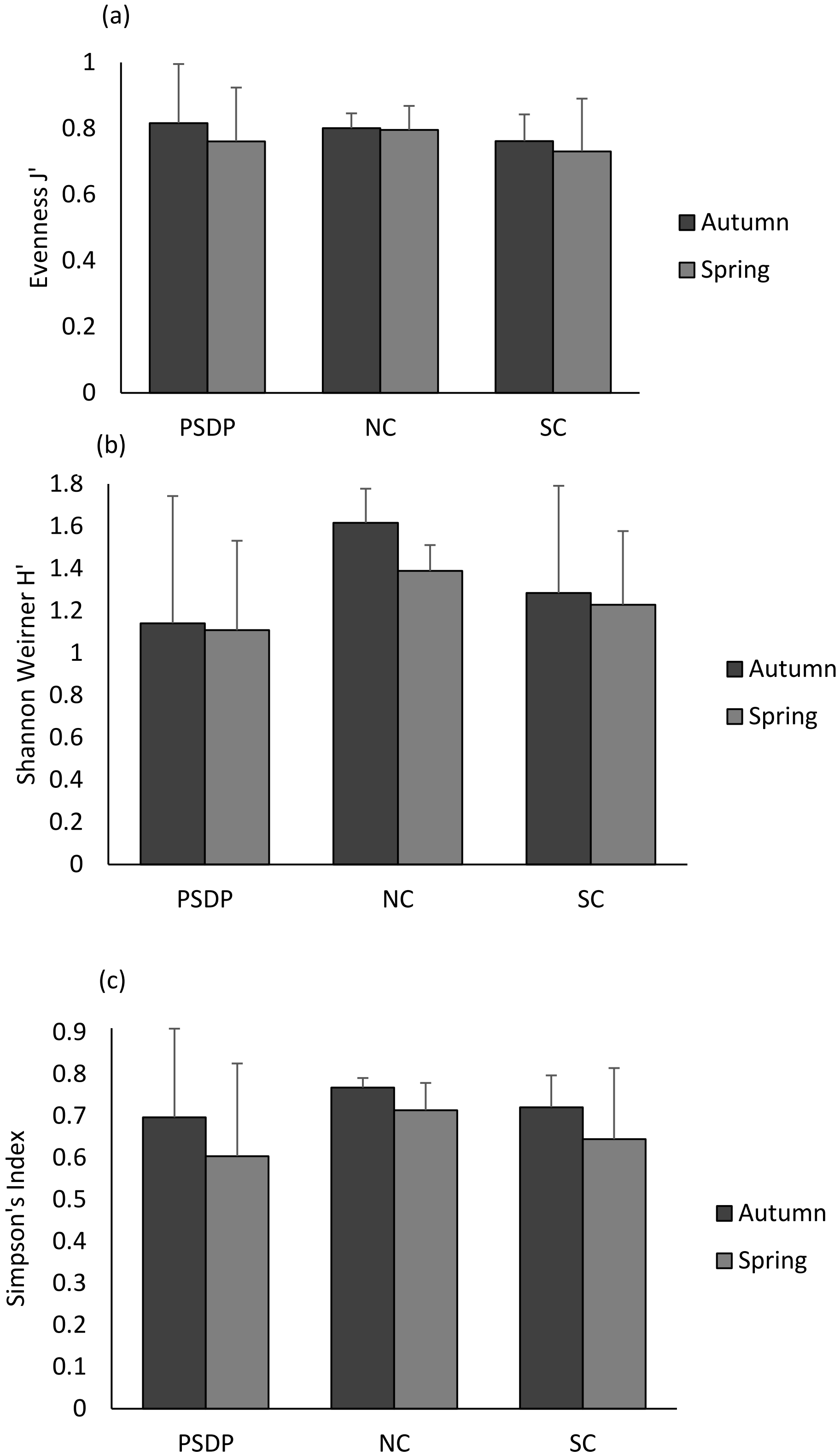



**Figure 8: Diversity values for macrofauna from the infauna surveys in Autumn and Spring 2023. Values are given for three diversity indices; (a) Pielou's evenness, (b) Shannon Wiener and (c) Simpsons Index. Note different ranges on Y axes across diversity indices.**

**Table 7: Univariate PERMANOVA results for macrofauna species diversity indices of Pielou's (J') evenness, Shannon-Wiener (Log-e') and Simpson's index from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: All significant differences are highlighted in bold text. Zo, Zone; Ti, Time Lo, Location (Zo) and Location nested in Zone factor. All significant differences are highlighted in bold text (P <0.05).**

| Source | df | Pielou's J' | Shannon-Wiener Log e' | Simpson's |
|---|---|---|---|---|
| Zo | 1 | 0.45 | 0.44 | 0.39 |
| Ti | 1 | **0.038** | 0.13 | 0.12 |
| Lo (Zo) | 1 | 0.24 | 0.056 | 0.14 |
| Zo x Ti | 1 | 0.09 | 0.19 | 0.26 |
| Mo X Lo (Zo) | 1 | 0.86 | 0.51 | 0.45 |
| Residual | 34 | | | |

### *3.3.2 Macrofauna abundances*

Macrofauna total abundances were similar across all locations during both autumn and spring surveys (Figure 9). The distribution of main taxa such as Arthropoda, Annelida, Mollusca and Echinodermata were also similar across all locations during both seasonal surveys (Figure 9). The presence of Capitellidae worms was only mainly observed at all locations during the spring survey, but they were present in low abundances at the NC location during autumn (Figure 9). The total macrofauna, and abundances of Arthropoda, Mollusca and Echinodermata were significantly different between sites within locations within seasons (Table 8). Annelid worm abundances were only significantly different at the site level within locations across the entire survey period (i.e. both seasons combined) (Table 8). Capitellid worm abundances were significantly different between times in particular zones, which was determined to be the PSDP zone from pairwise tests based on greater abundances in autumn (PERMANOVA, P = 0.046).

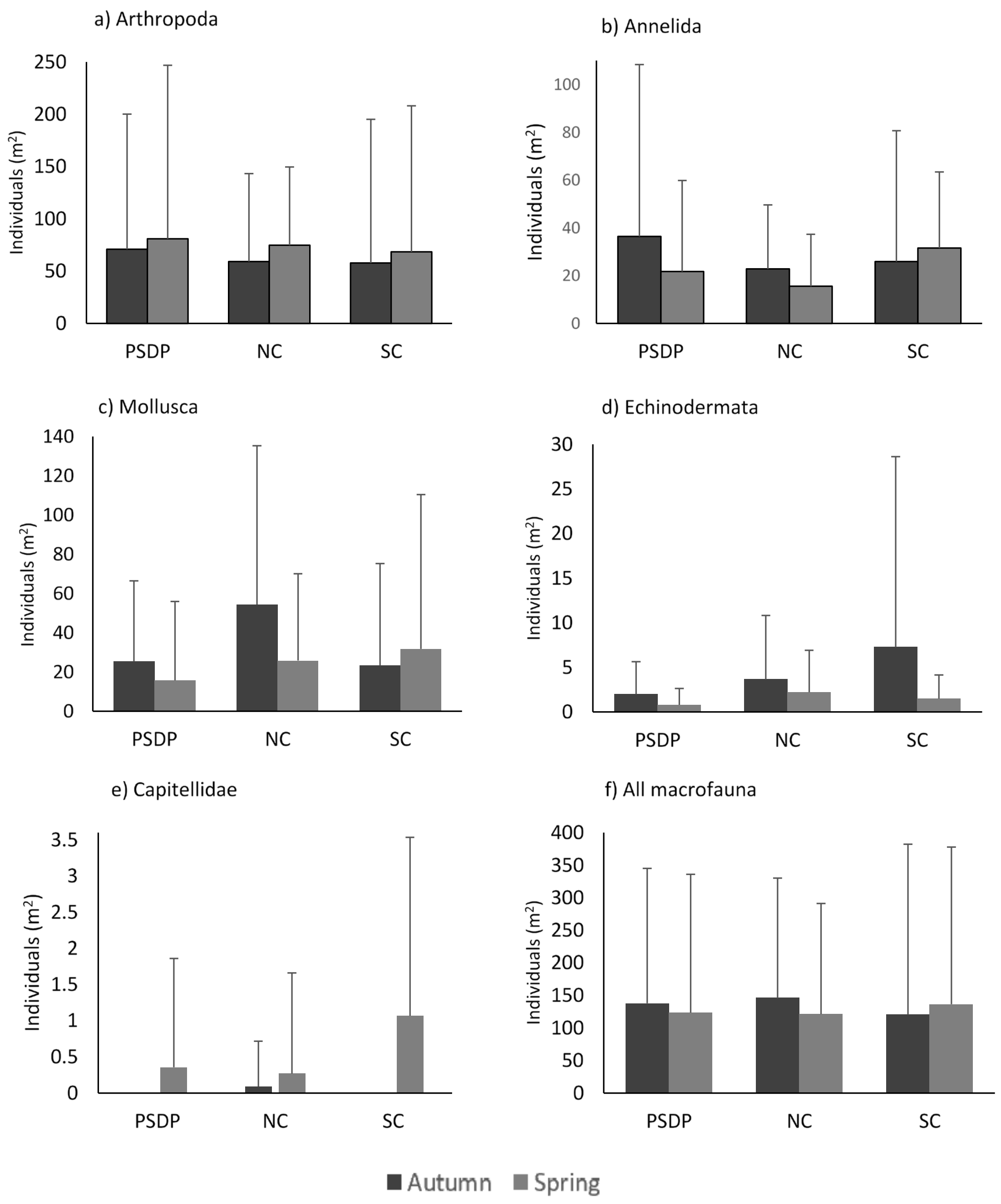



**Figure 9: Abundances (mean + SD) of common benthic macrofauna obtained from sediments in the 2023 surveys at the three Locations with sites pooled from; Port Stanvac Desalination Plant (PSDP; 10 sites), North Control (NC; 5 sites), and South Control (SC; 5 sites). Total abundances include the main taxa found as; a) Arthropoda, b) Annelida, c) Echinodermata, d) Mollusca, e) the environmental indicator Capitellidae and f) All benthic macrofauna combined as total abundances. Note different ranges in Individuals ($m^2$) on Y axes across taxa.**

**Table 8: Table 5: Univariate PERMANOVA results for key macrofauna taxa and total abundances from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor and; Si (Zo and Lo), Site nested in Location and Zone factors. All significant differences are highlighted in bold text (P<0.05).**

| Source | df | Total macrofauna | Annelida | Arthropoda | Mollusca | Echinodermata | Capitellidae |
|---|---|---|---|---|---|---|---|
| Zo | 1 | 0.20 | 0.81 | 0.37 | 0.40 | 0.07 | 0.79 |
| Ti | 1 | 0.69 | 0.78 | 0.058 | 0.70 | 0.43 | 0.53 |
| Lo (Zo) | 1 | 0.88 | 0.34 | 0.75 | 0.49 | 0.86 | 0.06 |
| Zo x Ti | 1 | 0.63 | 0.81 | 0.07 | 0.96 | 0.83 | 0.94 |
| Si (Lo (Zo)) | 17 | **0.0001** | **0.0001** | **0.0001** | **0.0001** | **0.049** | 0.34 |
| Ti x Lo (Zo) | 1 | 0.49 | 0.10 | 0.94 | 0.09 | 0.30 | **0.02** |
| Ti X (Si (Zo)) | 17 | **0.0009** | 0.059 | **0.002** | **0.01** | **0.02** | 0.24 |
| Residual | 360 | | | | | | |

### 3.3.3 Macrofauna community structure

Macrofauna community structure showed grouping in the autumn (March) survey, with the PSDP and NC control location the most similar (Figure 10). The spring survey (September) showed separation from the previous autumn season and all locations had unique groupings to each other (Figure 10). The main significant difference was between the autumn and spring surveys due to seasonal changes across all locations (Table 9). Sites within locations and between seasons differed significantly, which contributed to the unique groupings between locations in the spring survey, likely due to natural site-to-site variation with the onset of seasonal change (Table 9).

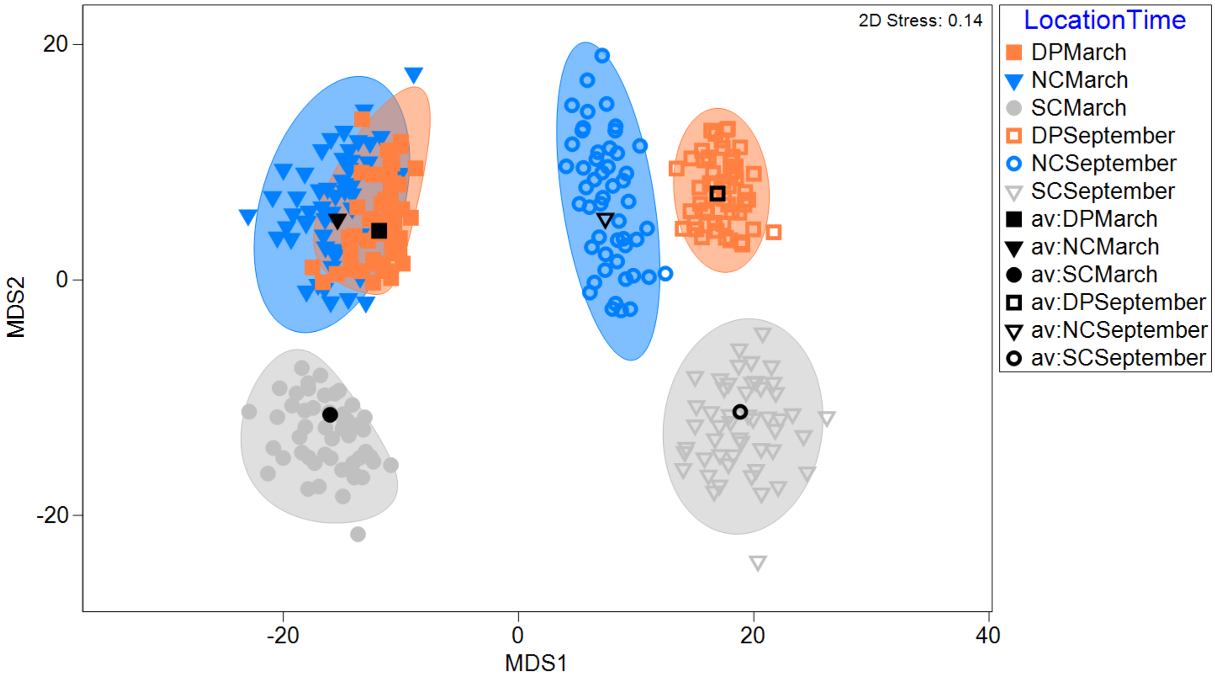



**Figure 10: Bootstrap multi-dimensional scaling (MDS) plots of macrofauna across infauna surveys at the PSDP (DP), North Control (NC) and South Control (SC) locations in Autumn and Spring 2023. Data visualisation based on square root transformations and Bray-Curtis similarity matrices.**

**Table 9: Multivariate PERMANOVA results for all macrofauna communities from the autumn and spring 2023 infauna surveys. Analyses on Euclidean distances were based on statistical design of: Zo, Zone; Ti, Time Lo, Location (Zo), Location nested in Zone factor and; Si (Zo and Lo), Site nested in Location and Zone factors. All significant differences are highlighted in bold text (P<0.05).**

| Source | df | Macrofauna community |
|---|---|---|
| Zo | 1 | 0.53 |
| Ti | 1 | **0.02** |
| Lo (Zo) | 1 | 0.25 |
| Zo x Ti | 1 | 0.89 |
| Si (Lo (Zo)) | 17 | **0.0001** |
| Ti x Lo (Zo) | 1 | 0.14 |
| Ti X (Si (Zo)) | 17 | **0.0001** |
| Residual | 360 | |

# 4. Discussion

Across the seasonal autumn and spring surveys in 2023 the sediment condition and associated benthic communities there were no significant differences between the Port Stanvac Desalination Plant (PSDP) and control zones (North Control, NC; South Control, SC). The site-to-site variation identified in sediment conditions, meiofauna and macrofauna and changes between seasons (autumn and spring) were not unique but consistent with natural processes previously observed in subtidal soft sediment habitats in Gulf St Vincent (Ramsdale et al. 2011; Loo et al. 2014; Loo et al. 2021).

Sediment conditions were consistent across all zones and locations within zones across both autumn and springs seasons in the 2023 survey. Sediments largely consisted of sand and mud, with no large gravel sediment grain sizes that were observed in previous surveys (e.g. Ramsdale et al. 2011; Dittmann et al. 2017). There was typical site-to-site variation in the amount of sand and finer mud sediment grain sizes, but that consistently occurred across all locations and throughout both seasons (Loo et al. 2014; Dittmann et al. 2017).

In the 2023 survey, the most common meiofauna were Foraminifera, which changed between seasons, but that pattern was consistent across all locations. Copepods, nematodes and ostracods also contributed greatly to meiofauna across the 2023 survey. Most of those taxa were consistent across locations and seasons, except for nematodes that were only found at the PSDP and SC locations, and only during the spring survey. The greater presence of nematodes in spring is a common response to increased productivity in the microphytobenthos and phytoplankton blooms, which require organic deposits in sediments and the water column that can change year-to-year (Rudnick et al. 1985; Venekey et al. 2019). Any reductions in the detrital pool along coastlines will be responded to by reductions in meiofauna abundances, particularly nematodes (Rudnick et al. 1985).

The diversity of meiofauna was low across the 2023 survey at all locations compared to previous surveys (Dittmann et al. 2017; Loo et al. 2021). However, the diversity indices were comparable to previous surveys with dominance of fauna (e.g. Foraminifera) contributing to reduced evenness of contributions across taxa (Dittmann et al. 2017). The very dynamic sediment movement along the Adelaide metropolitan coastline, where finer sediments are suspended and move in a northerly direction along the coast as a net sand budget, would also have a strong influence on the abundances of meiofauna (Deans et al. 2003). Thus, the dominance of sands and less finer sediment grain sizes (e.g. mud) could be attributing to the lower diversity and abundances of meiofauna across all locations (i.e. PSDP, NC and SC) in 2023 compared to other years (Ramsdale et al. 2011; Dittmann et al. 2017).

The methodology for obtaining and processing of meiofauna has changed across the Port Stanvac Desalination Plant surveys across years, making it difficult to compare year-to-year variation (Ramsdale et al. 2011; Loo et al. 2014; Cheshire 2014; Loo et al. 2021). However, the consistency of meiofauna across zones and locations has been observed across survey years and certainly not with any reduced diversity or abundances at the PDSP location within each survey year (Ramsdale et al. 2011; Loo et al. 2014; Dittmann et al. 2017; Loo et al. 2021).

The macrofauna taxa that were contributing most to abundances across the 2023 surveys were arthropods, followed by annelid worms and molluscs. The contributions of those taxa were similar to the compositions found in previous surveys across the three locations regularly surveyed as part of the PSDP environmental monitoring program (Ramsdale et al. 2011; Dittmann et al. 2017). As a bio-indicator, capitellid worms are useful in determining if there are impacts from disturbances such as organic inputs and nutrient loading to sediments (Dauvin and Ruellet 2007).Capitellid worms varied across sites and seasons in the 2023 survey, but they were significantly greater at the PSDP zone in autumn. It is difficult to determine what the response of capitellids at the PSDP zone could be during the autumn 2023 survey, but being close to the coast, there could be influences from terrestrial runoff and legacy pollutants in sediments from previous industrial activity at the site. In comparison, the sensitivity of echinoderms to disturbances (e.g. pollutants salinity tolerances) also makes them a good bioindicator (de la Ossa Carretero et al. 2016). In the 2023 survey, there were no significant changes to the echinoderm abundances across time or between locations. The only differences in echinoderms were between sites within locations across seasons, which are standard patterns of natural variation with population dynamics.

Community structure of macrofauna did not vary across zones or locations during the 2023 survey. Although, there was a shift in the community structure of macrofauna between the autumn and spring seasons, but that was consistent for all zones and locations. The macrofauna community structure patterns observed in the 2023 survey are consistent with previous surveys where large temporal variation and site-to-site fluctuations across the metropolitan Adelaide coastline (Ramsdale et al. 2011; Loo et al. 2014; Dittmann et al. 2017; Loo et al. 2021).

Overall, there are consistencies of sediment dynamics and associated benthic meiofauna and macrofauna across the PSDP and control zones through time (e.g. 2010 to this 2023 survey). There are still inconsistencies in methodology between research groups through time for field survey and laboratory processing methodology, which prevents thorough analyses of comparable datasets. However, there could be some alignment of datasets at higher taxonomic levels (e.g. annelid worms, arthropods etc.) and with conversion of data to presence/absence. Macrofauna data could also be assessed from a functional trait perspective, which would align the data to comparable standardised indices and provide very useful information about the biological function of sediments aligned with the Adelaide Aqua desalination plant environmental monitoring program through time (see Lam Gordillo et al. 2020). That could be combined with specific assessments of bioindicator species (e.g. Capitellidae, Echinodermata and others to be investigated) to provide a holistic approach based on the challenges with incomparable datasets.

# 5. Acknowledgements

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# 7. Appendix

**Table S1: Descriptions of grain size distributions and sorting co-efficients using geometric methods of moments (Blott and Pye, 2001) from all Sites and Locations, during the (a) Autumn) and (b) Spring 2023 infauna surveys.**

| | | Grain size distribution statistics | | | | | Size Fractions (%) | |
|---|---|---|---|---|---|---|---|---|
| **Location** | **Site** | **Median (µm)** | **Mean (µm)** | **Size Classification** | **Sorting** | **Sorting Classification** | **Sand** | **Silt** |
| **Port Stanvac Desalination Plant (PSDP)** | 1 | 697.1690059 | 632.814042 | Medium Sand | 2.529648 | Poorly Sorted | 95.35701 | 4.642994 |
| | 2 | 787.9571625 | 559.739278 | Medium Sand | 2.979654 | Poorly Sorted | 95.51946 | 4.480537 |
| | 3 | 899.9574758 | 784.572186 | Coarse Sand | 2.158397 | Moderately Sorted | 97.86227 | 0.544489 |
| | 4 | 481.6668005 | 395.341058 | Medium Sand | 3.58167 | Poorly Sorted | 86.20766 | 1.016188 |
| | 5 | 857.1359056 | 640.879866 | Very Coarse Sand | 2.927543 | Poorly Sorted | 94.00424 | 5.329566 |
| | 6 | 395.5849857 | 391.280474 | Fine Sand | 2.201711 | Poorly Sorted | 97.53644 | 2.463561 |
| | 7 | 1328.760628 | 1127.1132 | Very Coarse Sand | 2.050638 | Well Sorted | 98.34435 | 1.655654 |
| | 8 | 509.7558815 | 411.880695 | Medium Sand | 3.267391 | Poorly Sorted | 91.63888 | 8.361119 |
| | 9 | 709.6881498 | 617.847185 | Very Coarse Sand | 3.012459 | Poorly Sorted | 94.14557 | 5.854431 |
| | 10 | 1215.401034 | 990.953808 | Very Coarse Sand | 2.656386 | Poorly Sorted | 95.33817 | 4.661827 |
| **Glenelg North Control (NC)** | 1 | 899.8925708 | 735.040239 | Very Coarse Sand | 2.254604 | Moderately Sorted | 94.40653 | 5.593466 |
| | 2 | 759.1984339 | 643.278559 | Coarse Sand | 3.212267 | Moderately Sorted | 97.08533 | 2.914667 |
| | 3 | 592.3361679 | 502.244467 | Medium Sand | 3.489553 | Poorly Sorted | 86.63751 | 13.36249 |
| | 4 | 445.0383129 | 385.300249 | Medium Sand | 2.224649 | Poorly Sorted | 97.59047 | 2.409534 |
| | 5 | 662.3897572 | 574.426031 | Medium Sand | 2.291719 | Poorly Sorted | 95.82345 | 4.176546 |
| **Port Noarlunga South Control (SC)** | 1 | 585.6751306 | 553.962288 | Medium Sand | 1.894059 | Moderately Sorted | 99.6531 | 0.346899 |
| | 2 | 669.6385976 | 519.397582 | Coarse Sand | 2.837199 | Poorly Sorted | 96.12681 | 3.873193 |
| | 3 | 865.1546504 | 771.306989 | Coarse Sand | 1.853762 | Moderately Sorted | 99.45551 | 0.544489 |
| | 4 | 541.5462132 | 462.432623 | Medium Sand | 2.260888 | Poorly Sorted | 98.98381 | 1.016188 |
| | 5 | 724.1792745 | 679.083959 | Coarse Sand | 2.155339 | Moderately Sorted | 98.39044 | 1.609563 |

**Table S2: Total abundances of meiofauna taxonomic groups from all sites and Locations during the autumn and spring 2023 infauna surveys.**

| Phylum | Subphylum | Class | Subclass | Infraclass / Superorder | Order | Family | PSDP | SC | NC |
|---|---|---|---|---|---|---|---|---|---|
| Annelida | | Polychaeta | | | | | 1 | 1 | 3 |
| Arthropoda | | Branchiopoda | Phyllopoda | Diplostraca | | | 24 | 9 | 10 |
| Arthropoda | Crustacea | Cephalocarida | | | | | 1 | - | - |
| Arthropoda | Crustacea | Hexanauplia | Copepoda | | | | 222 | 69 | 60 |
| Arthropoda | Crustacea | Ostracoda | | | | | 77 | 26 | 119 |
| Arthropoda | Chelicerata | Arachnida | Acariformes | | | | 3 | - | - |
| Arthropoda | Chelicerata | Arachnida | Acariformes | Trombidiformes | | | 1 | - | - |
| Ciliophora | | | | | | | 2 | 1 | 1 |
| Echinodermata | | | | | | | - | - | - |
| Foraminifera | | | | | | | 424 | 116 | 136 |
| Gastrotricha | | | | | | | - | - | 3 |
| Mollusca | Aculifera | Aplacophora | | | | | - | - | 1 |
| Mollusca | Bivalvia | | | | | | 15 | 3 | 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mollusca | Gastropoda | | | | 10 | 2 | 9 |
| Mollusca | | | | | 4 | 8 | - |
| Nematoda | | | | | 18 | 3 | - |
| Platyhelminthes | | Turbellaria | Proseriata | Nematoplanidae | 197 | 39 | 76 |
| Platyhelminthes | | Turbellaria | | | 21 | - | 19 |
| Platyhelminthes | | | | | 4 | 2 | - |
| Tardigrada | | | | | 18 | 5 | 2 |

**Table: List and total abundances of macrofauna taxonomic groups from all sites and Locations during the autumn and spring 2023 infauna survey.**

| Phylum | Class | Subclass | Order | Family | PSDP | SC | NC |
|---|---|---|---|---|---|---|---|
| Annelida | Polychaeta | Errantia | Eunicida | Arabellidae | 34 | 1 | 1 |
| Annelida | Polychaeta | Errantia | Eunicida | Dorvilleidae | 67 | 5 | 11 |
| Annelida | Polychaeta | Errantia | Eunicida | Eunicidae | 22 | 25 | 21 |
| Annelida | Polychaeta | Errantia | Eunicida | Lumbrineridae | 7 | 8 | 8 |
| Annelida | Polychaeta | Errantia | Eunicida | Lysaretidae | 2 | - | 1 |
| Annelida | Polychaeta | Errantia | Eunicida | Oenonidae | 9 | 1 | - |
| Annelida | Polychaeta | Errantia | Eunicida | | 79 | 9 | 3 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Aphroditidae | 3 | 3 | 3 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Chrysopetalidae | 11 | 7 | 13 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Glyceridae | 59 | 17 | 14 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Hesionidae | 74 | 16 | 25 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Nephtyidae | 28 | 15 | 27 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Nereididae | 37 | 43 | 21 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Phyllodocidae | 18 | 6 | 8 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Annelida | Polychaeta | Errantia | Phyllodocida | Pilargidae | 51 | 4 | 8 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Pisionidae | 41 | 25 | 5 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Polynoidae | 5 | 13 | 13 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Sigalionidae | 261 | 150 | 72 |
| Annelida | Polychaeta | Errantia | Phyllodocida | Syllidae | 171 | 109 | 44 |
| Annelida | Polychaeta | Errantia | Phyllodocida | | 6 | 10 | - |
| Annelida | Polychaeta | Errantia | Amphinomida | Amphinomidae | 4 | 5 | 4 |
| Annelida | Polychaeta | Sedentaria | Sabellida | Oweniidae | 49 | 22 | 11 |
| Annelida | Polychaeta | Sedentaria | Sabellida | Sabellidae | 16 | 27 | 7 |
| Annelida | Polychaeta | Sedentaria | Sabellida | Serpulidae | 3 | 3 | 1 |
| Annelida | Polychaeta | Sedentaria | Sabellida | Spirorbidae | 18 | 4 | 8 |
| Annelida | Polychaeta | Sedentaria | Sabellida | | 4 | 1 | - |
| Annelida | Polychaeta | Sedentaria | Spionida | Poecilochaetidae | 68 | 46 | 31 |
| Annelida | Polychaeta | Sedentaria | Spionida | Spionidae | 75 | 39 | 16 |
| Annelida | Polychaeta | Sedentaria | Terebellida | Ampharetidae | 8 | 3 | 6 |
| Annelida | Polychaeta | Sedentaria | Terebellida | Cirratulidae | 12 | 5 | 2 |

| Phylum | Class | Subclass | Order | Family | PSDP | SC | NC |
|---|---|---|---|---|---|---|---|
| Annelida | Polychaeta | Sedentaria | Terebellida | Flabelligeridae | 1 | 1 | 2 |
| Annelida | Polychaeta | Sedentaria | Terebellida | Pectinariidae | 14 | 1 | 1 |
| Annelida | Polychaeta | Sedentaria | Terebellida | Terebellidae | 8 | 4 | 4 |
| Annelida | Polychaeta | Sedentaria | Terebellida | Trichobranchidae | 1 | - | - |
| Annelida | Polychaeta | Sedentaria | Terebellida | | 20 | 6 | 4 |
| Annelida | Polychaeta | Sedentaria | | Maldanidae | 26 | 12 | 1 |
| Annelida | Polychaeta | Sedentaria | | Arenicolidae | 1 | - | 1 |
| Annelida | Polychaeta | Sedentaria | | Capitellidae | 8 | 12 | 4 |
| Annelida | Polychaeta | Sedentaria | | Opheliidae | 1 | 8 | 3 |
| Annelida | Polychaeta | Sedentaria | | Orbiniidae | - | 1 | 1 |
| Annelida sp. 1 | | | Sipuncula | | 14 | 8 | 7 |
| Annelida sp. 2 | | | | | 2 | 1 | 2 |
| Annelida sp. 3 | | | | | - | 1 | - |
| Annelida sp. 4 | | | | | 1 | 2 | - |
| Annelida sp. 5 | | | | | - | 1 | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Annelida sp. 6 | | | | | 1 | 2 | - |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | Caprellidae | 165 | 86 | 46 |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | Dexaminidae | 114 | 68 | 29 |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | Isaeidae | 25 | 34 | - |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | Pardaliscidae | 1 | - | - |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | Corophiidae | 61 | 10 | - |
| Arthropoda | Malacostraca | Eumalacostraca | Amphipoda | | 1956 | 652 | 852 |
| Arthropoda | Malacostraca | Eumalacostraca | Cumacea | | 34 | 25 | 23 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Alpheidae | 5 | - | - |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Caridea | 18 | 2 | 5 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Galatheidae | 8 | 9 | 5 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Hymenosomatidae | 56 | 14 | 21 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Leucosiidae | 5 | 2 | 1 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Paguridae | - | - | 1 |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Porcellanidae | 1 | - | - |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Portunidae | 1 | 4 | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | Xanthidae | 1 | - | - |
| Arthropoda | Malacostraca | Eumalacostraca | Decapoda | | 2 | 4 | 3 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | Antheluridae | 8 | 5 | 3 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | Gnathiidae | 11 | 49 | 7 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | Janiridae | 55 | 73 | 29 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | Serolidae | 21 | 1 | 12 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | Sphaeromatidae | 21 | 9 | 15 |
| Arthropoda | Malacostraca | Eumalacostraca | Isopoda | | 7 | 6 | 20 |
| Arthropoda | Malacostraca | Phyllocarida | Leptostraca | | 59 | 27 | 57 |
| Arthropoda | Malacostraca | Phyllocarida | Mysida | | 1 | 1 | - |
| Arthropoda | Malacostraca | Eumalacostraca | Tanaidacea | | 337 | 118 | 100 |
| Arthropoda | Ostracoda | | | | 230 | 113 | 127 |
| Arthropoda | Pycnogonida | | Pantopoda | | 39 | 39 | 19 |
| Arthropoda | Copepoda | | | | 42 | 38 | 20 |
| Arthropoda | | | | | 3 | 4 | 2 |
| Brachiopoda | | | | | - | 3 | - |

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|---|---|---|---|---|---|---|---|
| Chordata | | | Amphioxiformes | | - | - | 3 |
| Chordata | Ascidiacea | | | | 14 | 11 | 14 |
| Chordata | | | | | 1 | - | 5 |
| Cnidaria | | | | | 1 | 6 | 4 |
| Echinodermata | Asteroidea | Ambuloasteroidea | Forcipulatida | Asteriidae | 2 | - | 2 |
| Echinodermata | Crinoidea | | | | - | - | 1 |
| Echinodermata | Echinoidea | Euechinoidea | Spatangoida | Loveniidae | 1 | 3 | - |
| Echinodermata | Echinoidea | | | | 38 | 72 | 36 |
| Echinodermata | Holothuroidea | Actinopoda | Dendrochirotida | Cucumariidae | 1 | 4 | 1 |
| Echinodermata | Holothuroidea | | | | 5 | 6 | 4 |
| Echinodermata | Ophiuroidea | | Ophiurida | | 16 | 14 | 22 |
| Mollusca | Bivalvia | Autobranchia | Adapedonta | Hiatellidae | 85 | 90 | 72 |
| Mollusca | Bivalvia | Autobranchia | Adapedonta | Solenidae | - | 2 | - |
| Mollusca | Bivalvia | Autobranchia | Carditida | Carditidae | - | 4 | 1 |
| Mollusca | Bivalvia | Autobranchia | Gastrochaenida | Gastrochaenidae | 19 | 5 | 6 |
| Mollusca | Bivalvia | Autobranchia | Limida | Limidae | 3 | 11 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mollusca | Bivalvia | Autobranchia | Lucinida | Lucinidae | 1 | 1 | - |
| Mollusca | Bivalvia | Autobranchia | Mytilida | | 362 | 131 | 389 |
| Mollusca | Bivalvia | Autobranchia | Pectinida | Pectinidae | 7 | 17 | 5 |
| Mollusca | Bivalvia | Autobranchia | Venerida | Veneridae | 174 | 92 | 156 |
| Mollusca | Bivalvia | Autobranchia | | Myochamidae | 1 | 2 | 2 |
| Mollusca | Bivalvia | Protobranchia | Nuculanida | Nuculanidae | 3 | 2 | - |
| Mollusca | Bivalvia | Pteriomorphia | | | 1 | - | - |
| Mollusca | Bivalvia | | | Juvenile Bivalve | 97 | 165 | 141 |
| Mollusca | Gastropoda | Caenogastropoda | Littorinimorpha | Naticidae | 4 | 1 | 5 |
| Mollusca | Gastropoda | Caenogastropoda | Littorinimorpha | Triviidae | - | - | 1 |
| Mollusca | Gastropoda | Caenogastropoda | Neogastropoda | Muricidae | 1 | - | - |
| Mollusca | Gastropoda | Heterobranchia | Cephalaspidea | Aglajidae | - | 1 | - |
| Mollusca | Gastropoda | Heterobranchia | Cephalaspidea | Haminoeidae | 3 | 1 | - |
| Mollusca | Gastropoda | Heterobranchia | Nudibranchia | Dendrodorididae | 1 | - | - |
| Mollusca | Gastropoda | Heterobranchia | Nudibranchia | | 1 | - | - |
| Mollusca | Gastropoda | Heterobranchia | | Architectonicidae | - | - | 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mollusca | Gastropoda | Heterobranchia | | | 1 | 1 | - |
| Mollusca | Gastropoda | Patellogastropoda | | Nacellidae | 18 | 24 | 35 |
| Mollusca | Gastropoda | Vetigastropoda | Trochida | Trochidae | 4 | 2 | 3 |
| Mollusca | Gastropoda | Vetigastropoda | Trochida | Turbinidae | - | - | 1 |
| Mollusca | Gastropoda | | | Juvenile Gastropoda | 12 | 14 | 13 |
| Mollusca | Scaphopoda | | Dentaliida | Dentaliidae | 2 | 1 | 2 |
| Mollusca | Polyplacophora | | | | 105 | 44 | 26 |
| Mollusca | Neogastropoda | | | | 2 | - | 1 |
| Nematoda | | | | | 32 | 30 | 51 |
| Nemertea | | | | | 2 | - | 2 |
| Platyhelminthes | | | | | - | 1 | 1 |
| Porifera | Calcarea | Calcaronea | Leucosolenida | Leucosoleniidae | 7 | - | 4 |
| Porifera | Calcarea | Calcaronea | Leucosolenida | Sycettidae | 1 | 2 | 2 |
| Porifera | Calcarea | | | | 2 | - | - |
| Porifera | Demospongiae | | | | 4 | - | 1 |
| Porifera | | | | | 13 | 5 | 10 |