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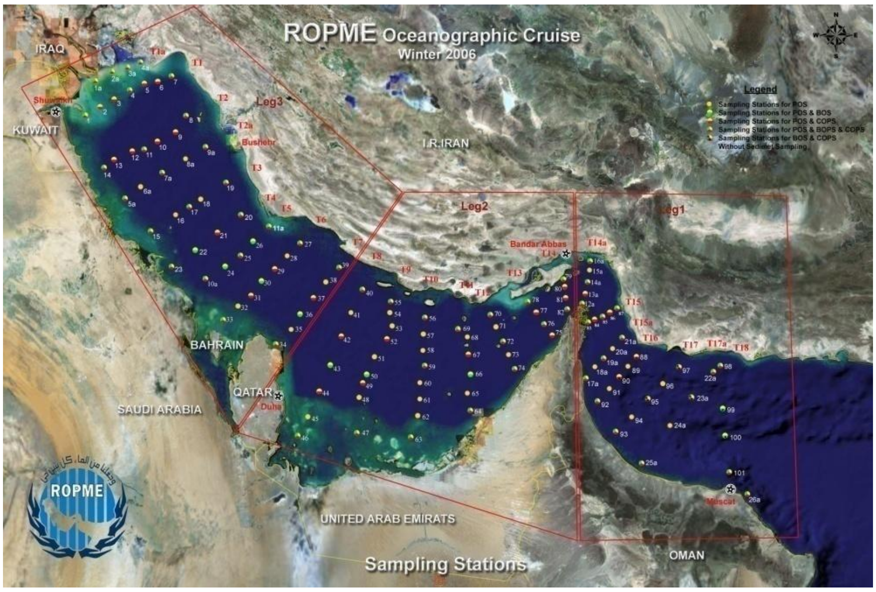
**Regional Organization for the Protection of the Marine Environment**

# *ROPME Oceanographic Cruise - Winter 2006*




## Technical Report Series

### Technical Report : No. 11

# *Macrobenthos in the ROPME Sea Area*

***April 2012***

***ROPME Oceanographic Cruise - Winter 2006***

***Technical Report Series:***

1. Physical Oceanography
2. Contaminants in Marine Sediments
3. Nutrients
4. Chlorophyll-*a*
5. Phytoplankton
6. Zooplankton
7. Decapod Larvae
8. Ichthyoplankton
9. Tintinnids
10. Meiobenthos
11. Macrobenthos

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This Report has been prepared by the Center for Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals (KFUPM-RI), as the Principal Investigator on 'Macrobenthos'. The Report is being separately subjected to peer review and linking with other relevant data and information, in order to develop an integrated understanding of the ROPME Sea Area. Meanwhile, in order to bestow the benefit of viewing the results in their preliminary form and promote a general level of understanding of the marine environment of the Region, notwithstanding the possible delay by peer review, this document is being brought out as part of a special Technical Report Series in the very form in which it was submitted by the Principal Investigator. Owing to this reason, ROPME shall not accept responsibility on the accuracy of data or interpretations contained in this Report. ROPME does not also subscribe to the inappropriate terms used to denote parts or full of the ROPME Sea Area inadvertently used by the Principal Investigator or provided in the published references and citations.

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# PREFACE

In recognition of the importance of the oceanographic Cruises in the ROPME Sea Area to understand the state of the marine environment, ROPME Council has assigned high priority to the ROPME scientific Cruises. In pursuance of the Council Decision CM12/7, ROPME was mandated to coordinate a comprehensive oceanographic Cruise in Winter 2006. The Cruise was planned in such a way that the results and reports of the studies can find their way into the synthesis of ROPME State of the Marine Environment Report.

As a result of sustained efforts, cooperation of Member States, guidance of the designated scientific committee for the Cruise, encouragements from the Executive Committee of ROPME and the generous provisions made by the Council, the historic Winter Cruise was carried out successfully on board of M/V Ghods of I. R.Iran during 1st February and 11th March 2006.

Totally, 115 stations covering the RSA have been surveyed and 97 experts from ROPME Member States participated in the Cruise. The survey covered most of the main oceanographic disciplines.

The collected samples during the Cruise were distributed on a competitive basis to the competent laboratories in the Region and elsewhere for detailed analyses while sub-sample sets were kept in ROPME Marine Sample Bank to enable repetitive analyses in future, when required.

To enhance benefits from the reproduced results of the Cruise among Regional scientific community towards a better understanding of the marine environment in the RSA and to enable furtherance of marine researches, ROPME Secretariat decided on the publication of the results in a series of Technical Reports as follows:

1. Physical Oceanography
2. Contaminants in Marine Sediments
3. Nutrients
4. Chlorophyll-*a*
5. Phytoplankton
6. Zooplankton
7. Decapod Larvae
8. Ichthyoplankton
9. Tintinnids
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11. Macrobenthos

The present Technical Report is devoted to the macrobenthic communities in the RSA. The analyses of macrobenthos and reporting have been conducted by a team of scientists led by Dr. Abdulaziz Al-Suwailem of KFUPM, Saudi Arabia.

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# Executive Summary

Regional Organization for the Protection of the Marine Environment (ROPME) sustains the achievements of the oceanographic cruises it held in the summer of 2000, 2001 and in the winter of 2006. The Winter 2006 Cruise aimed to expand the scale and scope of oceanographic observations in the ROPME Sea Area by incorporating winter variability and with addition of other parameters relevant to the monitoring and assessment of environmental conditions in the RSA. The ROPME cruise series reinforce existing mechanisms for a regional scientific cooperation, and contribute as well to national efforts in protecting the RSA marine environment which serves well the development and security agenda of the ROPME member states. Data generated out of the ROPME cruises are deemed invaluable in boosting knowledge and interests for ensuring the sustainable use of shared resources and environment in the RSA. Thus, the goals of the ROPME Cruise Program are in line with current global thrusts and in compliance with international commitments on resource conservation and development. The present study is based on the infaunal macrobenthic samples collected during Winter 2006 Cruise of ROPME.

For the study, benthic samples were collected from 51 stations distributed along 21 transects of inner and middle RSA, extending from latitudes 23.52 to 29.87N and longitudes 48.48 to 58.70E. All the stations were within the depth range of 13-104m. Polychaete worms comprised the majority (52%) of the collected macrobenthos, followed by crustaceans (27%) and mollusks (13%). Taxonomic identification of specimens was carried out down to species level. As many as 202 species belonging to 141 genera and 100 families were recorded from the study area. Higher number of species was recorded from the northern inner RSA which is likely to be due to large number of samples studied from this area. Macrobenthic abundance ranged between 60 ind. $m^{-2}$ and 1530 ind. $m^{-2}$ with a mean of 425 ind. $m^{-2}$. Relatively higher macrobenthic density was observed in Sea of Oman where abundance of polychaetes and crustaceans caused this higher total abundance. A comparison of the east-central-west regions of inner RSA indicated that east coast holds highest average benthic abundance (498 ind. $m^{-2}$) and lowest (301 ind. $m^{-2}$) in west coast. A statistically significant depth-wise variation in benthic abundance was absent.

Univariate diversity analysis showed value greater than three for Shannon diversity in about 75% of the stations indicates the healthiness of macrobenthic community. Species dominance was generally low in the RSA. Average diversity was more or less similar in the three regions. On the other hand, average diversity was higher in east coast than west coast.

Correlation analysis indicated the absence of any relationship of diversity indices with latitude, longitude and depth.

Community structure of benthos was outlined with the help of multivariate analysis of PRIMER. The dendrogram and nMDS showed the absence of any sort of grouping of stations within or between the three zones or with substrata as well. The *k*-dominance plot suggests no dominance of species and thereby in general, indicated no stress to the biota. In the present study, the species accumulation curve was not reached an asymptote and the estimates by various methods suggest that some more species would be recorded if an exhaustive sampling effort was carried out. In accordance with the dominance plot, geoplot also showed the healthy nature of the benthic community. ANOSIM of PRIMER showed no dissimilarity between the three regions whereas, there was discrimination between the benthos of coarser and muddy substrata. As per SIMPER analysis of PRIMER, the discrimination between these two substrata is mainly due to certain polychaete and amphipod species. The BVSTEP analysis of PRIMER, found out 27 determining species which are a subset of total 202 species capable of determining the community structure in RSA. This was mainly composed of polychaetes, crustaceans and mollusks.

The present study has made an attempt to know the relationship between benthos and environmental parameters. Among the hydrographical parameters, only salinity showed a significant negative correlation with fauna. When the water quality and sediment quality parameters were correlated with benthos, though there were correlations, most of the relationships are not relevant for benthos, except correlation of fauna with PAH and heavy metals. The rank correlations of benthos with environmental parameters showed variables such as ammonia, mean grain size, extractable organic matter, Pb and Mn formed the best combination explaining the distribution of fauna. The role of sediment texture in influencing the distribution of benthos has been attempted. Benthic abundance was higher in sandy substratum while diversity was higher in muddy substratum.

Polychaete/amphipod ratio is being used as an effective tool in studying the oil impact assessment. The ratio higher than one is considered to be stressed with oil pollution. In the present study no station had ratio higher than one and hence the benthic community is considered to be healthy in nature.

# 1. Introduction

Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area is the sea surrounded by the eight Member States of ROPME: Bahrain, Islamic Republic of Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. ROPME cruises aim to expand the scale and scope of oceanographic observations in the ROPME Sea Area by incorporating spatial and temporal variability of biotic and abiotic parameters and with the addition of parameters relevant to the monitoring and assessment of environmental conditions in the RSA. The ROPME cruise series reinforces existing mechanisms for a regional scientific cooperation, and contribute as well to national efforts in protecting the RSA marine environment which serves well the development and security agenda of the ROPME member states. Data generated out of the ROPME cruises are deemed invaluable in boosting knowledge and interests for ensuring the sustainable use of shared resources in the RSA. Thus, the goals of the ROPME cruises are in line with current global thrusts and support compliance with international commitments on environmental conservation and development.

ROPME carried out an oceanographic cruise in Winter 2006 with a view to comprehend the existing physico-chemical, geological and biological characteristics of the ROPME Sea Area (hereafter called RSA). Samples were collected from 51 stations distributed along 21 transects in the RSA. At the request of ROPME, the Research Institute of King Fahd University of Petroleum and Minerals conducted an analysis of infaunal benthos. The present study on macrobenthos is based on systematic sampling procedures and collected samples from each degree squares of RSA. This will generate excellent information on benthic productivity along the RSA which will bring out latitudinal and longitudinal variations.

Benthic study is imperative to know the dynamics and health of the marine environment. Benthic organisms help in the deposition, breakdown and turn over of organic matter in the seabed and facilitate the recycling of nutrients. Studies on the benthic system are important in evaluating the health and productivity of the marine environment. Benthic macro invertebrates are the dominant groups in the marine sediments from the intertidal areas to the deep sea. These organisms provide a key link in marine food webs. There exists a relationship between the benthic standing crop and the production of exploited demersal fishes and crustaceans. Benthic organisms have also been used as test organisms in toxicological studies (Mackie and Oliver, 1996). Benthos, especially polychaetes and amphipods are useful in monitoring the effects of pollution in the marine environment because the life history of the benthos, especially their longevity, provides long-term exposure to toxic substances. Benthic organisms dwell in sediments, which enhance their contact with many pollutants. Thus, pollution effects are easily detected in the benthos. Also, decomposition, the process where dead organic matter is broken down into $CO_2$ and simple inorganic molecules takes place principally in the benthic environment. Study on the rate of decomposition therefore provides an effective assessment of the ecosystem (Petersen, 1918, and Warwick, 1993).

The present study encompasses the spatial variation in the standing stock, species composition, diversity and community structure of macrobenthic organisms. Ecological relationships of the benthos are also attempted. The Marine Studies Section of the Research Institute of King Fahd University of Petroleum and Minerals produced this report.

# 2. Materials and Methods

## 2.1 Study Area

ROPME Sea Area (RSA) is extending between $16^0$39'N, $53^0$3'30"E; $16^0$00'N, $53^0$25E; $17^0$00'N, $56^0$30'E; $20^0$30'N, $60^0$00'E; $25^0$04'N, $61^0$25'E (Figure 1). The RSA can be divided into three parts such as *The inner RSA*, *The middle RSA* and *The outer RSA*, each with its own distinct physical and biological characteristics (SOMER, 2003). The inner RSA consists of the shallow embayment area (mean depth of about 35m) west of $56^0$E longitude that extends along the NW/SE axis from the Strait of Hormuz to the northern coast of I.R. Iran. The middle RSA includes the Sea of Oman, a deep basin (depth exceeding 2,500m along its central channel) and outer RSA, which extends from Ra's Al-Hadd to the southern border of Oman exhibiting a wide range of habitats. The inner RSA is affected by rapid meteorological changes owing to its shallowness. The marine topography of this area is very varied with an estuarine area in the extreme north near the mouth of Shatt Al-Arab, an extremely shallow area between Saudi Arabia, Bahrain and Qatar (Salway Bay) and a broad shelf area between Qatar, the United Arab Emirates and Oman (Hassan and El-Samra, 1985). The middle RSA provides an important link which allows the ambient oceanic waters to flow into the inner RSA and its warm saline waters to form a bottom layer that exists via the Sea of Oman.

The surface water temperature in the RSA varies between $12^0$C in winter and >$35^0$C in summer. The temperature difference between summer and winter is greatest (>$20^0$C) in the north-west and smallest (<$11^0$C) at Hormuz. Salinity gradually increases from south to north due to higher evaporation, with lower salinity being found along the Iranian side. In summer, the surface salinity varies from 34 (June) on the southern Omani coast of the Arabian Sea to 38.9 in the northern part of the Sea of Oman, and increases up to 42 just off Bahrain. Very high salinity, 70 has been reported in the Gulf of Salwah at its southern extremity. The level of dissolved oxygen (DO) in the surface waters of the inner RSA ranged from 4.05 to 6.8mg/l at the time of summer 2001 (SOMER, 2003). The distribution of dissolved oxygen in the surface waters in various parts of the middle and outer RSA in Oman waters was recorded on different occasions. In the Sea of Oman, it ranged from 4.37 mg/l to 11.2 mg/l. The measurement of hydrogen ion concentration (pH) during summer 2001 showed higher levels in the bottom water than surface. The surface pH ranged from 7.92 to 8.23. In general, the surface pH in the middle and outer RSA (8.130-8.214) is lower than the inner RSA (8.210-8.320). Previous studies (Brewer *et al.*, 1978, and SOMER, 2003) reported that the surface nutrient content in the middle and outer RSA is much higher than in the inner RSA. For example, high phosphate surface water (>1µmol/l) from the outer RSA rapidly loses phosphates through mixing and biological stripping as it moves north to the inner RSA (<0.1µmol/l). The Umitaka-Maru Cruises (1993-1994) carried out in the inner RSA and Strait of Hormuz reported maximum values of nitrates, phosphates and silicates near Iranian coast (Hashimoto *et al*. 1995). Data of the ROPME 2001 Cruise during August indicated that levels of nitrite, nitrate, phosphate and silicate were higher in the bottom waters of the inner RSA whilst ammonia levels were higher in the surface waters.

Sedimentological studies indicated that fine (mud) sediments predominate in the north-western part of the RSA which reflects the influence of the river inputs in the area. Much of the RSA floor is biogenic sediment, produced by micro-organisms, predominantly Foraminifera. There is a wide range of other limestone-producing fauna and flora such as corals and some calcareous algae, though in terms of sediment production these are quantitatively unimportant. Carbonate sands are predominant in Saudi Arabia and the UAE coast, whereas, on the Iranian side these are mixed with a greater proportion of terrigenous sediments from the wind, and numerous small riverine inputs (Purser and Siebold, 1973). Relatively large amounts of sand are deposited by prevailing NW winds that blow across the axis of the RSA. Khalaf *et al*. (1986) estimated that as much as 100t/km$^2$ of sand are deposited annually in the inner RSA.

The major environmental concerns in the RSA include: the introduction of various pollutants, physical alteration including destruction of habitats, the use of destructive fishing techniques and overexploitation of marine biological resources, and the introduction of invasive species (SOMER, 2003).

## 2.2 Methodology

Sediment samples for the macrobenthic study were collected from 51 stations belonging to 22 transects during February-March 2006, extending from latitudes 23.52 to 29.87N and longitudes 48.48 to 58.70E (Figure 1 & Table 1). The depth of the stations ranged from 13m to 104m. Triplicate samples were collected from each station using a van Veen grab (0.1m$^2$ bite area); however, for this report, single sample from each station that ROPME sent to KFUPM for analysis was considered. Sediment for the macrobenthic study was sieved onboard using 500µm (0.5mm) mesh and the residual sediment with organisms was preserved in 5-7% buffered formalin and stained with Rose Bengal. Prior to the analyses, samples were stained with Rose Bengal solution overnight and washed with copious freshwater. All the macrobenthic organisms were initially sorted into major groups and subsequently identified down to species level. Species identification was made on the basis of standard literatures, references and internet searches (Day, 1967a,b; Barnard and Drummond, 1982; Ruffo, 1982, 1989, 1993; Hall, 1985; LeCroy, 2000). Specimens were isolated, counted, photographed and then preserved in separate vials with 5% buffered formalin for future use.

## 2.3 Data Analyses

The benthic data set was treated with various univariate, multivariate and graphical analysis of PRIMER (Plymouth Routines in Multivariate Ecological Research, version 5). The species diversity was examined using the univariate diversity indices such as Margalef (d), Pielou's evenness (J'), Shannon-Weiner (H'), Simpson (λ'), Taxonomic diversity index with the sub-routine DIVERSE.

Multivariate analysis was performed on benthos species by station data matrix, following the approach of Clarke (1993) and Clarke and Warwick (1994). Q-mode (site similarity) analysis using the Bray-Curtis similarity measure was applied to double square-root-transformed species-abundance data to group the samples with similar community composition or ecological conditions, following the procedure described by Clarke and Warwick (1994). The stations were plotted on a 2-dimentional map by non-metric multidimensional scaling (MDS) ordination (Ludwig and Reynolds, 1988), based on the similarity matrix. Cluster analysis was done to find out the similarities between groups. The most commonly used clustering technique is the hierarchical agglomerative method by using Bray – Curtis coefficient (Bray and Curtis 1957). One way ANOSIM (analysis of similarity) was carried out to test differences found in the communities between habitats, and species typifying variation between habitats were identified using the SIMPER (Similarity percentage) subroutine. To compare the biodiversity between different regions, dominance plots were drawn by ranking the species in decreasing order of abundance. Relative abundance expressed as percentage of abundance in the sample was plotted across the species, against the increasing rank as the x-axis, the latter on a log scale. On the y-axis, the cumulative percentage was plotted. BVSTEP, another subroutine of PRIMER, stepwise searches of combinations of species considered to be responsible for the pattern in the biotic assemblages, was also carried out.

Species accumulation curves were also built (Goteli and Colwel, 2001). Five non parametric species richness estimators were calculated, such as Sobs Curve, Jacknife, Bootstrap, MM (Michaelis-Menton and UGE (Ugland, Gray & Ellingsen). Sob's curve shows the increase in the total number of different species as samples were successively pooled. Jacknife estimates collector's curve which used to predict how many species would have been discovered had the sampling been more intensive. Bootstrap was used to find out the number of species based on the set of proportions of samples that contain each species. MM parametric model was used to compare the outcome of other estimators. UGE tool was used to look backward at the expected behaviour of S (number of species) as samples were removed and to get information about number of S at the end of the series. Geometric class plot was prepared by plotting the percentage of species against number of individuals per species as outlined by Gray and Pearson (1982). This can give the information about the rare species.

To ascertain the relationship between biological and environmental variables, the BIO-ENV procedure (Clarke and Ainsworth, 1993) was employed. The basic principle behind this is to measure the agreement between the rank correlations of the biological (Bray-Curtis similarity) and environmental (Euclidean distance) matrices. A weighted Spearman rank correlation coefficient ($\rho\omega$) was used to determine the harmonic rank correlation between the biological matrix and all possible combinations of the environmental variables (water quality and sediment quality parameters).

*Polychaete/Amphipod ratio:* This ratio is based on the behavior of opportunistic polychaetes which proliferate and sensitive amphipods which decline on the outbreak of an oil pollution or organic enrichment. Pearson and Rosenberg (1978), Glemarec and Hily (1981), and Bellan (1984) selected opportunistic polychaetes species belonging to Capitellidae, Spionidae, Cirratulidae and Eunicidae families in relation to their ability to proliferate after an increase in organic matter. Similarly amphipods, living in such conditions were considered as indicators of oil pollution (Sanders *et al.*, 1980, and Swartz *et al.*, 1982). Gesteira and Dauvin (2000) tested different ratios like polychaetes / crustaceans + 1, opportunistic polychaetes / crustaceans + 1, polychaetes / amphipods + 1 and opportunistic polychaetes / amphipods to identify more efficient ratio for identifying oil impacts on soft bottom communities. They suggested log10 (opportunistic polychaetes / amphipods + 1) as the most effective one. In the present study, abundance of opportunistic polychaete families such as Spionidae, Cirratulidae, Capitellidae and Eunicidae (*Nematonereis unicornis*) and all the amphipod families were taken for the calculation of polychaete/amphipod ratio.

For the convenience of analysis and interpretation, the data from all the transects were pooled into three specific zones such as Northern inner RSA (T 1-7, 2a = 26 stations), Southern inner RSA (T 8-14 = 13 stations) and Sea of Oman (T 15-18, 14a, 15a, 17a = 12 stations).

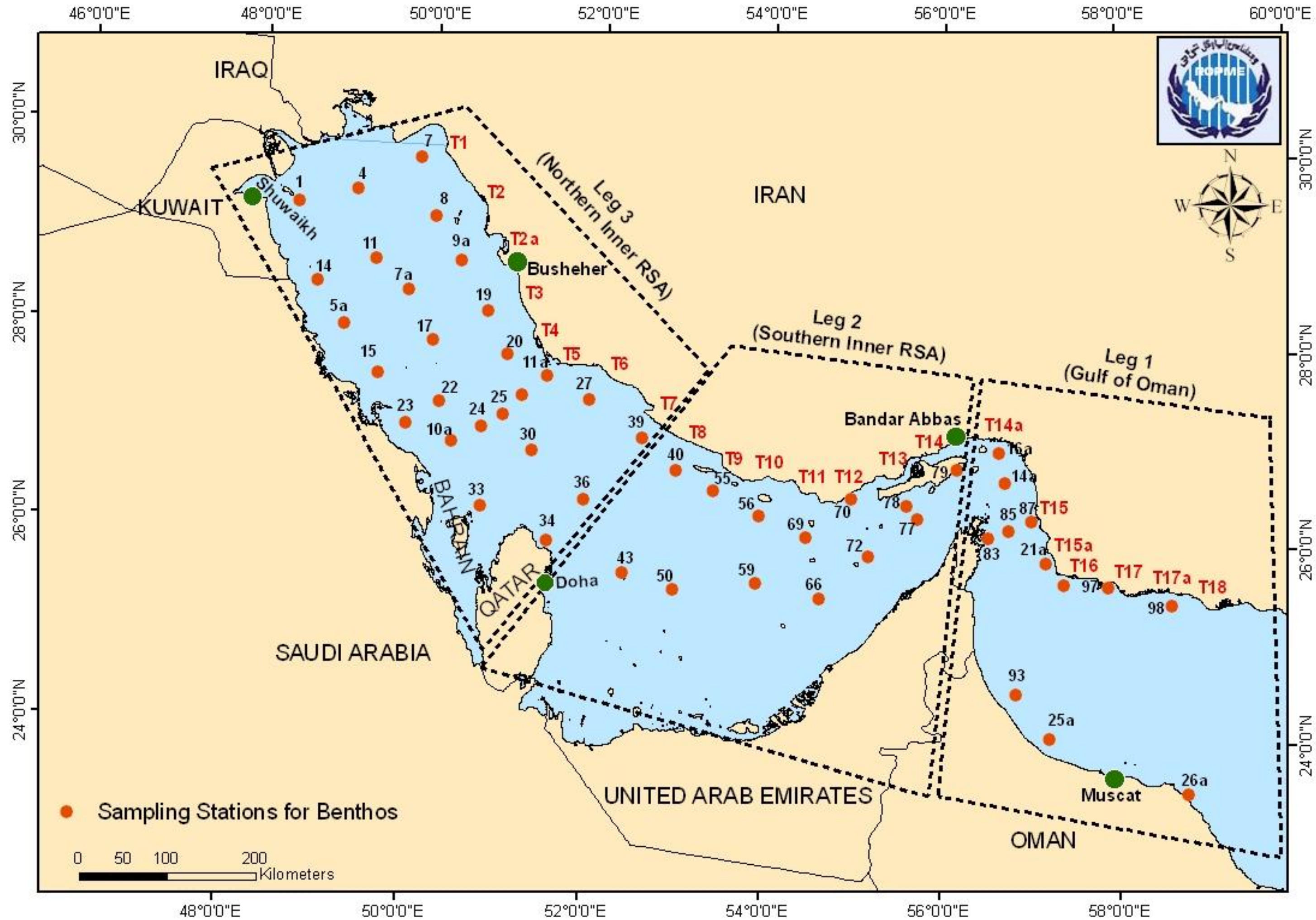



**Figure 1.** Benthos sampling stations for the ROPME Biological Oceanography Studies during Winter 2006 Cruise

**Table 1.** Benthos sampling stations with bathymetric details

| St. No. | Station Designation | Transect | Date | Time | Latitude | Longitude | Depth (m) |
|---|---|---|---|---|---|---|---|
| 1 | T1 S1 MA1 | 1 | 09/03/2006 | 18:24:44 | 29.35 | 48.48 | 13.28 |
| 4 | T1 S4 MA1 | 1 | 09/03/2006 | 10:24:37 | 29.22 | 49.44 | 41 |
| 7 | T1 S7 MA1 | 1 | 08/03/2006 | 13:56:56 | 29.87 | 49.87 | 13 |
| 8 | T2 S8 MA1 | 2 | 08/03/2006 | 7:02:29 | 29.29 | 50.09 | 42 |
| 11 | T2 S11 MA1 | 2 | 07/03/2006 | 12:20:40 | 28.82 | 49.42 | 44.01 |
| 14 | T2 S14 MA1 | 2 | 07/03/2006 | 6:45:26 | 28.56 | 48.76 | 24.72 |
| 5a | T2a S5a MA1 | 2a | 06/03/2006 | 17:35:27 | 28.14 | 49.09 | 21.3 |
| 7a | T2a S7a MA1 | 2a | 06/03/2006 | 12:19:39 | 28.52 | 49.82 | 54.95 |
| 9a | T2a S9a MA1 | 2a | 06/03/2006 | 7:33:53 | 28.85 | 50.40 | 47.71 |
| 15 | T3 S15 MA1 | 3 | 05/03/2006 | 6:58:52 | 27.66 | 49.52 | 21 |
| 17 | T3 S17 MA1 | 3 | 05/03/2006 | 13:05:23 | 28.02 | 50.13 | 60 |
| 19 | T3 S19 MA1 | 3 | 05/03/2006 | 17:47:26 | 28.35 | 50.74 | 57 |
| 20 | T4 S20 MA1 | 4 | 04/03/2006 | 6:58:17 | 27.91 | 50.99 | 63 |
| 22 | T4 S22 MA1 | 4 | 04/03/2006 | 12:44:13 | 27.40 | 50.23 | 57 |
| 23 | T4 S23 MA1 | 4 | 04/03/2006 | 16:04:55 | 27.16 | 49.87 | 43 |
| 24 | T5 S24 MA1 | 5 | 03/03/2006 | 7:10:16 | 27.17 | 50.73 | 65 |
| 25 | T5 S25 MA1 | 5 | 03/03/2006 | 9:34:06 | 27.30 | 50.97 | 67 |
| 26 | T5 S26 MA1 | 5 | 03/03/2006 | 13:13:01 | 27.51 | 51.18 | 73 |
| 10a | T5 S10a MA1 | 5 | 02/03/2006 | 17:00:48 | 27.00 | 50.40 | 26 |
| 11a | T5 S11a MA1 | 5 | 03/03/2006 | 15:36:56 | 27.72 | 51.45 | 17 |
| 27 | T6 S27 MA1 | 6 | 01/03/2006 | 11:19:21 | 27.49 | 51.95 | 54 |
| 30 | T6 S30 MA1 | 6 | 01/03/2006 | 17:41:44 | 26.95 | 51.31 | 71 |
| 33 | T6 S33MA1 | 6 | 02/03/2006 | 7:02:02 | 26.36 | 50.76 | 14 |
| 34 | T7 S034 MA1 | 7 | 28/02/2006 | 8:13:47 | 26.04 | 51.52 | 14 |
| 36 | T7 S36 MA1 | 7 | 28/02/2006 | 13:57:50 | 26.47 | 51.92 | 52 |
| 39 | T7 S39 MA1 | 7 | 01/03/2006 | 6:23:48 | 27.12 | 52.57 | 77 |
| 40 | T8 S40 MA1 | 8 | 23/02/2006 | 6:37:32 | 26.80 | 52.96 | 86 |
| 43 | T8 S43 MA1 | 8 | 23/02/2006 | 14:48:58 | 25.73 | 52.39 | 33 |
| 50 | T9 S50 MA1 | 9 | 22/02/2006 | 7:43:17 | 25.58 | 52.97 | 39 |
| 55 | T9 S55 MA1 | 9 | 22/02/2006 | 16:29:52 | 26.60 | 53.40 | 86 |
| 56 | T10 S56 MA1 | 10 | 21/02/2006 | 6:55:23 | 26.35 | 53.93 | 93 |
| 59 | T10 S59 MA1 | 10 | 21/02/2006 | 12:45:14 | 25.66 | 53.90 | 42 |
| 66 | T11 S66 MA1 | 11 | 15/02/2006 | 16:25:05 | 25.52 | 54.62 | 42 |
| 69 | T11 S69 MA1 | 11 | 15/02/2006 | 21:58:12 | 26.14 | 54.46 | 75 |
| 70 | T12 S70 MA1 | 12 | 14/02/2006 | 14:12:36 | 26.54 | 54.97 | 44 |
| 72 | T12 S72 MA1 | 12 | 15/02/2006 | 8:25:15 | 25.95 | 55.17 | 72 |
| 77 | T13 S77 MA1 | 13 | 14/02/2006 | 7:57:39 | 26.34 | 55.73 | 61 |
| 78 | T13 S78 MA1 | 14 | 14/02/2006 | 10:28:43 | 26.48 | 55.61 | 45 |
| 79 | T14 S79 MA1 | 14 | 13/02/2006 | 10:03:30 | 26.85 | 56.17 | 45 |
| 14a | T14a S14a MA1 | 14a | 09/02/2006 | 7:26:25 | 26.72 | 56.72 | 64 |
| 16a | T14a S16a MA1 | 14a | 09/02/2006 | 11:16:39 | 27.02 | 56.66 | 30 |
| 83 | T15 S83 MA1 | 15 | 08/02/2006 | 13:01:13 | 26.15 | 56.53 | 95 |
| 85 | T15 S85 MA1 | 15 | 08/02/2006 | 7:46:38 | 26.22 | 56.77 | 104 |
| 87 | T15 S87 MA1 | 15 | 07/02/2006 | 11:49:22 | 26.32 | 57.03 | 26 |
| 21a | T15a S21a MA1 | 15a | 07/02/2006 | 7:22:06 | 25.89 | 57.19 | 57 |
| 88 | T16 S88 MA1 | 16 | 06/02/2006 | 7:12:11 | 25.67 | 57.40 | 65 |
| 93 | T17 S93 MA1 | 17 | 05/02/2006 | 7:13:42 | 24.55 | 56.85 | 67 |
| 97 | T17 S97 MA1 | 17 | 05/02/2006 | 18:02:16 | 25.64 | 57.90 | 54 |
| 25a | T17a S25a MA1 | 17a | 04/02/2006 | 19:24:11 | 24.09 | 57.23 | 50 |
| 98 | T18 S98 MA1 | 18 | 04/02/2006 | 7:14:02 | 25.45 | 58.62 | 50 |
| 26a | T18 S26a MA1 | 18 | 03/02/2006 | 7:57:47 | 23.52 | 58.77 | 53 |

# 3. Results

## 3.1 Physico-Chemical Profiles of RSA

A summary of the hydrographical and sediment parameters are presented in Table 2 and contours plotted for each parameter are given in Figures 2-4. Bottom water temperature during February-March 2006 ranged from 16.58$^0$C (northern inner RSA) to 23.14$^0$C (Sea of Oman). There was a progressive increase in temperature from northern part of inner RSA towards Strait of Hormuz. Temperature in the Sea of Oman was found to be >21.69$^0$C during this season. Salinity (measured using the Practical Salinity Scale) was within the range of 36.33 – 44.07. In the inner RSA except the extreme north off Kuwait, the salinity was higher than 38 and the highest was recorded from the Gulf of Salwah. In major part of the inner RSA, salinity lies in the range of 40 - 42. Salinity in the Sea of Oman was below 38 except the Strait of Hormuz off UAE. Dissolved oxygen (DO) varied between 2.65 and 8.25 ml/L. Lowest was recorded from the Sea of Oman, off Oman and highest from the northern inner RSA, off Kuwait. A general decrease in the bottom DO was seen from northern inner RSA towards Sea of Oman which can be due to the deepening of floor in the Sea of Oman. The pH in the major part of the inner RSA was >8.0 with an exception of lower value noted in the proximity of Strait of Hormuz and from there down to Sea of Oman the pH was lower than 8.0.

**Table 2.** Summary of hydrographical and sediment parameters of RSA
*(Data presented as mean ± SD (range))*

| Characteristic | Northern Inner RSA | Southern Inner RSA | Sea of Oman |
|---|---|---|---|
| Temperature ($^0$C) | 19.0 ± 1.2 (16.7-21.5) | 21.9 ± 0.7 (20.7-22.8) | 22.5 ± 0.4 (21.7-23.1) |
| Salinity (PSU) | 40.7 ± 1.0 (37.8-44.1) | 39.8 ± 1.4 (37.0-41.5) | 37.1 ± 1.2 (36.3-39.8) |
| DO (ppm) | 7.1 ± 0.5 (5.8-8.3) | 5.9 ± 0.6 (4.8-6.7) | 5.2 ± 0.9 (2.7-6.4) |
| pH | 8.2 ± 0.1 (8.1-8.5) | 8.2 ± 0.3 (7.2-8.4) | 7.9 ± 0.1 (7.8-8.1) |
| TOC (%) | 0.9 ± 0.4 (0.4-1.8) | 1.2 ± 0.3 (0.5-1.6) | 0.7 ± 0.3 (0.4-1.3) |
| Mean grain size | 3.8 ± 2.2 (0.3-7) | 3.8 ± 2.5 (0.7-6.9) | 4.7 ± 2.4 (1.0-7.4) |

## 3.2 Sediment Characteristics of RSA

There was considerable spatial variation in the substrata ($P<0.05$). Eight (8) different sediment types were observed in the study area. They were coarse sand, medium sand, fine sand, very fine sand, coarse silt, medium silt, fine silt and very fine silt. Substratum was muddy in nature in most of the stations. Table 3 shows the sediment types and mean grain size along the RSA. Contour plot of sediment types show the prevalence of coarser sediment along the Saudi coast and muddy along the northern Iranian coast. While the substrata were muddy in the Iranian coast of Sea of Oman, it was sandy along the Oman coast. This is in agreement with the distribution of sediment textures reported by Wagner and van der Togt (1973). Total organic carbon (TOC%) in the sediment varied from 0.3 to 1.81%. Near zero values were observed along the northern part of inner RSA, however, in the majority of the stations, TOC values ranged between 0.5 and 1.5%.

**Table 3.** Sediment types, mean grain size value and TOC (%) in various stations along the RSA

| St. No | Sample ID | MZ (Φ) Value | Sediment Type | TOC (%) | St. No | Sample ID | MZ (Φ) Value | Sediment Type | TOC (%) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | T1S1 | 0.63 | CS | 0.51 | 40 | T8S40 | 5.5 | MZ | 1.42 |
| 4 | T1S4 | 5.5 | MZ | 0.48 | 43 | T8S43 | 1.73 | MS | -- |
| 7 | T1S7 | 6.63 | FZ | 0.54 | 50 | T9S50 | 5.5 | MZ | 1.15 |
| 8 | T2S8 | 4.6 | CZ | 0.93 | 55 | T9S55 | 0.8 | CS | 1.44 |
| 11 | T2S11 | 0.3 | CS | 0.48 | 56 | 10S56 | 1 | CS | 1.57 |
| 14 | T2S14 | 3.33 | VFS | 1.81 | 59 | T10S59 | 1.63 | MS | 0.99 |
| 5a | T2aS5a | 0 | CS | --- | 66 | T11S66 | 5.3 | MZ | 1.17 |
| 7a | T2aS7a | 4.93 | CZ | 1.2 | 69 | T11S69 | 0.7 | CS | 0.68 |
| 9a | T2aS9a | 3.46 | VFS | 0.62 | 70 | T12S70 | 6.86 | FZ | 1.1 |
| 15 | T3S15 | 0.866 | CS | 0.99 | 72 | T12S72 | 2.333 | FS | 1.06 |
| 17 | T3S17 | 3.633 | VFS | 1.05 | 77 | T13S77 | 6.86 | FZ | 1.54 |
| 19 | T3S19 | 6.06 | FZ | 0.95 | 78 | T13S78 | 6.6 | FZ | 1.36 |
| 20 | T4S20 | 7 | FZ | 0.72 | 79 | T14S79 | 4.76 | CZ | 0.47 |
| 22 | T4S22 | 4.53 | CZ | 0.81 | 14a | T14aS14a | 5.3 | MZ | 1.16 |
| 23 | T4S23 | 6.866 | FZ | 1.68 | 16a | T14aS16a | 7.36 | VFZ | 0.6 |
| 24 | T5S24 | 3.833 | VFS | 1.25 | 83 | T15S83 | 1.03 | MS | 0.74 |
| 25 | T5S25 | 5.3 | MZ | 0.85 | 85 | T15S85 | 3.8 | VFS | 1.26 |
| 26 | T5S26 | 5.833 | MZ | 0.46 | 87 | T15S87 | 6.46 | MS | 0.39 |
| 10a | T5S10a | 0.73 | CS | 0.99 | 21a | T15aS21a | 6.33 | FZ | 0.6 |
| 11a | T5S11a | 6.966 | FZ | 0.37 | 88 | T16S88 | 5.86 | FS | 0.79 |
| 27 | T6S27 | 4.4 | CZ | 0.72 | 93 | T17S93 | 2.1 | FS | 0.44 |
| 30 | T6S30 | 3.1 | VFS | 0.72 | 97 | T17S97 | 7 | VFZ | 0.63 |
| 33 | T6S33 | 0.36 | CS | 0.86 | 25a | T17aS25a | 1.66 | MS | 0.95 |
| 34 | T7S34 | 2.066 | FS | 0.83 | 98 | T18S98 | 7.3 | VFZ | 0.85 |
| 36 | T7S36 | 3.8 | VFS | 1.61 | 26a | T18S26a | 1.86 | MS | 0.53 |
| 39 | T7S39 | 3.63 | VFS | 0.87 | | | | | 1.42 |

MZ=Mean Grain size
CS=Coarse sand, MS=Medium sand, FS, Fine sand, VFS=Very fine sand, CZ=Coarse silt, MZ=Medium silt, FZ=Fine silt, VFZ=Very fine silt

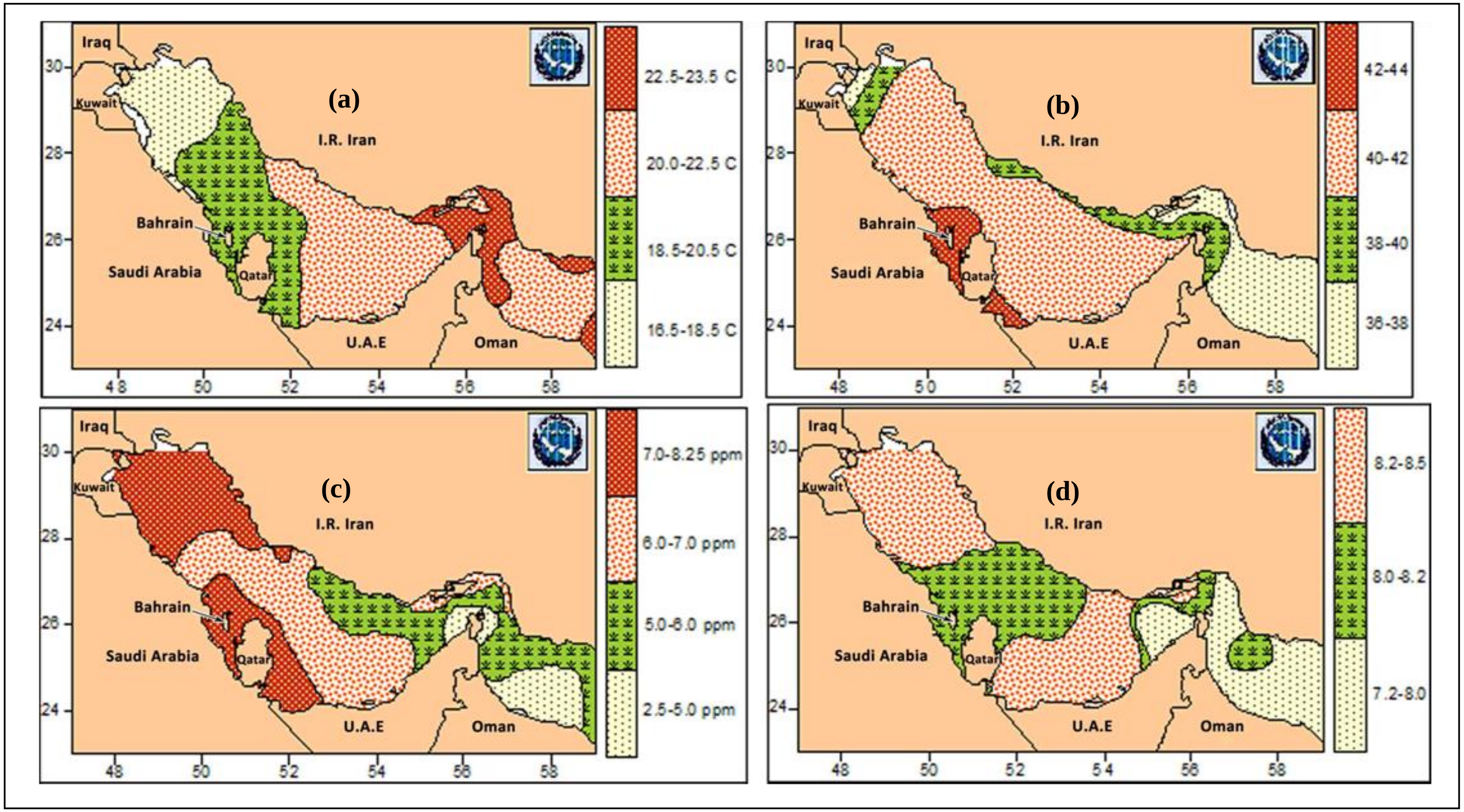



**Figure 2.** Hydrographical parameters of the bottom water along the RSA (a) temperature, (b) salinity, (c) DO and (d) pH

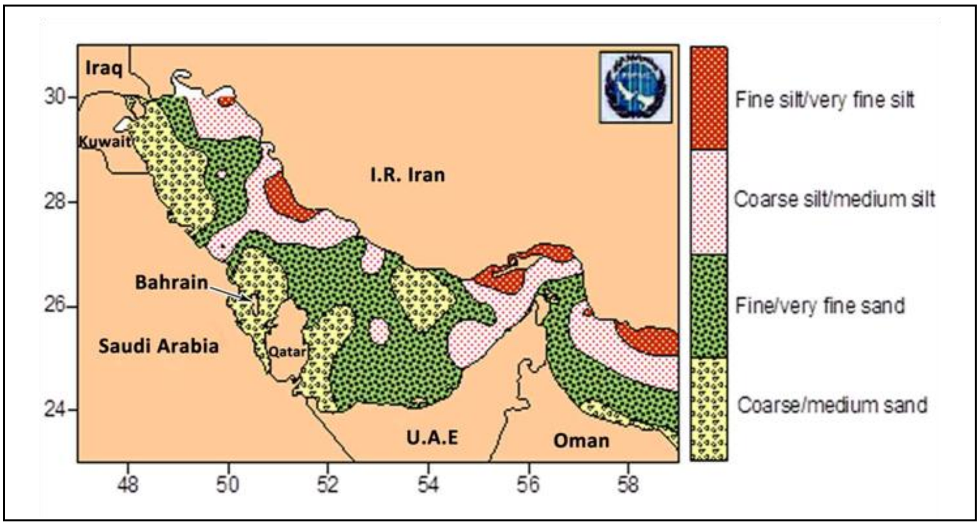



**Figure 3.** Map showing the various sediment types in the RSA

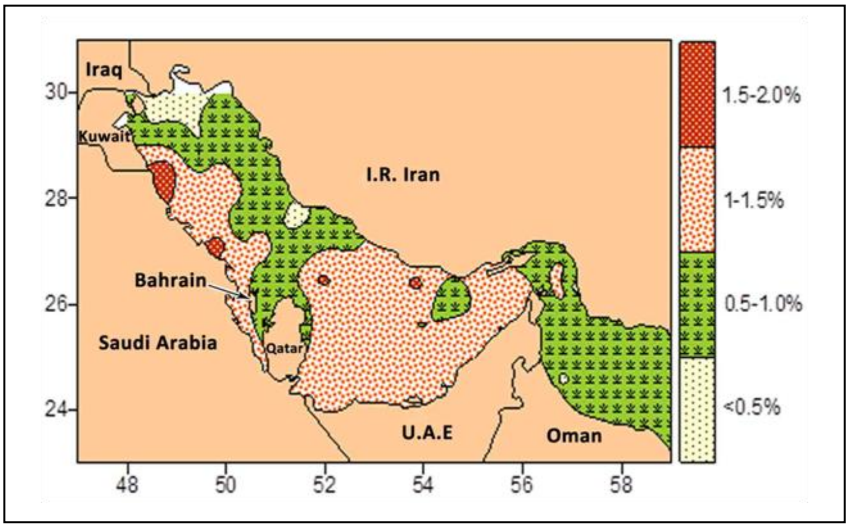



**Figure 4.** Map showing the distribution of TOC (%) in the RSA

## 3.3 Macrobenthos of RSA

### 3.3.1 Taxonomic Composition

Polychaete worms comprised the majority (52%) of the collected macrobenthos, followed by crustaceans (27%) and mollusks (13%) (Figure 5). Percentage composition of major taxa in the three divisions of the study area is presented in Figure 6. Representation of polychaetes and crustaceans were higher in the Sea of Oman with a lesser mollusks abundance.

As many as 202 species belonging to 141 genera and 100 families were recorded from the study area (Appendix A). This includes, 86 species of polychaetes, 41 species of gastropods, 30 species of bivalves, 26 species of crustaceans, 2 species of scaphopods and 17 species belonging to other taxa. Contours of species number recorded from various stations are plotted in Figure 7. This indicates that in majority of the stations species recorded were ranged between 10 and 20. In the northern RSA, species number varied from 3 (station 33) to 22 (station 7a), while, in southern RSA, the range was 5 (station 66) to 31 (station 69) and in the Sea of Oman, the range was 5 (station 83) to 22 (stations 85 and 26a). Higher number of species (162) was recorded from northern inner RSA likely to be due to large number of samples (26) studied from this area, followed by southern inner RSA (91 species from 13 samples) and Sea of Oman (91 species from 12 samples). The number of species recorded from major taxa of from the three study zones are presented in Table 4.

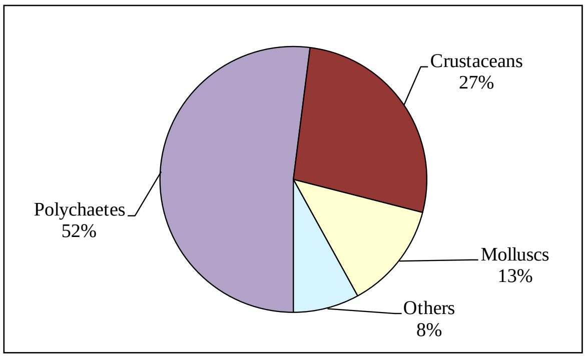



**Figure 5.** Percentage composition of major macrobenthic taxa of RSA

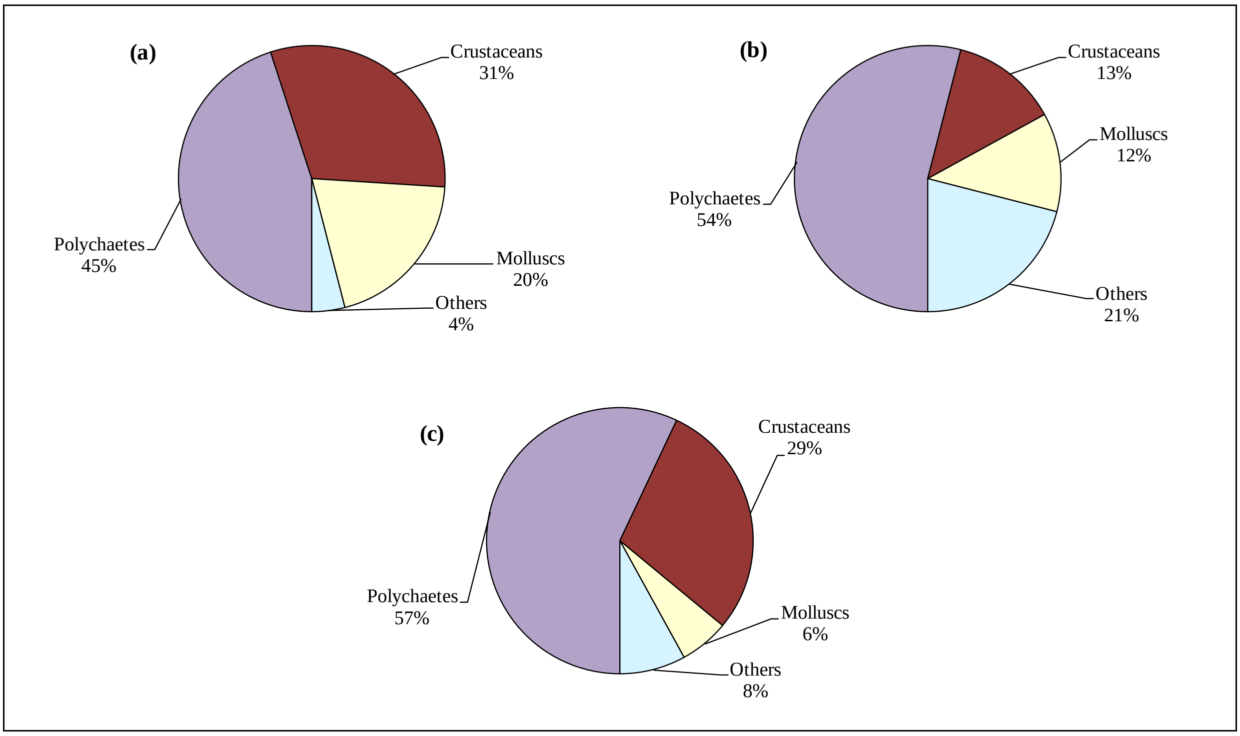



**Figure 6.** Percentage composition of major macrobenthic taxa of the three zones of RSA (a) Northern inner RSA, (b) Southern inner RSA and (c) Sea of Oman

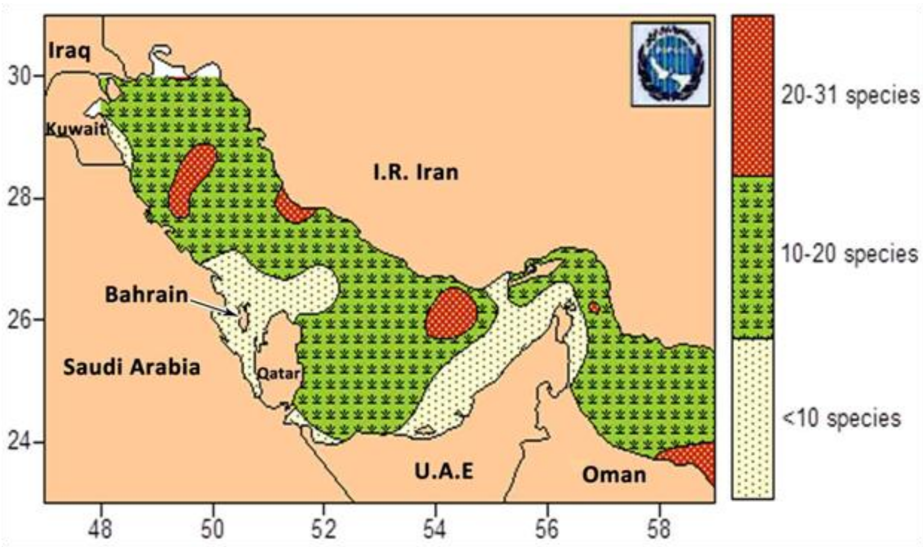



**Figure 7.** Contours of macrobenthic species number of RSA

**Table 4.** Number of species belonging to major taxa recorded from the three zones of the study area

| Taxa | Northern Inner RSA | Southern Inner RSA | Sea of Oman |
|---|---|---|---|
| Polychaetes | 72 | 51 | 47 |
| Crustaceans | 25 | 9 | 14 |
| Bivalves | 24 | 7 | 7 |
| Gastropods | 29 | 13 | 14 |
| Scaphopods | 2 | 1 | 0 |
| Others | 10 | 10 | 9 |
| Total | 162 | 91 | 91 |

Among the 141 genera, polychaetes contributed more with 55 genera, followed by gastropods (29), crustaceans (18), bivalves (21), scaphapods (1) and others (17). Of the 100 families, polychaetes were represented by 30 families, gastropods 24, bivalves 14, scaphopods 1, crustaceans 15 and others 16.

Dominant species recorded were *Ampelisca brevicornis* (Amphipoda), *Prionospio* sp. and *Eurythoe* sp. (Polychaeta). The ten dominant macrobenthic species are listed in Table 5. Polychaete, *Prionospio* sp. was found to be the most occurred species which was recorded from 34 stations.

In the polychaetes, most speciose families were Eunicidae (15 species), Spionidae (8 species) and Amphinomidae (7 species) whilst in amphipods, it was family Ampelicidae (6 species), in bivalves, family Veneridae (11 species) and in gastropods, family Turridae (9 species). There were quite a large number of families represented by 1-2 species in all the taxa (Appendix B).

**Table 5.** Dominant macrobenthic species in the study area

| Taxa | Species | Abundance (ind. $m^{-2}$) | No. of stations (N=51) |
|---|---|---|---|
| Amphipoda | *Ampelisca brevicornis* | 40 | 24 |
| Polychaetae | *Prionospio* sp. | 29 | 34 |
| Polychaetae | *Eurythoe* sp. | 20 | 9 |
| Amphipoda | *Ampithoe rubricata* | 16 | 16 |
| Amphipoda | *Ampelisca typica* | 14 | 11 |
| Polychaetae | *Amphicteis gunneri* | 13 | 9 |
| Ophiuroidea | *Ophiocnemus marmorata* | 12 | 8 |
| Polychaetae | *Lumbrineris* sp. | 10 | 21 |
| Polychaetae | *Nephtys dibranchis* | 9 | 21 |
| Polychaetae | *Eunice* sp. | 8 | 19 |

### 3.3.2 Macrobenthic Density

Density of macrobenthos varied between 60 ind. $m^{-2}$ (station 83, transect 15) and 1530 ind. $m^{-2}$ (station 88, Transect 16) with a mean of 425 ind. $m^{-2}$. Polychaetes were the major taxa contributing 7% to 97% with a mean of 231 ind. $m^{-2}$. Contribution of crustaceans was 0% to 86% with a mean of 123 ind. $m^{-2}$ whilst mollusks' was 0% to 54% with a mean of 60 ind. $m^{-2}$. Macrobenthic density in various stations along the study area is presented in Figures 8-10 and Appendix C.

Contour plots of population density of total macrobenthos, polychaetes, crustaceans and mollusks show the spatial variation in fauna (Figures 11- 14). These Figures illustrate a higher macrobenthic density in the Sea of Oman which is mainly due to the higher abundance of polychaetes and crustaceans. Relatively higher abundance of crustaceans and mollusks made the increase in total benthic abundance in the northern inner RSA compared to southern inner RSA. This is evident in Figure 15 also which shows the region-wise comparison of macrobenthos of the three regions of the RSA. Average density was higher in Sea of Oman (686 ind. $m^{-2}$) and lowest was in Southern inner RSA (298 ind. $m^{-2}$) (Figure 15). Northern inner RSA showed an average density of 422 ind. $m^{-2}$. Only in the northern inner RSA, samples were collected from the east coast, central and west coast and a comparison of the macrobenthos of east-central-west stations were carried out. The data indicated that east coast holds highest average benthic abundance (498 ind. $m^{-2}$) and lowest (301 ind. $m^{-2}$) in west coast. The central waters showed an average abundance of 458 ind. $m^{-2}$ (Figure 16).

In general, the density of polychaetes followed the pattern of total macrobenthos with relatively higher abundance (250-1220 ind. $m^{-2}$) in the Saudi coast of northern inner RSA and Sea of Oman. Crustaceans have shown higher abundance (100-1300 ind. $m^{-2}$) in northern inner RSA and Sea of Oman whilst mollusks showed higher density (100-500 ind. $m^{-2}$) in the northern inner RSA only.

Correlation analysis did not illustrate a depth-wise variation in fauna whereas polychaetes showed an increase in the abundance with increase in longitude and decrease in the abundance with increase in the latitude ($P$=0.05). Mollusks showed a decrease in the abundance with increase in longitude ($P$=0.05).

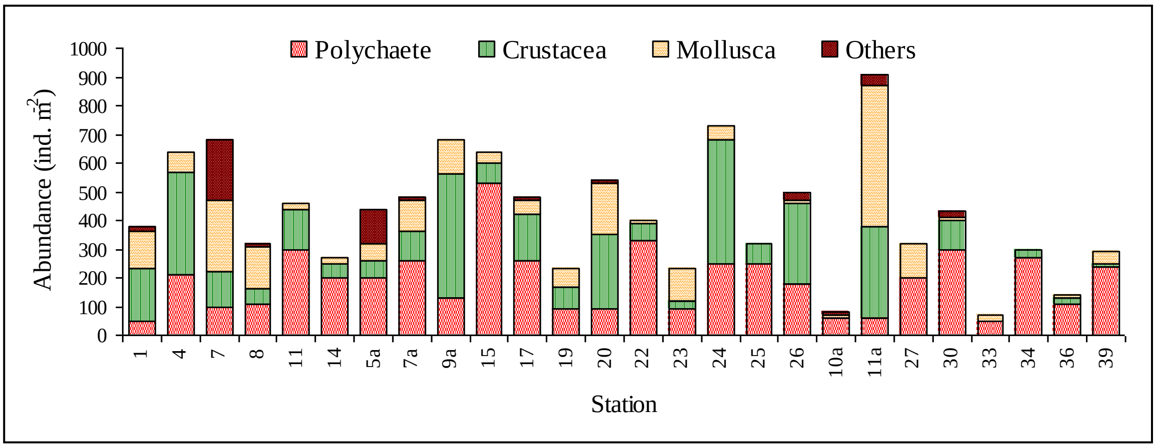



**Figure 8.** Macrobenthic biomass in various stations of northern inner RSA

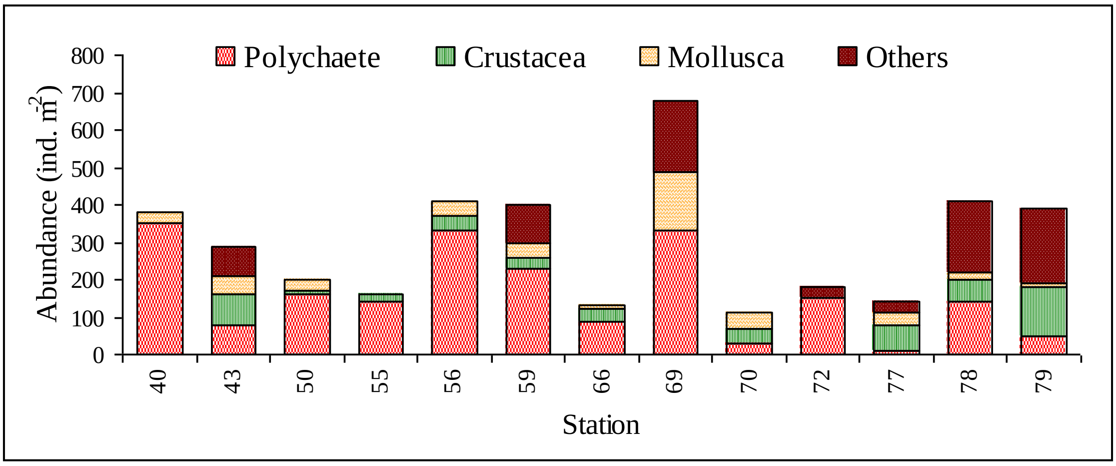



**Figure 9.** Macrobenthic biomass in various stations of southern inner RSA

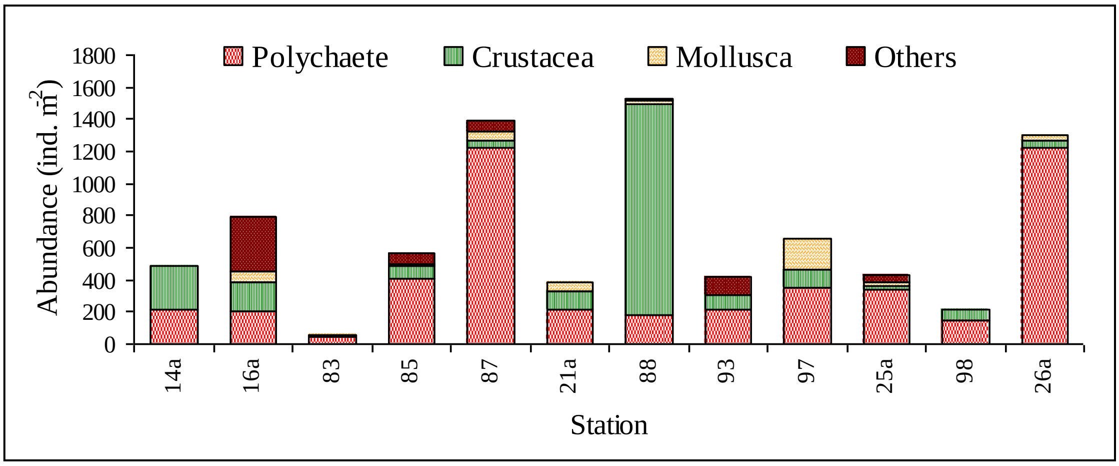



**Figure 10.** Macrobenthic biomass in various stations of Sea of Oman

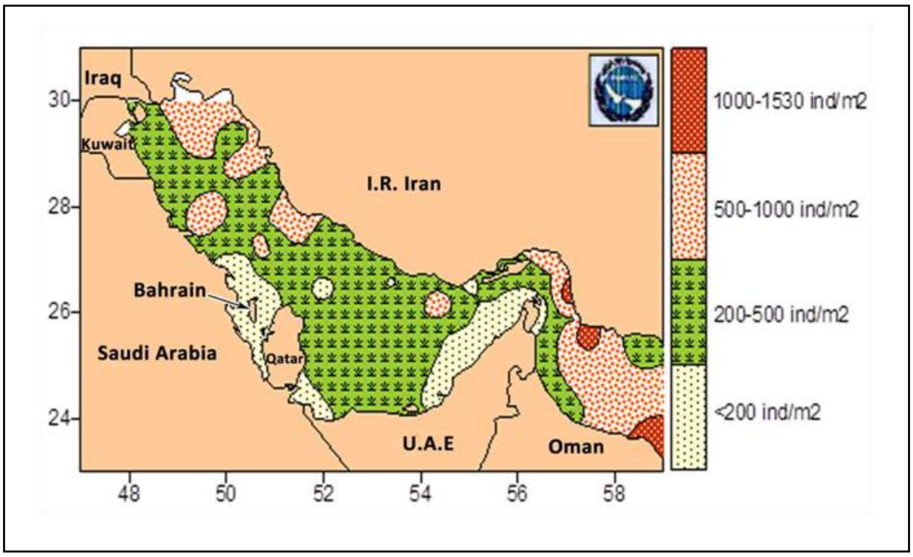



**Figure 11.** Contours of total macrobenthic abundance (ind. $m^{-2}$) of RSA

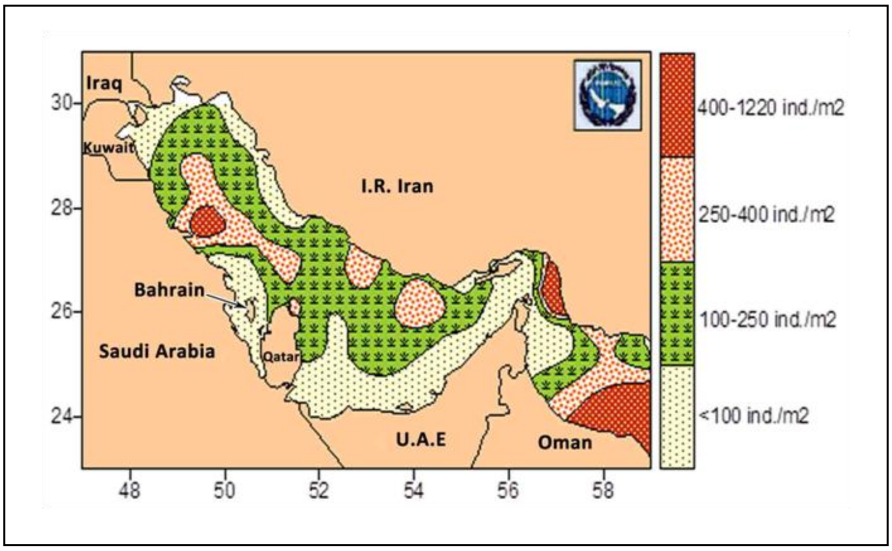



**Figure 12. Contours of polychaete abundance (ind. $m^{-2}$) of RSA**

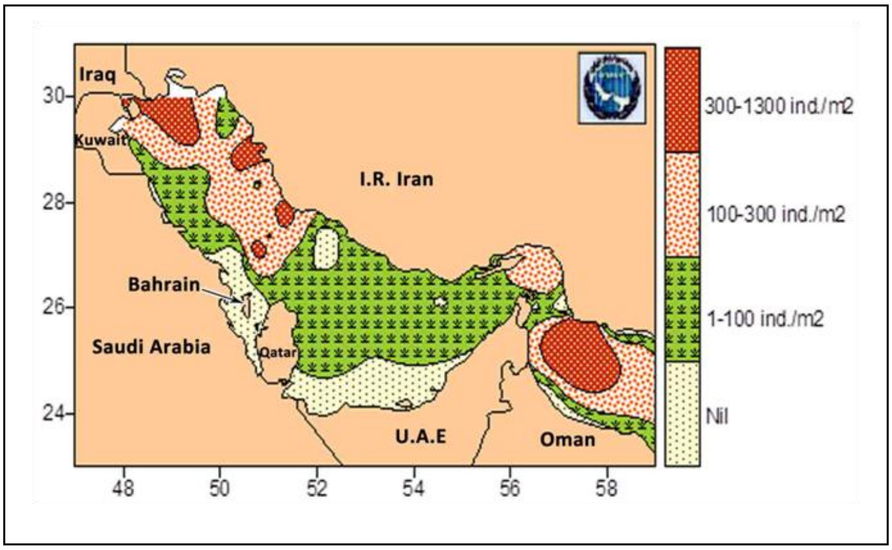



**Figure 13. Contours of crustacean abundance (ind. $m^{-2}$) of RSA**

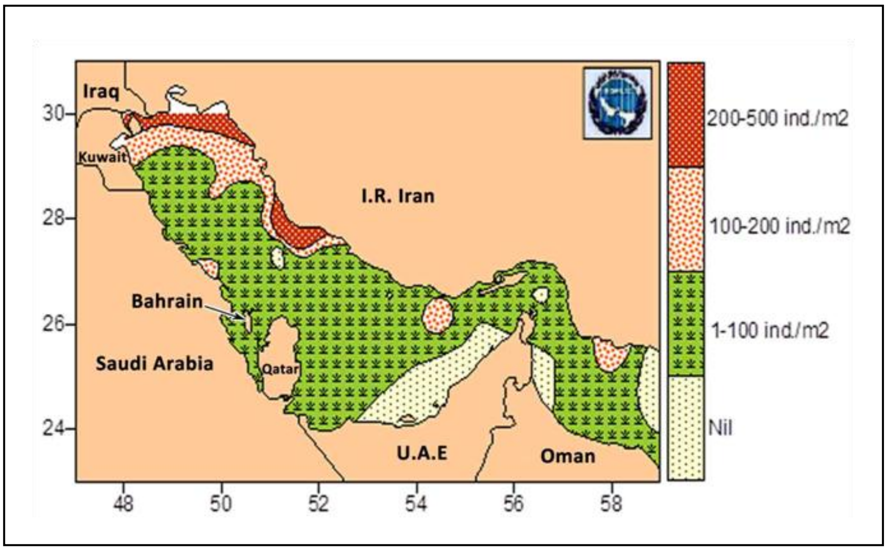



**Figure 14.** Contours of molluscan abundance (ind. $m^{-2}$) of RSA

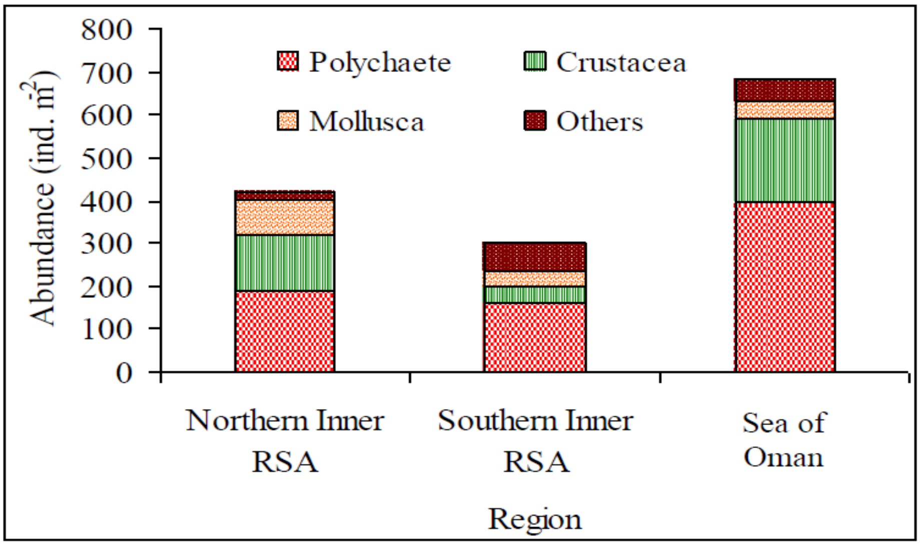



**Figure 15.** Region-wise comparison of macrobenthos of the three regions of RSA

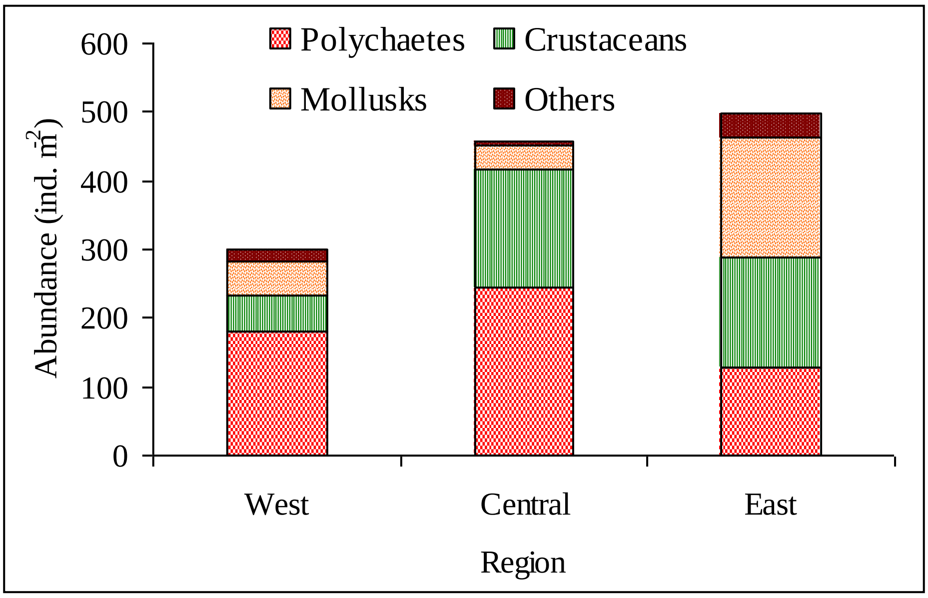



**Figure 16.** Region-wise comparison of macrobenthos along the northern inner RSA

### 3.3.3 Macrobenthic Diversity and Dominance

Diversity indices such as Margalef richness (d), Shannon diversity (H' log2), Pielou's evenness (J') and Simpson dominance (Lambda') were calculated for the macrobenthos. The results are presented in Figures 17 to 20 and in Appendix D. The species richness index varied between 1.0 (station 33, T6) and 6.9 (station 69, T11) with a mean of 0.87. Richness above 3 was observed in 78% of the stations. Richness values were comparatively lower in off Bahrain, off Qatar and in southern inner RSA close to the Strait of Hormuz. Higher values (5-7) were observed in three stations one each situated in the northern inner RSA, southern inner RSA and Sea of Oman. The species diversity index ranged from 1.4 (station 33, T6) to 4.4 (station 69, T11) with a mean of 3.3. About 75% of the stations had shown diversity values greater than 3 which indicate a healthiness of the macrobenthic community. Species diversity value lower than 3 was noticed in off Bahrain and off Qatar and stations in the southern inner RSA close to Strait of Hormuz. Species evenness index ranged from 0.5 (station 88, T16) to 0.98 (station 98, T18) with a mean of 0.87. Over 85% of the stations had evenness values greater than 0.8 which indicates the RSA as a whole has an even distribution of macrobenthic species. A general lower evenness was observed in the Sea of Oman. Species dominance index ranged from 0.03 (station 98, T18) to 0.43 (station 88, T16) with a mean of 0.12. Species dominance was generally low in the RSA. Stations near off Bahrain, off Qatar and in the Sea of Oman near I.R. Iran coast exhibited relatively higher range of dominance (0.2-0.4).

Region-wise comparison of macrobenthic diversity of the three regions of the RSA are presented in Figure 21, which shows higher average diversity in the northern inner RSA (3.3) and lower in the Sea of Oman (3.1). The southern inner RSA showed an average diversity of 3.2. The diversity variation in the east-west direction has been compared by taking three zones such as west, central and east coast. Figure 22 shows a higher average diversity (3.5) in the east and lower (3.0) in the west. The central waters showed an average diversity of 3.4.

Correlation analysis indicated the absence of any relationship of diversity indices with latitude, longitude and depth.

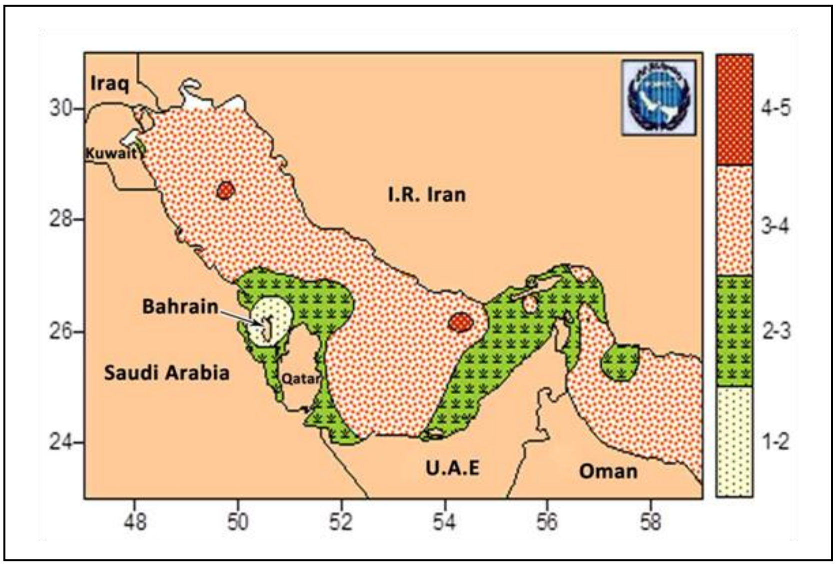



**Figure 17.** Contours of species richness of macrobenthos along the RSA

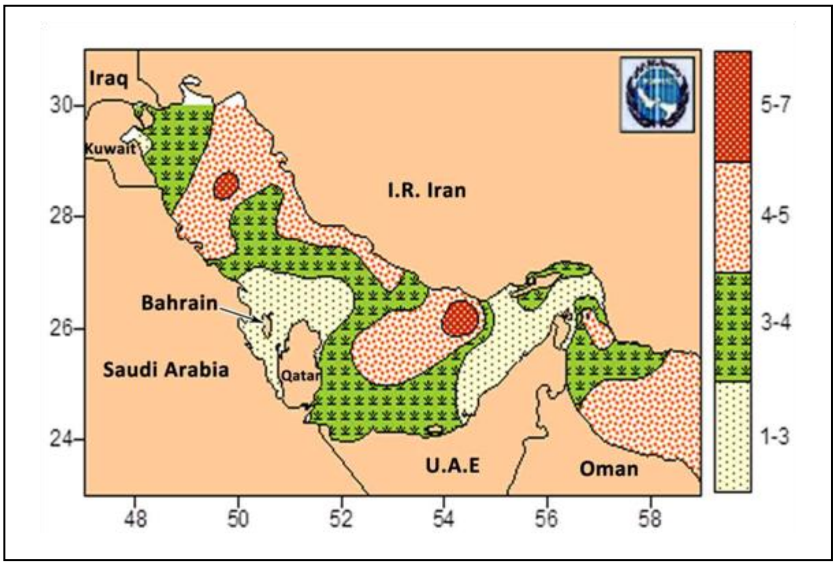



**Figure 18.** Contours of species diversity of macrobenthos along the RSA

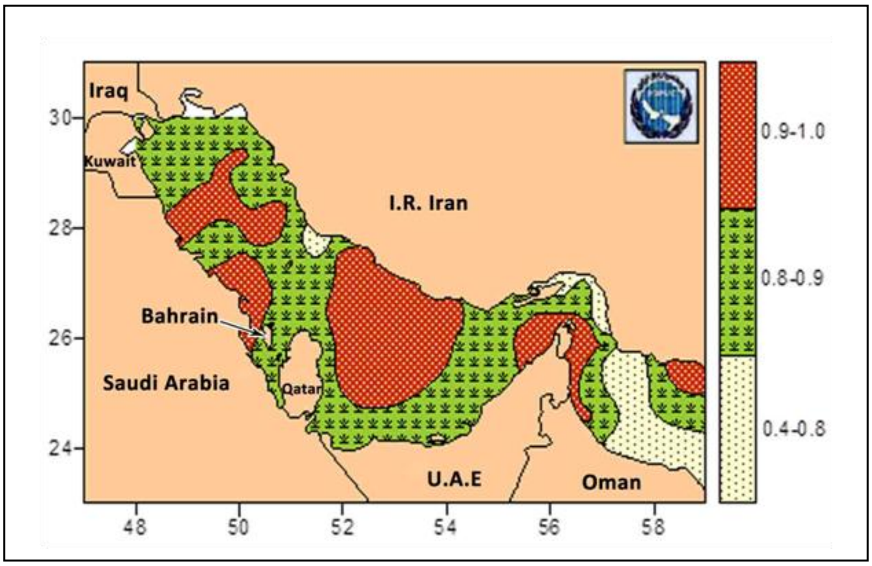



**Figure 19.** Contours of species evenness of macrobenthos along the RSA

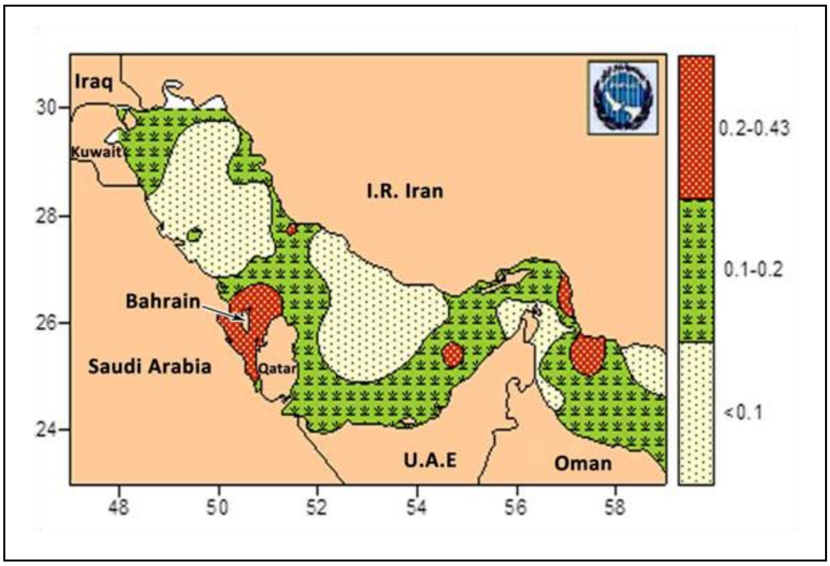



**Figure 20.** Contours of species dominance of macrobenthos along the RSA

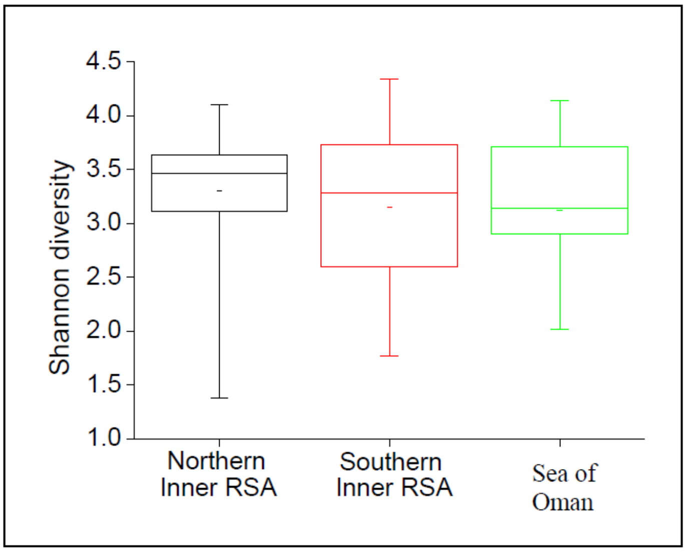



**Figure 21.** Box and whisker plots of species diversity of macrobenthos of the three regions of RSA

Data presented as mean (-) ± Perc 25, 75 (box) and minimum, maximum (whisker).

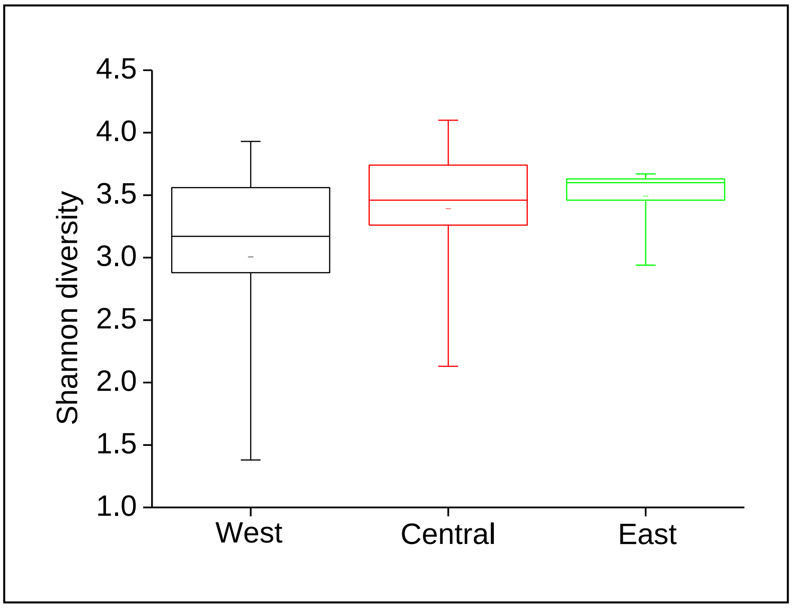



**Figure 22.** Box and whisker plots of species diversity of macrobenthos of the three regions of northern inner RSA

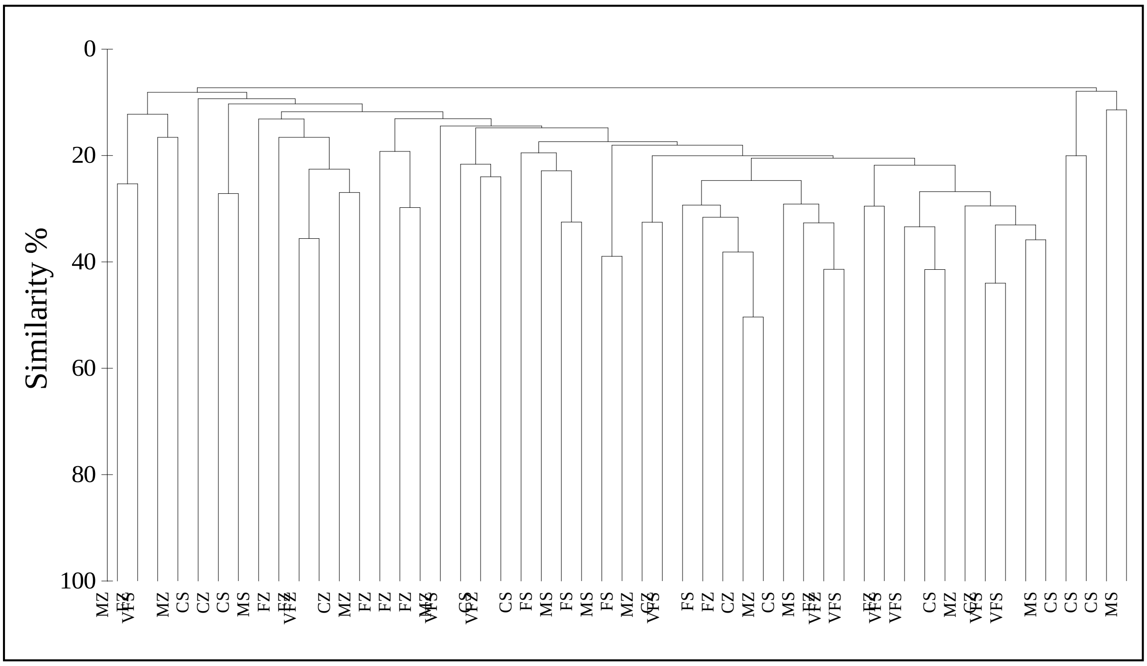
Data presented as mean (-) ± Perc 25, 75 (box) and minimum, maximum (whisker).

### 3.3.4 Multivariate Community Structure of Macrobenthos

Community composition, examined through dendrogram based on Bray Curtis similarity showed the absence of grouping of stations with sediment or the three zones of the study area (Figures 23 & 24). This was further evidenced in the MDS ordination in which stations in the three zones are found to be intermixed indicating the absence of intra-zone grouping (Figure 25). The stations in the outlier of the plot are those with less number of species (3-6). Multiple *k*-dominance plots (Clarke & Warwick, 1994), facilitated discrimination of macrobenthic species according to species' relative contribution to abundance. Up to 25 species constituted 60% of the total fauna in northern inner RSA, while it required 20 species for southern inner RSA and only 10 species for Sea of Oman (Figure 26). The geometric class plot (Figure 27) indicated the occurrence of more rare species as geometric class 1 is constituted by 25-85% of the total species in various stations. This indicates the healthy condition prevailing in the benthic environment. Species accumulation curve was plotted to determine the likelihood of getting the maximum number of species in the study area if the sampling was intense (Figure 28, see values in Appendix E). In the present study, as many as 202 species were identified. The estimates based on Sobs, Chao, UGE and Michaelis Menton agree with this, but Jacknife and Bootstrap showed the likelihood of getting 286 and 240 species respectively.

One-way ANOSIM was carried out to find out whether there is any difference between the fauna of three zones as well as the fauna of different substrata. Though eight types of substrata were noticed, these were summarized into three classes of substrata for this analysis, such as, coarse sand, sand and mud. There was no significant difference in the fauna of the three zones, however, significant variation was observed between the fauna of coarse sand and mud (ANOSIM, Global R = 0.142, significance p=0.1). The 'R values for each combination are given in Table 6. Further, SIMPER analysis was carried out to identify the discriminating species which are responsible for the dissimilarity between the fauna of coarse sand and mud. The species contributing the variation is presented in the Table 7. Most of the species are dominant species in terms of numerical abundance.

BVSTEP, a subroutine of PRIMER software, was used to find out the highly determining species in the study area. Determining species are the subset of total species, which determine the community structure in that environment. From the total 202 species, the program identified 27 determining species in the study area, whose Bray-Curtis similarity matrix correlates with that for the full species set at $\rho>0.95$. These species were *Aphrotid* sp., *Chloeia* sp., *Ancistrosyllis constricta*, *A.parva*, *Nephtys dibranchia*, *N. sphaerocirrata*, *Glycera* sp., *Eunice* sp., *Lumbrnereis* sp. *Prionospio* sp., *Magelona cincta*, *Cirratulus* sp., *Notomastus aberans*, *Maldane* sp., *Pectinaria crassa*, *Amphicteis gunneri*, *Ampharte acutifrons*, *Ampelisca spinipes*, *A. tenuicornis*, *A. typica*, *Diastylis* sp., *Donax* sp., *Paphia textile*, *Tellina angulata*, *Kurtziella limonitella*, *Nassa dorsata* and *Branchiostoma* sp.




MZ=Mean Grain size

**Figure 23.** Dendrogram for similarity of stations between the three zones of the study area with substrata as factor
(CS=Coarse sand, MS=Medium sand, FS, Fine sand, VFS=Very fine sand, CZ=Coarse silt, MZ=Medium silt, FZ=Fine silt, VFZ=Very fine silt)

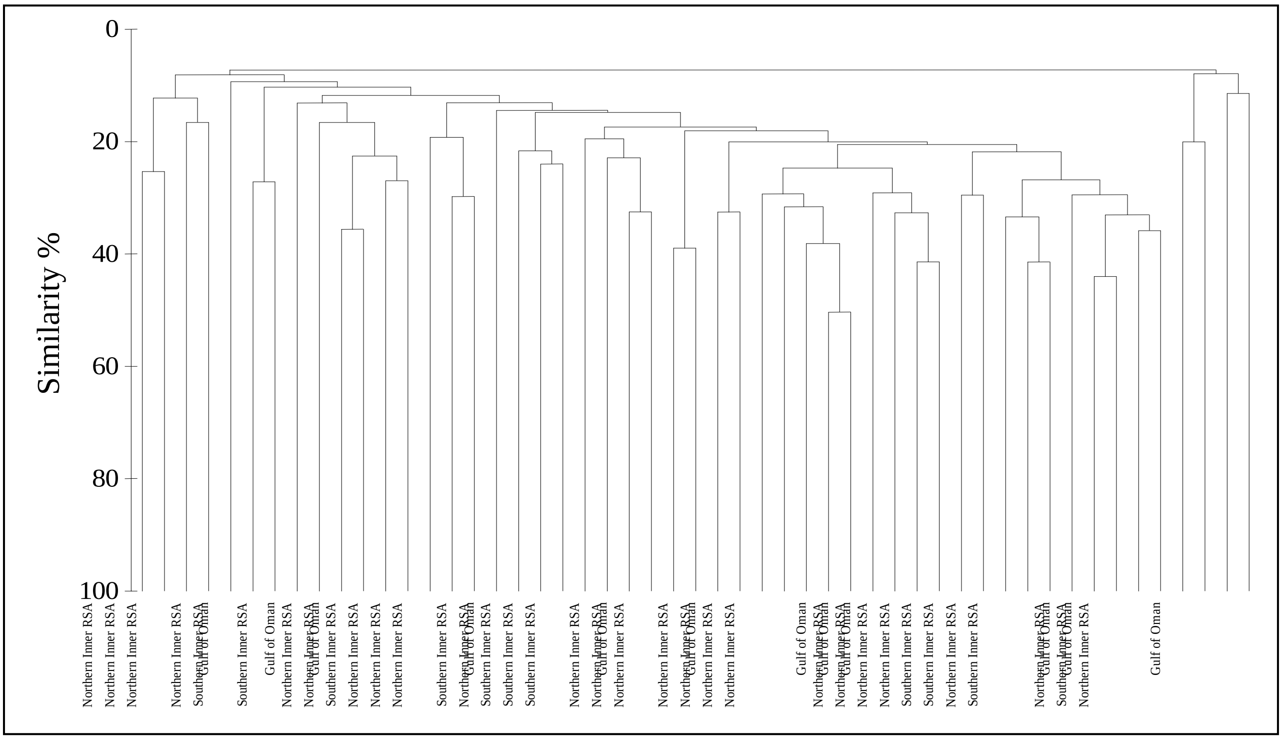



**Figure 24.** Dendrogram for similarity of stations between the three zones of the study area

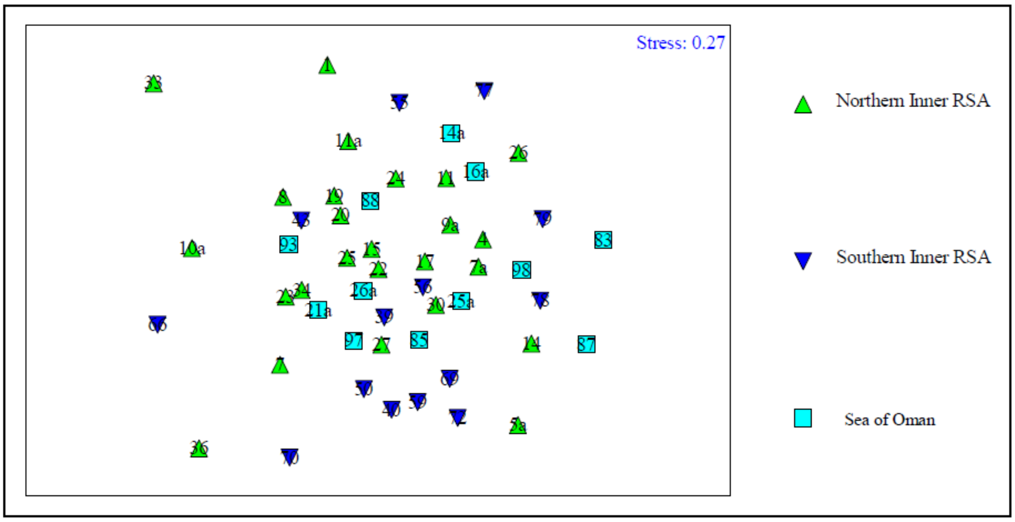



**Figure 25.** MDS ordination for stations of the three zones of the study area

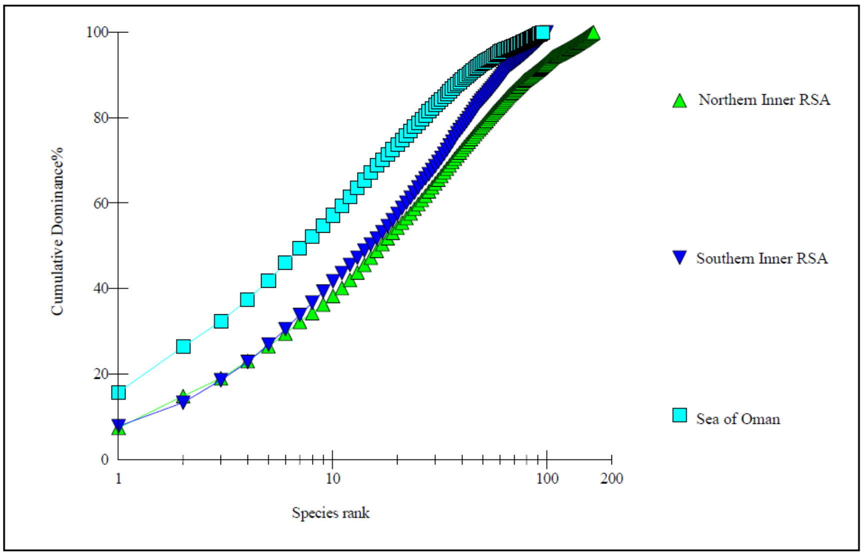



**Figure 26.** k-dominance curves of three zones of study area based on the macrobenthic species abundance matrix

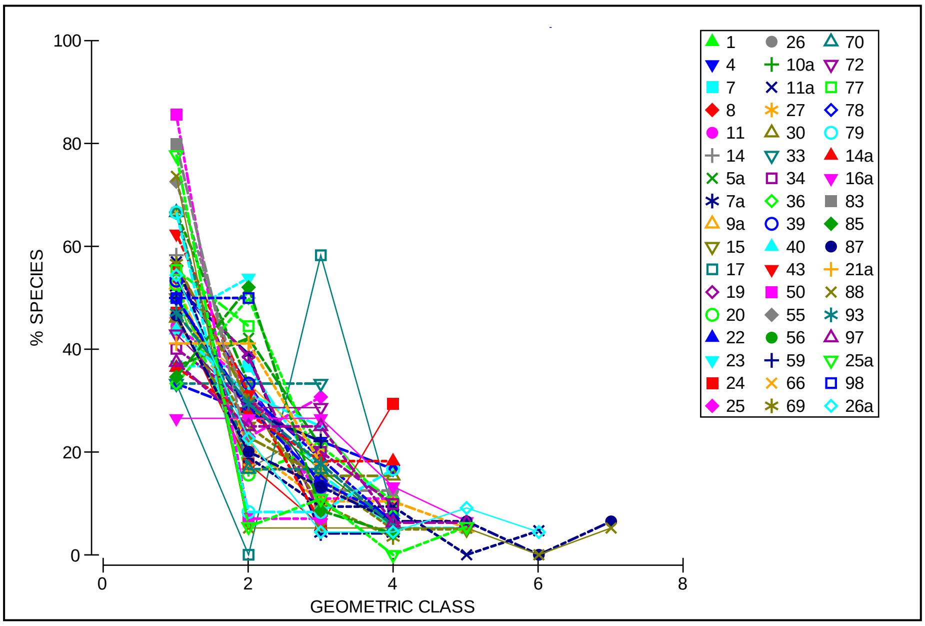



**Figure 27.** Geometric class plot of the study area based on the macrobenthic species abundance matrix

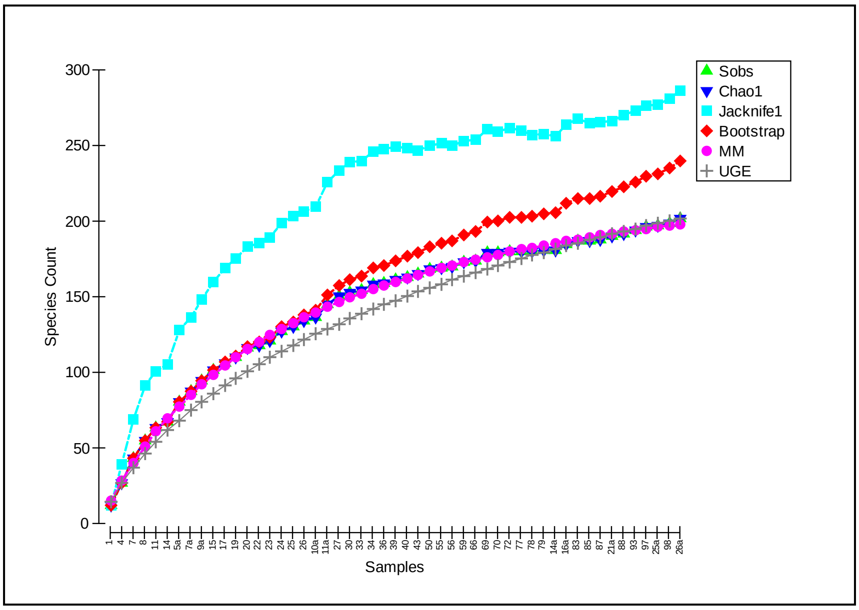



**Figure 28.** Species estimators for the macrobenthos of RSA

**Table 6.** Comparison of regions (factor- depth ranges and substratum) using one-way ANOSIM

| Group | R-statistic | Significance Level | Possible Permutations | Actual Permutations | Number Observed |
|---|---|---|---|---|---|
| ***Zone-wise*** | | | | | |
| Northern inner RSA & Southern Inner RSA | 0.113 | 5.8 | Too Many | 999 | 57 |
| Northern inner RSA & Sea of Oman | 0.028 | 34.2 | Too Many | 999 | 341 |
| Southern inner RSA & Sea of Oman | 0.027 | 28.1 | Too Many | 999 | 280 |
| ***Substratum-wise*** | | | | | |
| Coarse sand & Mud | 0.251 | 0.6 | 92561040 | 999 | 5 |
| Coarse sand & Sand | 0.186 | 2.2 | 13123110 | 999 | 21 |
| Sand & Mud | 0.074 | 4.1 | Too Many | 999 | 40 |

**Table 7.** Species typifying the variability of coarse sand and mud resulting from SIMPER analysis ranked in decreasing order of their importance to the similarity within their habitat. Only species cumulatively contributing c. 50% to the similarity are listed. Average dissimilarity is 91.76%

| Species | (Av.Abund) Coarse Sand | (Av.Abund) Mud | Av.Diss | Diss/SD | Contrib% | Cum.% |
|---|---|---|---|---|---|---|
| *Prionospio* sp. | 32 | 18.26 | 4.49 | 1.02 | 4.89 | 4.89 |
| *Ampithoe rubricata* | 16 | 18.7 | 3.75 | 0.65 | 4.09 | 8.98 |
| *Ampelisca brevicornis* | 3 | 27.39 | 3.74 | 0.94 | 4.07 | 13.05 |
| *Ampelisca typica* | 8 | 16.09 | 2.72 | 0.55 | 2.96 | 16.01 |
| *Ophiocnemus marmorata* | 4 | 19.13 | 2.48 | 0.38 | 2.71 | 18.72 |
| *Eunice* sp. | 14 | 3.91 | 2.4 | 0.7 | 2.61 | 21.33 |
| *Nephtys dibranchis* | 2 | 13.04 | 2.25 | 0.64 | 2.45 | 23.78 |
| *Orchasterias* sp. | 15 | 0 | 1.98 | 0.42 | 2.16 | 25.94 |
| *Cirratulus* sp. | 13 | 3.48 | 1.84 | 0.6 | 2 | 27.94 |
| *Lumbrineris* sp. | 7 | 9.57 | 1.78 | 0.68 | 1.94 | 29.88 |
| *Chloeia* sp. | 8 | 8.26 | 1.67 | 0.53 | 1.82 | 31.7 |
| *Euphrosine capensis* | 16 | 0 | 1.59 | 0.33 | 1.73 | 33.43 |
| *Atylus falcatus* | 7 | 7.39 | 1.51 | 0.59 | 1.65 | 35.08 |
| *Gammarus locusta* | 11 | 0 | 1.5 | 0.32 | 1.63 | 36.72 |
| *Cyclostrema eburnea* | 0 | 18.26 | 1.45 | 0.21 | 1.58 | 38.3 |
| *Paralacydonia paradoxa* | 6 | 6.09 | 1.3 | 0.74 | 1.41 | 39.71 |
| *Nassa hepatica* | 0 | 10 | 1.27 | 0.32 | 1.38 | 41.09 |
| *Ampithoe gammaroides* | 0 | 11.3 | 1.17 | 0.44 | 1.28 | 42.37 |
| *Glycera* sp. | 7 | 4.78 | 1.15 | 0.9 | 1.26 | 43.63 |
| *Mellita* sp. | 12 | 0 | 1.15 | 0.33 | 1.25 | 44.88 |
| *Capitella* sp. | 5 | 3.91 | 1.12 | 0.48 | 1.23 | 46.1 |
| *Eurythoe* sp. | 4 | 3.91 | 1.1 | 0.59 | 1.2 | 47.3 |
| *Aphrotid* sp. | 2 | 7.83 | 1.06 | 0.75 | 1.16 | 48.46 |
| *Dorvillea rudolphi* | 7 | 2.61 | 0.98 | 0.66 | 1.07 | 49.53 |
| *Amphicteis gunneri* | 3 | 3.48 | 0.96 | 0.47 | 1.04 | 50.57 |

### 3.3.5 Environmental Correlates of Macrobenthos

Tables 8 to 10 show the correlation coefficient of macrobenthos with environmental parameters. Among the hydrographical parameters, salinity was found to be negatively influencing the abundance of total macrobenthos and polychaetes and positively influencing species evenness ($P$=0.05) (Table 8). The amount of chlorophyll *a* showed positive correlation ($P$=0.05) with abundance of crustaceans and mollusk, whilst, in the case of nutrients, nitrate exhibited positive correlation with abundance of total benthos and polychaetes and negative correlation with species evenness ($P$=0.05). Among the sediment parameters, mean grain size showed a positive correlation with molluskan abundance and extractable organic matter (EOM) and TOC showed negative correlation with molluskan abundance ($P$=0.05) (Table 9). Among the hydrocarbons in the sediment, PAH was found to be negatively influencing species evenness and diversity (Table 9). Similarly, several heavy metals exhibited a negative correlation with the species evenness and some with the total abundance of benthos (Table 10).

BIO-ENV analysis was undertaken to measure the rank correlations of the biotic abundance with environmental parameters. The following environmental variables were used: depth, temperature, salinity, DO, pH, nitrite, silicate, phosphate, ammonia and sediment parameters such as mean grain size, extractable organic matter, TOC (%) carbonates, sediment contaminants such as heavy metals (Al, Sb, As, Ba, Ca, Cd, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Ni, Se, Ag, Sr, Sn, U, V, Zn and Hg), TPH, PAHs, chrysen equivalents, ROPME oil equivalents, HCHs, DDTs and PCBs. The result showed five environmental variables such as ammonia, mean grain size, extractable organic matter, Pb and Mn in sediment to influence the abundance of benthos in RSA ($\rho$=0.342).

There were considerable variation in macrobenthic abundance and substrata (Figure 29a) and diversity and substrata (Figure 29b). In general, average macrobenthic abundance was higher in sandy substratum. This was due to the higher abundance of polychaetes and crustaceans in this substratum. However, the abundance was lower in sandy substratum.

### 3.3.6 Polychaete-amphipod Ratio

Polychaete/amphipod ratio is being used for assessing the impact of oil pollution on benthic fauna. Rapid disappearance and slow recovery of amphipods along with the proliferation of opportunistic polychaetes alter this ratio in oil contaminated areas. The ratio between opportunistic polychaete abundance and amphipod abundance + 1, in $\log_{10}$ scale will be >1 in impacted communities, whereas in stable conditions the ratio will be ≤ 1. In the present study, the ratio was <1 (Table 11) in all the stations. In certain stations, due to the absence of either opportunistic polychaetes or amphipods or both, ratio observed was zero

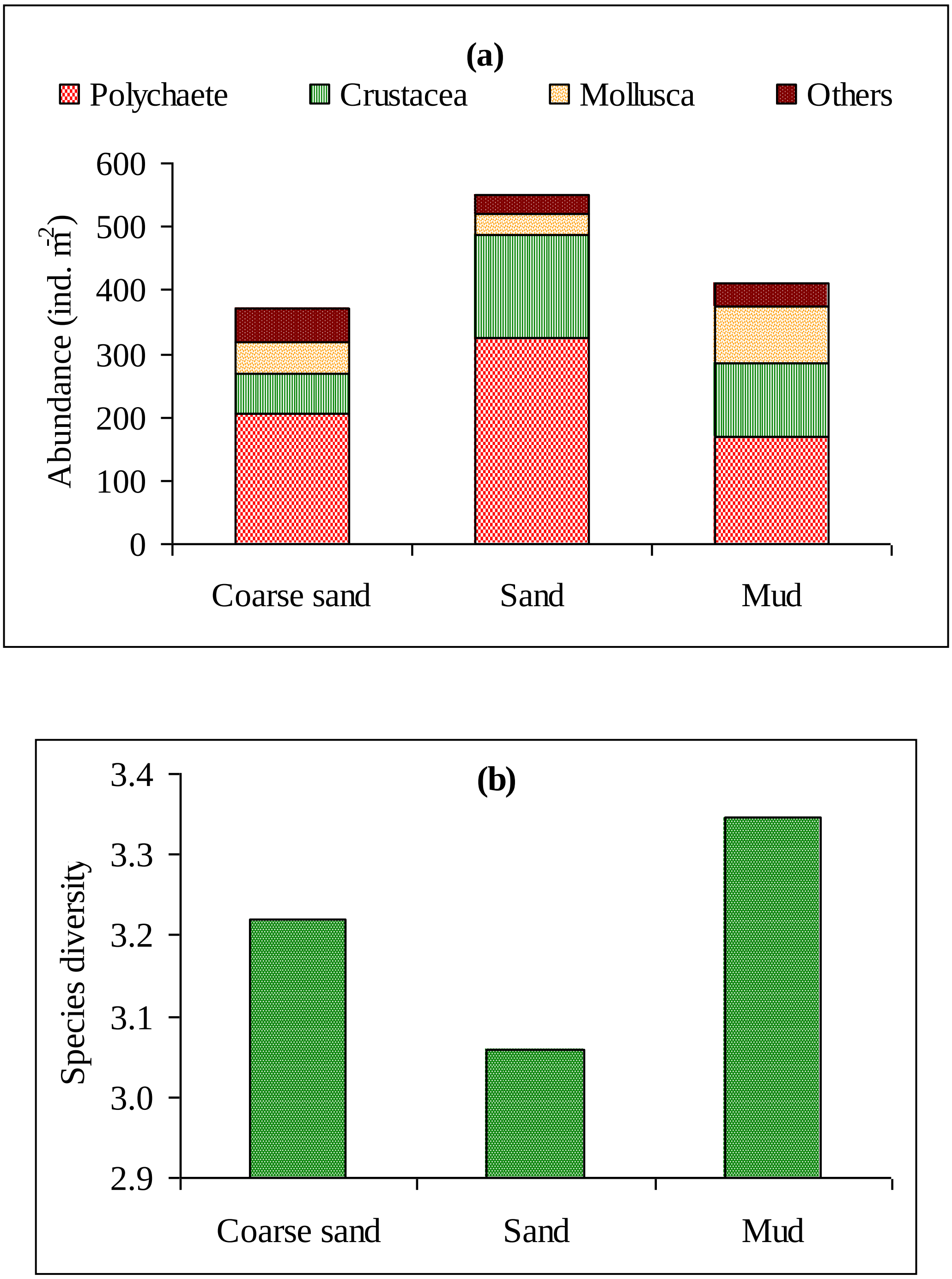



**Figure 29.** Relationship between macrobenthos and substrata (a) abundance and substrata and (b) species diversity and substrata

**Table 8.** Correlation between benthos and water quality parameters

| | Polychaetes | Crusta-ceans | Molluscs | Others | Total Abundance | d | J' | H'(log2) | Lambda' |
|---|---|---|---|---|---|---|---|---|---|
| Long. | 0.33 | -0.23 | -0.29 | 0.31 | 0.09 | -0.14 | -0.18 | -0.24 | 0.2 |
| Lat. | -0.36 | 0.27 | 0.27 | -0.13 | -0.05 | 0.09 | 0.08 | 0.18 | -0.11 |
| Depth | -0.09 | -0.22 | -0.15 | 0.34 | -0.17 | -0.04 | 0.09 | -0.06 | -0.04 |
| Temp | 0.24 | -0.05 | -0.21 | 0.22 | 0.14 | -0.08 | -0.21 | -0.2 | 0.21 |
| Salinity | -0.31 | -0.22 | 0.05 | -0.29 | -0.42 | -0.04 | 0.44 | 0.06 | -0.25 |
| O2ppm | -0.22 | 0.1 | 0.31 | -0.02 | -0.02 | -0.09 | 0.06 | 0.02 | -0.02 |
| pH | -0.24 | 0.1 | 0.27 | 0.01 | -0.04 | 0.22 | 0.12 | 0.23 | -0.17 |
| Chl a | -0.13 | 0.42 | 0.37 | -0.03 | 0.27 | -0.03 | -0.28 | -0.07 | 0.23 |
| Nitrate | 0.45 | 0.13 | -0.19 | -0.03 | 0.35 | 0.09 | -0.33 | -0.09 | 0.22 |
| Nitrite | 0.11 | 0.1 | -0.31 | -0.01 | 0.06 | -0.17 | -0.16 | -0.13 | 0.15 |
| Silicate | 0.04 | -0.15 | -0.32 | -0.06 | -0.17 | 0.09 | 0.11 | 0.08 | -0.12 |
| Phosphate | 0.28 | 0.08 | -0.22 | 0.12 | 0.23 | 0.07 | -0.28 | -0.05 | 0.18 |
| Ammonia | 0.14 | 0.03 | -0.19 | 0.29 | 0.14 | -0.17 | -0.16 | -0.14 | 0.18 |
| (yellow) | = Significant +ve correlation (*P*<0.05) | | | | (green) | = Significant -ve correlation (*P*<0.05) | | | |

**Table 9.** Correlation between benthos and sediment quality parameters

| | Polychaetes | Crustaceans | Molluscs | Others | Total Abundance | d | J' | H'(log2) | Lambda' |
|---|---|---|---|---|---|---|---|---|---|
| Mean grain size | -0.09 | 0.24 | 0.29 | 0.1 | 0.19 | -0.05 | -0.19 | -0.01 | 0.13 |
| EOM | -0.13 | -0.19 | -0.29 | -0.02 | -0.30 | -0.24 | 0.20 | -0.16 | -0.04 |
| TOC | -0.21 | -0.23 | -0.32 | -0.25 | -0.45 | -0.13 | 0.39 | 0.00 | -0.25 |
| Carbonates | -0.06 | -0.36 | -0.20 | -0.11 | -0.36 | -0.05 | 0.31 | -0.03 | -0.20 |
| Total Unresolved | -0.07 | -0.01 | -0.10 | -0.07 | -0.10 | 0.02 | -0.10 | -0.06 | 0.13 |
| Total PHs | -0.10 | -0.05 | -0.14 | -0.09 | -0.17 | -0.01 | -0.03 | -0.07 | 0.08 |
| Total PAHs | 0.08 | 0.47 | 0.16 | 0.08 | 0.43 | -0.11 | -0.47 | -0.28 | 0.46 |
| Total HCHs | 0.28 | -0.05 | -0.14 | 0.06 | 0.15 | -0.08 | -0.07 | -0.06 | 0.05 |
| Total DDTs | -0.03 | -0.10 | 0.01 | 0.10 | -0.06 | 0.06 | 0.11 | 0.10 | -0.12 |
| Total PCBs | 0.05 | -0.07 | -0.04 | -0.09 | -0.04 | 0.11 | 0.08 | 0.13 | -0.10 |
| Chrysene equivalent | -0.10 | 0.16 | -0.09 | -0.18 | -0.04 | 0.08 | 0.13 | 0.13 | -0.12 |
| ROPME Oil equivalent | -0.10 | 0.15 | -0.08 | -0.17 | -0.04 | 0.09 | 0.13 | 0.14 | -0.13 |
| (yellow) | =Significant +ve correlation (*P*<0.05) | | | | (green) | =Significant -ve correlation (*P*<0.05) | | | |

**Table 10.** Correlation between benthos and heavy metals in sediment

| | Polychaetes | Crusta-ceans | Molluscs | Total Abundance | d | J' | H'(log2) | Lambda' |
|---|---|---|---|---|---|---|---|---|
| Al | 0.03 | 0.42 | 0.26 | 0.39 | 0.04 | -0.35 | -0.01 | 0.24 |
| Sb | 0.47 | 0.09 | 0.06 | 0.42 | 0.29 | -0.18 | 0.22 | -0.05 |
| As | 0.24 | -0.06 | 0.06 | 0.21 | 0.06 | -0.22 | -0.05 | 0.08 |
| Ba | -0.01 | 0.34 | 0.31 | 0.32 | 0.03 | -0.26 | 0.05 | 0.15 |
| Ca | 0.01 | -0.36 | -0.26 | -0.34 | -0.10 | 0.29 | -0.07 | -0.18 |
| Cd | 0.02 | 0.03 | 0.14 | 0.08 | 0.30 | 0.05 | 0.27 | -0.14 |
| Cr | 0.11 | 0.16 | 0.06 | 0.26 | 0.13 | -0.32 | 0.05 | 0.18 |
| Co | 0.02 | 0.35 | 0.23 | 0.34 | 0.08 | -0.31 | 0.06 | 0.17 |
| Cu | 0.06 | 0.05 | 0.03 | 0.11 | 0.12 | -0.24 | 0.01 | 0.16 |
| Fe | 0.06 | 0.38 | 0.26 | 0.40 | 0.02 | -0.37 | -0.03 | 0.26 |
| Pb | -0.11 | -0.09 | -0.07 | -0.18 | -0.37 | 0.00 | -0.44 | 0.37 |
| Li | -0.08 | 0.41 | 0.34 | 0.33 | 0.06 | -0.29 | 0.03 | 0.18 |
| Mg | -0.01 | 0.25 | 0.25 | 0.29 | 0.12 | -0.32 | 0.04 | 0.19 |
| Mn | 0.03 | 0.28 | 0.27 | 0.31 | 0.04 | -0.20 | 0.08 | 0.10 |
| Ni | 0.07 | 0.14 | 0.07 | 0.21 | 0.13 | -0.31 | 0.02 | 0.20 |
| Se | -0.02 | 0.15 | -0.27 | -0.02 | -0.05 | -0.03 | -0.06 | 0.01 |
| Ag | 0.04 | 0.29 | 0.18 | 0.29 | 0.03 | -0.22 | 0.05 | 0.11 |
| Sr | 0.01 | -0.29 | -0.34 | -0.35 | -0.31 | 0.30 | -0.21 | -0.10 |
| Sn | -0.01 | -0.07 | -0.05 | -0.03 | 0.01 | 0.06 | 0.05 | -0.06 |
| U | -0.26 | -0.08 | -0.13 | -0.28 | -0.11 | 0.11 | -0.01 | -0.08 |
| V | 0.05 | 0.35 | 0.29 | 0.38 | 0.07 | -0.32 | 0.03 | 0.21 |
| Zn | 0.01 | 0.26 | 0.31 | 0.28 | -0.05 | -0.25 | 0.00 | 0.18 |
| Hg | -0.09 | 0.18 | 0.01 | 0.00 | -0.06 | 0.04 | 0.10 | -0.10 |

Significant +ve correlation (yellow); Significant -ve correlation (green)

**Table 11.** Polychaete - amphipod ratio (Log 10 (opportunistic polychaete / amphipod + 1)) ratio in the various stations of RSA

| Station | Polychaete -Amphipod Ratio | Station | Polychaete -Amphipod Ratio |
|---|---|---|---|
| 1 | -- | 40 | -- |
| 4 | 0.08 | 43 | 0.30 |
| 7 | 0.08 | 50 | 0.30 |
| 8 | 0.15 | 55 | 0.18 |
| 11 | 0.23 | 56 | 0.68 |
| 14 | 0.15 | 59 | 0.67 |
| 5a | 0.48 | 66 | -- |
| 7a | 0.25 | 69 | -- |
| 9a | 0.02 | 70 | -- |
| 15 | 0.50 | 72 | -- |
| 17 | 0.12 | 77 | 0.00 |
| 19 | 0.14 | 78 | 0.12 |
| 20 | 0.09 | 79 | 0.03 |
| 22 | 0.52 | 14a | 0.10 |
| 23 | 0.43 | 16a | 0.02 |
| 24 | 0.06 | 83 | -- |
| 25 | 0.36 | 85 | 0.90 |
| 26 | 0.10 | 87 | 0.58 |
| 10a | -- | 21a | 0.19 |
| 11a | 0.03 | 88 | 0.00 |
| 27 | -- | 93 | 0.56 |
| 30 | -- | 97 | 0.07 |
| 33 | -- | 25a | 1.04 |
| 34 | 0.85 | 98 | 0.18 |
| 36 | -- | 26a | 0.68 |
| 39 | 1.08 | 40 | -- |

--: no ratio due to the absence of either polychaetes, amphipods or both

# 4. Discussion

## 4.1 Sediment Characterisitcs of RSA

The importance of substratum in influencing the distribution of benthic organisms is well documented (Peterson, 1913, Ford, 1923; Davis, 1925; Jones, 1950; Sanders, 1958; Jansson, 1967; Johnson, 1977; Grant & Butman, 1987; Palacin *et al*., 1991). The present study covered the inner RSA and Sea of Oman and observed the predominance of fine sand and muddy substrata in these areas as reported by Wagner and van der Togt (1973). The observation is also well corroborated with the other studies made by Al-Ghadban *et al*. (1993, 1998) and ROPME (1993 a,b, 1994). Al-Ghadban *et al*. (1993) and Massoud *et al*. (1996) suggested that the areas with muddy substratum, represents a deposition environment with relatively low sediment movement. In addition to this, in some areas, terrigenous sediments could be seen moving to the shallow marine areas. The deposition of finer sediments was greatly noticed along the eastern Iranian side compared to the western side (Wagner and van der Togt, 1973). This was mainly attributed to the counter clock circulation from the Indian Ocean (Al-Ghadban *et al*. 1998). In the inner RSA, sediments and their characteristics generally follow distributions that align with the northwest – southwest axis of the RSA. The studies revealed a pattern in which, the RSA floor slopes progressively from the southern coast to the basin centre. Wagner and van der Togt (1973) stated increasing protection from wave action in the centre of the basin, resulting in transport of only fine materials to the centre of the RSA basin. The heterogeneity of substrata all along the study area showed that tidal currents in the western RSA vary from mixed, mainly semi-diurnal in north, to mixed mainly diurnal in south (KFUPM/RI, 1990, 2003).

## 4.2 Atributes of Macrobenthos of RSA

Benthic fauna contains a diverse assemblage of animals encompassing different areas. They have a vital role in the marine food chains and the benthos like their counterparts, the plankton and nekton, are involved in the recycling of materials, the flow of energy through food chains, and the proliferation of their kinds (McIntyre, 1971, and Schweitzer, 1974). It is widely recognized that a detailed understanding of the bottom fauna is indispensable to obtain a comprehensive picture of the fishery potential of an area (Damodaran, 1973). Their role as an effective biological indicators in pollution monitoring programs including accidental oil spills are well accepted (Chasse, 1978; Dauvin, 1982, 1998; Smith and Simpson, 1995; Jewett *et al.*, 1999). The changes in the taxonomic composition, abundance and biomass of benthic organisms can be used to determine the integrated response to several kinds of anthropogenic disturbances (Warwick and Clarke, 1994, and Guidetti *et al*., 2000).

A distinguishing feature of RSA is the existence of various substrates like, soft sediment, seagrass bed, rocky and coral reef area (Basson *et al.*, 1977, and KFUPM/RI, 1988). The present study covered the soft bottom benthos, collecting macrobenthic samples from 51 stations. The study on infaunal macrobenthic composition revealed the presence of 202 species during Winter 2006. Polychaetes were the predominant group both in species composition and numerical abundance among all the macrobenthic animals sampled in RSA. The high degree of adaptability to a wide range of environmental factors greatly enables polychaetes to show a rather pronounced abundance and dominance in terms of density and species composition in diverse ecological niches. Such a dominance of polychaetes has been reported by previous studies conducted in the various regions of RSA (e.g. Basson *et al*., 1977; SATTL, 1982; CDE, 1984; McCain, 1984; Coles & McCain, 1990; Price and Coles, 1992; KFUPM/RI, 1986a, 87, 88, 2003, 2005a,b & 2006) as well as other parts of world (e.g. Alongi & Christofferson, 1992; Probert *et al*., 2001; Ellingsen & Gray 2002; Joydas, 2002).

The most abundant species were *Ampelisca brevicornis* (Amphipoda), *Prionospio* sp. and *Eurythoe* sp. (Polychaeta). The dominant crustacean species were amphipods belonging to the family Ampeliscida. In the present study, ampeliscids were comparatively abundant in the Sea of Oman. KFUPM study emphasized the abundance of ampeliscids in the offshore areas of Saudi waters of RSA (KFUPM/RI, 2003). Ampeliscids are more sensitive to oil pollution and are recognized as an oil pollution indicator (Lee *et al.*, 1977; Percy, 1977; Gesteira and Dauvin, 2000). In the present study, 6 species of ampeliscid were recorded. This shows light in to the fact a healthy condition is prevailing in the benthic environment.

A depth-wise variation was less pronounced in the present study as depth of majority of the stations was beyond 30m. A clear trend would be found out if more stations from shallow water would have sampled. However, longitudinal variation in polychaetes and mollusks and latitudinal variation in polychaetes were observed. In general, higher abundance was observed in Sea of Oman region and coastwise, it was East coast which had higher abundance.

The quantification of diversity is fundamental to the identification of changes which may be taking place and to our understanding of their possible consequences. The various diversity measures were calculated for benthos. In all stations, the Shannon diversity and richness were high. The diversity values greater than three generally indicate the healthiness of the environment. In the present study, 75% of the stations had values more than three.

Though evenness and dominance values showed slight changes between stations, the variation was less and the comparatively higher evenness and low dominance explain that there is no stress in the study area. In an impacted environment, the occurrence of opportunistic species (r-strategy species) is higher than in healthy, un-impacted environments; while equilibrium species (k-strategy species) are lower (Clarke and Warwick, 2001). In the present study, the dominance index calculated across the study area was less (0.03 – 0.43).

The number of species and species diversity were positively correlated ($r=0.31$, $P<0.05$), whereas the number of individuals and species diversity was inversely correlated ($r=-0.32$, $P<0.05$). This was probably due to the fact that when the number of individuals of some species increased, the number of individuals of other species decreased due to severe competition for the resources (Celik, 2002). Diversity is thought to initially increase with increasing productivity because of a rise in the number of species that can maintain a minimum viable population size. At high levels of productivity, diversity may decrease, possibly due to reduced spatial heterogeneity of food resources, changes in competitive structure, or enhanced environmental stress (Rosenzweig & Abramsky, 1993, and Levin *et al*., 2000). Resource availability for the benthos is a very important factor and has been shown to vary spatially (Glover *et al*., 2001). The diversity in terms of the actual number of species will vary over regional scales in response to changes in resource. In the English Channel, Vallet & Dauvin (1998) observed high diversity (3.58–4.75) in a depth range of 25-75m and attributed the high species diversity to the more stable physical condition.

Macrobenthic community structure was delineated with the help of multivariate analysis of PRIMER for windows on the species abundance data. Cluster analysis is a multivariate technique in which entities are sequentially linked together according to their similarity (or dissimilarity) producing a two dimensional hierarchical structure (dendrogram). In the present survey, dendrogram showed the absence of any kind of clustering of stations among or between the three zones or grouping based on substratum. The MDS plot was also in accordance with the dendrogram where stations in the three zones were found to be intermixed. In MDS, distances between samples on the ordination attempt to match the corresponding dissimilarities in community structure: nearby points have very similar communities. The stress value (0.27) expressed a weak ordination of the stations as the value higher than 0.2 indicates a weak ordination (Clarke, 1993).

The dominance curve extracts universal features of community structure which are not a function of the specific taxa present, and may therefore be related to levels of biological stress. In the present study, the curve representing Sea of Oman occurred at the top indicating low diversity. However, all the three curves started near the bottom suggesting no dominance of species and thereby in general, indicated no stress to the biota. The species accumulation curve is used to display the cumulative number of different species observed when there is addition of each new sample. There exists an advantage for predicting the total number of stations to be sampled for getting the maximum number of species. In the present study, the accumulation curve was not reached an asymptote (See Figure 28); the estimates by various methods suggest that some more species would be recorded if an exhaustive sampling effort was carried out.

Geoplot method, graphing the number of species that fall into a set of geometric (x2) abundance classes as a means of identifying the effects of stress to the biota, was proposed by Gray and Pearson (1982). In unpolluted condition, there may be many rare species and the curve appears rather smooth with its mode well deviated to the left whereas in polluted circumstances, there are fewer rare species and more abundant species so that the higher geometric abundance classes are more powerfully represented and the resulting curve follows a more irregular or 'uneven' pattern. In the present study, the geoplot revealed the presence of abundance classes upto 7 in the 51 stations indicating the occurrence of more number of individuals of all the species recorded. The plots were skewed to the right side. The geoplots in the present study showed the healthy nature of the benthic community which is in agreement with the dominance plot.

The similarity / dissimilarity between various stations of the study area were also tested using ANOSIM. The advantage of ANOSIM is that it obviates the need for doing multiple range tests after getting significant results through ANOVA. The 'R' value will never technically lie outside the range –1 to 1; R equals 1, only if all replicates within sites are more similar to each other than any replicates from different sites; R is approximately zero, if the null hypothesis is true, so that similarities between and within sites will be the same on average. R will usually fall between 0 and 1 indicating some degree of discrimination between the sites and less than zero indicates no discrimination. In the present observation, discrimination was noticed between data sets of stations with coarse sand and mud. As per SIMPER analysis, the discrimination between these two substrata is mainly due to certain polychaete and amphipod species. The BVSTEP analysis, found out the determining species which are a subset of total 202 species capable of determining the community structure in RSA. The analysis identified 27 species composed of mainly polychaetes, crustaceans and mollusks.

The present study has made an attempt to know the relationship between benthos and environmental parameters. Among the various hydrographical parameters, temperature, salinity, dissolved oxygen and pH are of considerable importance to the marine benthos. However, when individual effect of each parameter was performed, only salinity showed a significant correlation with fauna. Likewise, when the water quality and sediment quality parameters were correlated with benthos, though there was correlation, most of the relationships are irrelevant as far as benthos are concerned. Worth mentioning is the negative relationship of evenness with PAH and heavy metals which can be considered relevant. BIO-ENV procedure was also used in this study to understand the combined effect of various parameters on benthic organisms. It showed that the variables such as ammonia, mean grain size, extractable organic matter, Pb and Mn formed the best combination explaining the distribution of fauna.

Since the studies of Peterson (1913) several works have been conducted to correlate the infaunal invertebrates with sediment texture (Ford, 1923; Davis, 1925; Jones, 1950; Sanders, 1958; Jansson, 1967; Johnson, 1977; Grant & Butman, 1987; Palacin *et al*., 1991). However, there is little evidence that sediment grain size alone is the primary factor deciding infaunal species distribution. Sanders (1958) had proposed that suspension feeders were more abundant in sandy environments and deposit feeders were more abundant in muddy environments. However, Snelgrove & Butman (1994) established that many species are not always associated with a single sediment type, and that suspension and deposit feeders often co-occur in large numbers. The present study showed the predominance of total macrobenthos and groups such as polychaetes and crustaceans in sandy substratum however, diversity was higher in muddy substratum. Dominant species like *Prionospio* sp. (polychaete), and *Ampithoe rubricate* (amphipod) showed higher abundance both in muddy and sandy substrata.

In the oil impact assessment studies in the marine environments the polychaete/amphipod ratio has been developed as an effective tool (Bellan *et al*., 1988, and Gesteira and Dauvin, 2000). It has been observed that amphipods were highly sensitive to toxic chemicals and hydrocarbons. They disappear rapidly due to high mortality and take relatively long duration to recover after an oil spill (Lee *et al*., 1977; Percy, 1977; Sanders *et al*., 1980; Elmgren *et al*., 1983; Dauvin, 1987; Gesteira, 2001; Gesteira *et al*., 2003). On the other hand, polychaetes are found to be tolerant to a wide variety of contaminants including trace metals and hydrocarbons. This is mainly due to the many opportunistic taxa in this group. This difference in tolerance of polychaetes and amphipods through the "polychaete/ amphipod ratio" is useful in environmental monitoring. In the present study, no stations were found to have a ratio >1. However, ratio was absent in some stations due to the absence of polychaetes or amphipods or both. However, ampeliscid (amphipods), which are oil pollution indicator, showed comparatively higher occurrence in the present study. Its presence was observed in 33 stations. The nil ratio due to the absence of amphipods observed in some stations probably are "recovering stations" from the oil spill impact and have not fully recovered yet. Dauvin (1998) and Gesteira and Dauvin (2000) reported that the colonization of amphipods took 15 years in the Bay of Morlaix.

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# APPENDICES

## Appendix A: Species composition and abundance of macrobenthos of RSA

| TAXA/STATION NO | 1 | 4 | 7 | 8 | 11 | 14 | 5a | 7a | 9a | 15 | 17 | 19 | 20 | 22 | 23 | 24 | 25 | 26 | 10a | 11a | 27 | 30 | 33 | 34 | 36 | 39 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **POLYCHAETA** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aphrotid* sp. | 0 | 10 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bhawania goodei* | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amphinome rostrata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amphinome* sp. | 0 | 0 | 20 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chloeia inermis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chloeia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euphrosine capensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 160 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euphrosine myrtosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Eurythoe* sp. | 0 | 0 | 0 | 30 | 10 | 60 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eteone* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Phyllodoce malmgreni* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phyllodoce* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ancistrosyllis constricta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Ancistrosyllis parva* | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 10 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leocrates claparedii* | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Syllis longissima* | 0 | 0 | 0 | 0 | 10 | 10 | 10 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Syllis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Exogone clavator* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 40 | 0 | 0 |
| *Exogone normalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nereis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys dibranchis* | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 20 | 10 | 0 | 20 | 0 | 20 | 20 | 40 | 0 | 0 | 10 | 0 | 20 |
| *Nephtys macroura* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys hombergii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys sphaerocirrata* | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Paralacydonia paradoxa* | 0 | 10 | 0 | 0 | 30 | 0 | 0 | 10 | 10 | 10 | 0 | 0 | 30 | 20 | 0 | 0 | 40 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 20 |
| *Glycera rouxi* | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Glycera* sp. | 20 | 30 | 0 | 10 | 0 | 0 | 0 | 10 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 |

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| *Goniada* sp. | 0 | 20 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 20 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice australis* | 0 | 20 | 0 | 0 | 0 | 10 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice norvegica* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice pennata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice* sp. | 10 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 40 | 0 | 20 | 0 | 10 | 0 | 20 | 20 | 0 | 0 | 0 | 20 | 10 | 40 | 0 | 0 | 30 |
| *Nematonereis unicornis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diopatra neapolitana* | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 30 | 0 |
| *Onuphis holobranchiata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis geophiliformis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis conchylega* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis* sp. | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 |
| *Lumbrineris aberrans* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbrineris heteropoda* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbrineris* sp. | 0 | 0 | 10 | 0 | 10 | 20 | 0 | 0 | 10 | 0 | 40 | 0 | 10 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 20 | 0 | 0 | 0 | 30 |
| *Protodorvillea biarticulata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dorvillea rudolphi* | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| *Polydora ciliata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polydora* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pygospio elegans* | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Malacoceros indicus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aonides* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Prionospio cirrobranchiata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
| *Prionospio pinnata* | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 40 |
| *Prionospio* sp. | 0 | 50 | 0 | 0 | 0 | 10 | 50 | 30 | 10 | 120 | 40 | 10 | 10 | 90 | 30 | 40 | 50 | 60 | 0 | 10 | 10 | 50 | 0 | 90 | 0 | 20 |
| *Magelona cincta* | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 20 | 10 | 0 | 50 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 60 | 0 | 0 | 0 | 10 |
| *Magelona capensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cirratulus cirratus* | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cirratulus* sp. | 0 | 0 | 0 | 0 | 80 | 10 | 0 | 30 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Poecilochaetus serpens* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 |
| *Orbinia* sp. | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scoloplos* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Aricidea fauveli* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aricidea* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Paraonis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Armandia intermedia* | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cossura coasta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Parasclerocheilus capensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Capitella* sp. | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 30 | 50 |
| *Notomastus aberans* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Notomastus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Heteromastus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Euclymene lombricoides* | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euclymene* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Maldane sarsi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Maldanid* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Pherusa* sp. | 0 | 0 | 10 | 0 | 10 | 50 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sabellaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pectinaria crassa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 |
| *Amphicteis gunneri* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampharte acutifrons* | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampharetid* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Terebellides stroemi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polycirrus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pista typha* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pista unibranchia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pista* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 0 | 0 | 10 | 0 | 0 | 40 | 0 | 120 | 30 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Sabella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chone* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
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| **CRUSTACEA** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ampelisca brevicornis* | 0 | 0 | 50 | 50 | 0 | 0 | 0 | 10 | 90 | 20 | 70 | 50 | 80 | 40 | 30 | 130 | 60 | 0 | 0 | 40 | 0 | 0 | 0 | 30 | 0 | 0 |
| *Ampelisca macrocephala* | 0 | 80 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampelisca spinifer* | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampelisca spinipes* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampelisca tenuicornis* | 0 | 30 | 50 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampelisca typica* | 0 | 0 | 0 | 0 | 80 | 0 | 0 | 0 | 20 | 0 | 0 | 30 | 0 | 0 | 0 | 90 | 0 | 110 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampithoe gammaroides* | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Ampithoe rubricata* | 0 | 110 | 0 | 0 | 0 | 0 | 0 | 20 | 130 | 0 | 50 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 80 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Atylus falcatus* | 0 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dexamine spinosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Elasmopus rapax* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 190 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gammarus locusta* | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Hyale perieri* | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucothoe richicardii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Liljeborgia pallida* | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lysianassa ceratina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lysianassa insperata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Urothoe marina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Caprellida* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Apseudes* sp. | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crab larvae-zMegalopa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crab megalopa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diastylis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lepas* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Metapenaeus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Myodocopa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Mysidacea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Penaeus setiferus* | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Penaeus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Xenobalanus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **MOLLUSCA** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Anadara granosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Begunica variegata* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crassatella rostrata* | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Donax spinosus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Donax* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dosinia prostrata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Katelysia opima* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 |
| *Lucina edentula* | 10 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 10 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lucina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mactra (Mactrinula) laevis* | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Mactra* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Malleus malleus* | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Marcia* sp. | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Meretrix casta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Meretrix* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Modiolus metcalfei* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Paphia textile* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pinctata chemnitzii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| *Pinna bicolor* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pitar erycina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 10 |
| *Pitar nobilis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sanguinolaria diphos* | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scapharca inaequivalvis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tellina ala* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Tellina angulata* | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Tellina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Trachycardium* sp. | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus arakana* | 0 | 0 | 0 | 30 | 0 | 0 | 20 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus reticulata* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus* sp. | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ancilla ampla* | 0 | 0 | 0 | 0 | 0 | 10 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ancilla* sp. | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Architectonica* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Brachytoma crenularis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 0 | 10 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Brachytoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bullia belangeri* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cantharus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Conus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 |
| *Cronia contracta* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyclostrema eburnea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 420 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drilia umbilicata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drillia sacra* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Epitonium lamellosum* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Epitonium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Euchelus asperus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Janthina janthina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Janthina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Kurtziella limonitella* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lopphidoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Marginella loebeckeana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Marginella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mitra ambiqua* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassa dorsata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassa hepatica* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Nassaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius novaezelandiae* | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius suturalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Natica albula* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Patella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phalium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polinces didyma* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polinces* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Terebra triseriata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tibia curta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Tonna cumingii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tornatina inconspicua* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Trochus* sp. | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Turricula* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Turris nelliae* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Xenuroturris cingulifera cingulifera* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dentalium octangulatum* | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dentalium* sp. | 30 | 10 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| **OTHERS** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Amphioxus* | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Branchiostoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Bryozoa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Ceriantharia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clypeaster humilis* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crossaster papposus* | 0 | 0 | 20 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Culcita* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Echinocardium cordatum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Echinodiscus bisperforatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Echinodiscus* sp. | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fish larvae* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fungia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gorgonia ventilina* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Hydroida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Laganum depressum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lovenia elongata* | 0 | 0 | 180 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mellita* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ophiocnemus marmorata* | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| *Orchasterias* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polythoa* sp. | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Seaurchin* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dendrostomum pyroides* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Appendix A** (Contd…)

| TAXA/STATION NO | 40 | 43 | 50 | 55 | 56 | 59 | 66 | 69 | 70 | 72 | 77 | 78 | 79 | 14a | 16a | 83 | 85 | 87 | 21a | 88 | 93 | 97 | 25a | 98 | 26a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **POLYCHAETA** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Aphrotid* sp. | 10 | 0 | 10 | 0 | 0 | 10 | 0 | 10 | 10 | 0 | 0 | 10 | 0 | 0 | 40 | 0 | 0 | 0 | 10 | 0 | 0 | 30 | 0 | 0 | 0 |
| *Bhawania goodei* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amphinome rostrata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Amphinome* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chloeia inermis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chloeia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 10 | 0 | 120 | 0 | 10 | 70 |
| *Euphrosine capensis* | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euphrosine myrtosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eurythoe* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 10 | 10 | 0 | 0 | 0 | 820 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eteone* sp. | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phyllodoce malmgreni* | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phyllodoce* sp. | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ancistrosyllis constricta* | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 10 | 0 | 0 | 10 | 20 | 0 |
| *Ancistrosyllis parva* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 10 | 20 | 10 |
| *Leocrates claparedii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Syllis longissima* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Syllis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Exogone clavator* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Exogone normalis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nereis* sp. | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Nephtys dibranchis* | 40 | 0 | 10 | 0 | 0 | 0 | 60 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 20 | 0 | 0 | 20 | 0 | 0 | 50 | 0 | 20 |
| *Nephtys macroura* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys hombergii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nephtys sphaerocirrata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 80 | 0 | 0 | 10 | 10 |
| *Nephtys* sp. | 0 | 10 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Paralacydonia paradoxa* | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 |
| *Glycera rouxi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Glycera* sp. | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 20 | 10 | 10 | 0 | 10 | 0 | 30 | 20 | 20 | 10 |
| *Goniada* sp. | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 20 |
| *Eunice australis* | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice norvegica* | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice pennata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eunice* sp. | 0 | 10 | 0 | 30 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 10 | 0 | 0 | 0 | 110 |
| *Nematonereis unicornis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Diopatra neapolitana* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 |
| *Onuphis holobranchiata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis geophiliformis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis conchylega* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Onuphis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbrineris aberrans* | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbrineris heteropoda* | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lumbrineris* sp. | 0 | 0 | 50 | 0 | 20 | 10 | 0 | 30 | 0 | 0 | 0 | 20 | 10 | 0 | 0 | 0 | 20 | 0 | 0 | 60 | 0 | 50 | 0 | 20 | 30 |
| *Protodorvillea biarticulata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dorvillea rudolphi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 |
| *Polydora ciliata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polydora* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Pygospio elegans* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Malacoceros indicus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 160 |
| *Aonides* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Prionospio cirrobranchiata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Prionospio pinnata* | 10 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 130 | 30 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Prionospio* sp. | 10 | 30 | 10 | 0 | 80 | 50 | 0 | 60 | 0 | 60 | 0 | 0 | 10 | 0 | 0 | 10 | 90 | 0 | 30 | 0 | 40 | 20 | 180 | 0 | 30 |
| *Magelona cincta* | 20 | 0 | 0 | 0 | 30 | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Magelona capensis* | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cirratulus cirratus* | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| *Cirratulus* sp. | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 20 | 0 |
| *Poecilochaetus serpens* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 30 | 0 | 0 | 0 | 0 | 20 | 10 | 0 | 10 | 0 | 0 | 10 |
| *Orbinia* sp. | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scoloplos* sp. | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aricidea fauveli* | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Aricidea* sp. | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Paraonis* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| *Armandia intermedia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cossura coasta* | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Parasclerocheilus capensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Capitella* sp. | 60 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Notomastus aberans* | 10 | 0 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Notomastus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| *Heteromastus* sp. | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euclymene lombricoides* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euclymene* sp. | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Maldane sarsi* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Maldanid* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pherusa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 10 | 0 | 0 |
| *Sabellaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pectinaria crassa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Amphicteis gunneri* | 50 | 10 | 30 | 10 | 20 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 30 | 0 | 0 | 0 | 420 |
| *Ampharte acutifrons* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 30 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ampharetid* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Terebellides stroemi* | 0 | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 20 |
| *Polycirrus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Pista typha* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pista unibranchia* | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pista* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Sabella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chone* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **CRUSTACEA** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Ampelisca brevicornis* | 0 | 30 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 90 | 0 | 0 | 0 | 40 | 980 | 30 | 50 | 0 | 10 | 30 |
| *Ampelisca macrocephala* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| *Ampelisca spinifer* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 210 | 0 | 0 | 0 | 0 | 0 |
| *Ampelisca spinipes* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 20 | 50 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Ampelisca tenuicornis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 50 | 0 | 0 | 10 |
| *Ampelisca typica* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 130 | 60 | 0 | 0 | 0 | 0 | 120 | 0 | 0 | 0 | 20 | 10 |
| *Ampithoe gammaroides* | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Ampithoe rubricata* | 0 | 0 | 0 | 20 | 10 | 0 | 0 | 0 | 0 | 0 | 20 | 50 | 130 | 110 | 30 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Atylus falcatus* | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Dexamine spinosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Elasmopus rapax* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gammarus locusta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Hyale perieri* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Leucothoe richicardii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Liljeborgia pallida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lysianassa ceratina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lysianassa insperata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 |
| *Urothoe marina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Caprellida* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Apseudes* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crab larvae-zMegalopa* | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crab megalopa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Diastylis* sp. | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| *Lepas* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Metapenaeus* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 |
| *Myodocopa* | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mysidacea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Penaeus setiferus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Penaeus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Xenobalanus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **MOLLUSCA** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Anadara granosa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Begunica variegata* | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crassatella rostrata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Donax spinosus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Donax* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Dosinia prostrata* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Katelysia opima* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lucina edentula* | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lucina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mactra (Mactrinula) laevis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mactra* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Malleus malleus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Marcia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Meretrix casta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Meretrix* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Modiolus metcalfei* | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Paphia textile* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pinctata chemnitzii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pinna bicolor* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pitar erycina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Pitar nobilis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Sanguinolaria diphos* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Scapharca inaequivalvis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Tellina ala* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tellina angulata* | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 10 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tellina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Trachycardium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus arakana* | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus reticulata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Venus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ancilla ampla* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Ancilla* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Architectonica* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Brachytoma crenularis* | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Brachytoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| *Bullia belangeri* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cantharus* sp. | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Conus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cronia contracta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyclostrema eburnea* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drilia umbilicata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drillia sacra* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Epitonium lamellosum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Epitonium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Euchelus asperus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Janthina janthina* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Janthina* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Kurtziella limonitella* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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| *Lopphidoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Marginella loebeckeana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Marginella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mitra ambiqua* | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassa dorsata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassa hepatica* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 170 | 0 | 0 | 0 |
| *Nassaria* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius novaezelandiae* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| *Nassarius suturalis* | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Natica albula* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Patella* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Phalium* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polinces didyma* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polinces* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Terebra triseriata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tibia curta* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tonna cumingii* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tornatina inconspicua* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Trochus* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Turricula* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Turris nelliae* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Xenuroturris cingulifera cingulifera* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dentalium octangulatum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dentalium* sp. | 0 | 0 | 0 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **OTHERS** | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Amphioxus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Branchiostoma* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Bryozoa* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ceriantharia* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Clypeaster humilis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Crossaster papposus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Culcita* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 |
| *Echinocardium cordatum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Echinodiscus bisperforatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 |
| *Echinodiscus* sp. | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fish larvae* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fungia* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gorgonia ventilina* | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 |
| *Hydroida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| *Laganum depressum* | 0 | 10 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lovenia elongata* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mellita* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ophiocnemus marmorata* | 0 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 140 | 20 | 0 | 290 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 40 | 0 | 0 |
| *Orchasterias* sp. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Polythoa* sp. | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Seaurchin* | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 10 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dendrostomum pyroides* | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 30 | 0 | 10 | 10 | 0 | 0 | 0 | 0 |

## Appendix B: Details of family of various taxa recorded from the RSA

| Sl No. | Family | Species No. | Abundance (total ind.) | Percentage |
|---|---|---|---|---|
| | **Polychaetae** | | | |
| 1 | Ampharetidae | 3 | 760 | 3.35 |
| 2 | Amphinomidae | 7 | 1890 | 8.33 |
| 3 | Aphroditidae | 1 | 210 | 0.93 |
| 4 | Capitellidae | 4 | 510 | 2.25 |
| 5 | Cirratulidae | 2 | 350 | 1.54 |
| 6 | Cossuridae | 1 | 30 | 0.13 |
| 7 | Eunicidae | 15 | 1660 | 7.32 |
| 8 | Flabelligeridae | 1 | 120 | 0.53 |
| 9 | Glyceridae | 3 | 480 | 2.12 |
| 10 | Hesionidae | 1 | 20 | 0.09 |
| 11 | Lacydoniidae | 1 | 280 | 1.23 |
| 12 | Magelonidae | 2 | 320 | 1.41 |
| 13 | Maldanidae | 4 | 160 | 0.71 |
| 14 | Nephtyidae | 5 | 690 | 3.04 |
| 15 | Nereidae | 1 | 70 | 0.31 |
| 16 | Opheliidae | 1 | 30 | 0.13 |
| 17 | Orbiniidae | 2 | 110 | 0.49 |
| 18 | Palmyridae | 1 | 40 | 0.18 |
| 19 | Paraonidae | 3 | 50 | 0.22 |
| 20 | Pectinariidae | 1 | 50 | 0.22 |
| 21 | Phyllodocidae | 3 | 80 | 0.35 |
| 22 | Pilargidae | 2 | 290 | 1.28 |
| 23 | Sabellariidae | 1 | 100 | 0.44 |
| 24 | Sabellidae | 2 | 50 | 0.22 |
| 25 | Scalibregmidae | 1 | 10 | 0.04 |
| 26 | Spionidae | 8 | 2460 | 10.85 |
| 27 | Syllidae | 4 | 160 | 0.71 |
| 28 | Terebellidae | 5 | 630 | 2.78 |
| 29 | Trochochaetidae | 1 | 150 | 0.66 |
| | **Crustacea** | | | |
| 1 | Ampeliscidae | 5 | 3490 | 15.39 |
| 2 | Ampithoidae | 2 | 1270 | 5.60 |
| 3 | Atylidae | 1 | 240 | 1.06 |
| 4 | Dexaminidae | 1 | 110 | 0.49 |
| 5 | Melitidae | 1 | 280 | 1.23 |
| 6 | Gammaridae | 1 | 110 | 0.49 |
| 7 | Hyalidae | 1 | 70 | 0.31 |
| 8 | Leucothoidae | 1 | 30 | 0.13 |

| | | | | |
|---|---|---|---|---|
| 9 | Liljeborgiidae | 1 | 60 | 0.26 |
| 10 | Lysianassidae | 2 | 60 | 0.26 |
| 11 | Haustoriidae | 1 | 10 | 0.04 |
| 12 | Caprellidae | 1 | 30 | 0.13 |
| 13 | Apseudidae | 1 | 70 | 0.31 |
| 14 | Diastylidae | 1 | 160 | 0.71 |
| 15 | Lepadidae | 1 | 100 | 0.44 |
| 16 | Penaeidae | 3 | 110 | 0.49 |
| 17 | Balanidae | 1 | 10 | 0.04 |
| | | | | |
| | **Bivalvia** | | | |
| 1 | Arcidae | 2 | 20 | 0.09 |
| 2 | Cardidae | 1 | 10 | 0.04 |
| 3 | Carditidae | 1 | 50 | 0.22 |
| 4 | Crassatellidae | 1 | 60 | 0.26 |
| 5 | Donacidae | 2 | 50 | 0.22 |
| 6 | Isognomonodae | 1 | 30 | 0.13 |
| 7 | Lucinidae | 2 | 170 | 0.75 |
| 8 | Mactridae | 2 | 80 | 0.35 |
| 9 | Mytilidae | 1 | 20 | 0.09 |
| 10 | Pinnidae | 1 | 10 | 0.04 |
| 11 | Pteridae | 1 | 10 | 0.04 |
| 12 | Sanguinolaridae | 1 | 60 | 0.26 |
| 13 | Tellinidae | 3 | 230 | 1.01 |
| 14 | Veneridae | 11 | 480 | 2.12 |
| | | | | |
| | **Gastropoda** | | | |
| 1 | Architectonicidae | 1 | 10 | 0.04 |
| 2 | Buccinidae | 3 | 30 | 0.13 |
| 3 | Calyptraeidae | 1 | 80 | 0.35 |
| 4 | Cassidae | 1 | 20 | 0.09 |
| 5 | Conidae | 1 | 20 | 0.09 |
| 6 | Cyclostrematidae | 1 | 420 | 1.85 |
| 7 | Epitoniidae | 2 | 30 | 0.13 |
| 8 | Janthinidae | 2 | 70 | 0.31 |
| 9 | Marginellidae | 2 | 50 | 0.22 |
| 10 | Mitridae | 1 | 20 | 0.09 |
| 11 | Muricidae | 2 | 260 | 1.15 |
| 12 | Nassariidae | 3 | 150 | 0.66 |
| 13 | Naticidae | 3 | 50 | 0.22 |
| 14 | Olividae | 2 | 80 | 0.35 |
| 15 | Patellidae | 1 | 10 | 0.04 |
| 16 | Scaphandridae | 1 | 40 | 0.18 |

| | | | | |
|---|---|---|---|---|
| 17 | Strombidae | 1 | 10 | 0.04 |
| 18 | Terebridae | 1 | 10 | 0.04 |
| 19 | Tonnidae | 1 | 10 | 0.04 |
| 20 | Trochidae | 2 | 60 | 0.26 |
| 21 | Turridae | 9 | 220 | 0.97 |
| | | | | |
| | **Scaphopoda** | | | |
| 1 | Dentalidae | 2 | 150 | 0.66 |
| | | | | |
| | **Others** | | | |
| 1 | Bugulidae | 1 | 10 | 0.04 |
| 2 | Cerianthidae | 1 | 40 | 0.18 |
| 3 | Clypeasteridae | 1 | 100 | 0.44 |
| 4 | Culicidae | 1 | 60 | 0.26 |
| 5 | Fungiidae | 1 | 20 | 0.09 |
| 6 | Gorgonidae | 1 | 50 | 0.22 |
| 7 | Laganiidae | 1 | 20 | 0.09 |
| 8 | Lovenellidae | 1 | 180 | 0.79 |
| 9 | Mellitidae | 1 | 120 | 0.53 |
| 10 | Ophiuroidae | 1 | 590 | 2.60 |
| 11 | Sculellidae | 2 | 100 | 0.44 |
| 12 | Solasteridae | 1 | 90 | 0.40 |
| 13 | Sphaeridae | 1 | 10 | 0.04 |
| 14 | Themistidae | 1 | 120 | 0.53 |
| 15 | Zoanthidae | 1 | 50 | 0.22 |
| 16 | Branchiostomidae | 1 | 70 | 0.31 |

## Appendix C: Macrobenthic abundance of major groups of RSA

| St No | Polychaeta | Crustacea | Molluska | Others | Total |
|---|---|---|---|---|---|
| 1 | 50 | 180 | 130 | 20 | 380 |
| 4 | 210 | 360 | 70 | 0 | 640 |
| 7 | 100 | 120 | 250 | 210 | 680 |
| 8 | 110 | 50 | 150 | 10 | 320 |
| 11 | 300 | 140 | 20 | 0 | 460 |
| 14 | 200 | 50 | 20 | 0 | 270 |
| 5a | 200 | 60 | 60 | 120 | 440 |
| 7a | 260 | 100 | 110 | 10 | 480 |
| 9a | 130 | 430 | 120 | 0 | 680 |
| 15 | 530 | 70 | 40 | 0 | 640 |
| 17 | 260 | 160 | 50 | 10 | 480 |
| 19 | 90 | 80 | 60 | 0 | 230 |
| 20 | 90 | 260 | 180 | 10 | 540 |
| 22 | 330 | 60 | 10 | 0 | 400 |
| 23 | 90 | 30 | 110 | 0 | 230 |
| 24 | 250 | 430 | 50 | 0 | 730 |
| 25 | 250 | 70 | 0 | 0 | 320 |
| 26 | 180 | 280 | 10 | 30 | 500 |
| 10a | 60 | 0 | 10 | 10 | 80 |
| 11a | 60 | 320 | 490 | 40 | 910 |
| 27 | 200 | 0 | 120 | 0 | 320 |
| 30 | 300 | 100 | 10 | 20 | 430 |
| 33 | 50 | 0 | 20 | 0 | 70 |
| 34 | 270 | 30 | 0 | 0 | 300 |
| 36 | 110 | 20 | 10 | 0 | 140 |
| 39 | 240 | 10 | 40 | 0 | 290 |
| 40 | 350 | 0 | 30 | 0 | 380 |
| 43 | 80 | 80 | 50 | 80 | 290 |
| 50 | 160 | 10 | 30 | 0 | 200 |
| 55 | 140 | 20 | 0 | 0 | 160 |
| 56 | 330 | 40 | 40 | 0 | 410 |
| 59 | 230 | 30 | 40 | 100 | 400 |
| 66 | 90 | 30 | 10 | 0 | 130 |
| 69 | 330 | 0 | 160 | 190 | 680 |
| 70 | 30 | 40 | 40 | 0 | 110 |
| 72 | 150 | 0 | 0 | 30 | 180 |
| 77 | 10 | 70 | 30 | 30 | 140 |
| 78 | 140 | 60 | 20 | 190 | 410 |
| 79 | 50 | 130 | 10 | 200 | 390 |
| 14a | 210 | 280 | 0 | 0 | 490 |
| 16a | 200 | 180 | 70 | 340 | 790 |
| 83 | 40 | 0 | 20 | 0 | 60 |
| 85 | 410 | 80 | 10 | 70 | 570 |
| 87 | 1220 | 50 | 50 | 70 | 1390 |
| 21a | 220 | 110 | 50 | 0 | 380 |
| 88 | 180 | 1310 | 30 | 10 | 1530 |
| 93 | 210 | 100 | 0 | 110 | 420 |
| 97 | 350 | 110 | 200 | 0 | 660 |
| 25a | 340 | 20 | 20 | 50 | 430 |
| 98 | 150 | 60 | 0 | 0 | 210 |
| 26a | 1220 | 50 | 30 | 0 | 1300 |

## Appendix D: Abundance and diversity indices of macrobenthos

| Station No. | S | N | Species Richness (d) | Species Evenness (J') | Species Diversity (H'(log2)) | Species Dominance (Lambda') |
|---|---|---|---|---|---|---|
| 1 | 12 | 380 | 1.85 | 0.85 | 3.04 | 0.16 |
| 4 | 18 | 640 | 2.63 | 0.90 | 3.74 | 0.09 |
| 7 | 19 | 680 | 2.76 | 0.85 | 3.60 | 0.12 |
| 8 | 16 | 320 | 2.60 | 0.92 | 3.67 | 0.09 |
| 11 | 18 | 460 | 2.77 | 0.90 | 3.75 | 0.09 |
| 14 | 12 | 270 | 1.96 | 0.88 | 3.17 | 0.14 |
| 5a | 18 | 400 | 2.84 | 0.94 | 3.93 | 0.07 |
| 7a | 22 | 470 | 3.41 | 0.92 | 4.10 | 0.07 |
| 9a | 19 | 680 | 2.76 | 0.80 | 3.38 | 0.14 |
| 15 | 20 | 640 | 2.94 | 0.83 | 3.58 | 0.12 |
| 17 | 12 | 480 | 1.78 | 0.91 | 3.26 | 0.12 |
| 19 | 13 | 230 | 2.21 | 0.94 | 3.46 | 0.10 |
| 20 | 17 | 520 | 2.56 | 0.88 | 3.60 | 0.10 |
| 22 | 16 | 400 | 2.50 | 0.90 | 3.60 | 0.10 |
| 23 | 13 | 230 | 2.21 | 0.96 | 3.56 | 0.09 |
| 24 | 17 | 730 | 2.43 | 0.83 | 3.38 | 0.12 |
| 25 | 13 | 320 | 2.08 | 0.91 | 3.38 | 0.11 |
| 26 | 16 | 500 | 2.41 | 0.86 | 3.46 | 0.12 |
| 10a | 6 | 80 | 1.14 | 0.97 | 2.50 | 0.18 |
| 11a | 20 | 900 | 2.79 | 0.68 | 2.94 | 0.25 |
| 27 | 15 | 320 | 2.43 | 0.93 | 3.63 | 0.09 |
| 30 | 13 | 430 | 1.98 | 0.84 | 3.11 | 0.15 |
| 33 | 3 | 70 | 0.47 | 0.87 | 1.38 | 0.42 |
| 34 | 10 | 300 | 1.58 | 0.87 | 2.88 | 0.17 |
| 36 | 5 | 120 | 0.84 | 0.92 | 2.13 | 0.24 |
| 39 | 15 | 290 | 2.47 | 0.93 | 3.65 | 0.09 |
| 40 | 16 | 380 | 2.53 | 0.91 | 3.65 | 0.09 |
| 43 | 16 | 290 | 2.65 | 0.93 | 3.73 | 0.09 |
| 50 | 14 | 200 | 2.45 | 0.92 | 3.50 | 0.11 |
| 55 | 11 | 160 | 1.97 | 0.95 | 3.28 | 0.11 |
| 56 | 18 | 410 | 2.83 | 0.91 | 3.81 | 0.09 |
| 59 | 17 | 380 | 2.69 | 0.91 | 3.74 | 0.09 |
| 66 | 5 | 100 | 0.87 | 0.76 | 1.77 | 0.39 |
| 69 | 29 | 670 | 4.30 | 0.89 | 4.34 | 0.07 |
| 70 | 6 | 110 | 1.06 | 0.89 | 2.30 | 0.23 |
| 72 | 6 | 150 | 1.00 | 0.85 | 2.21 | 0.26 |
| 77 | 8 | 130 | 1.44 | 0.96 | 2.87 | 0.14 |
| 78 | 14 | 410 | 2.16 | 0.83 | 3.16 | 0.16 |
| 79 | 11 | 280 | 1.77 | 0.75 | 2.60 | 0.26 |
| 14a | 11 | 490 | 1.61 | 0.84 | 2.90 | 0.17 |
| 16a | 15 | 790 | 2.10 | 0.80 | 3.14 | 0.18 |
| 83 | 5 | 60 | 0.98 | 0.97 | 2.25 | 0.21 |
| 85 | 22 | 510 | 3.37 | 0.93 | 4.14 | 0.07 |
| 87 | 14 | 1380 | 1.80 | 0.56 | 2.13 | 0.39 |
| 21a | 17 | 380 | 2.69 | 0.94 | 3.84 | 0.08 |
| 88 | 19 | 1530 | 2.45 | 0.48 | 2.02 | 0.44 |
| 93 | 17 | 420 | 2.65 | 0.91 | 3.71 | 0.09 |
| 97 | 16 | 660 | 2.31 | 0.85 | 3.39 | 0.13 |
| 25a | 17 | 420 | 2.65 | 0.76 | 3.09 | 0.21 |
| 98 | 14 | 210 | 2.43 | 0.98 | 3.73 | 0.07 |
| 26a | 22 | 1300 | 2.93 | 0.69 | 3.09 | 0.18 |

## Appendix E: Species estimators for macrobenthos of RSA

| | Sobs | Chao | Jacknife | Bootstrap | MM | UGE |
|---|---|---|---|---|---|---|
| 1 | 12 | 12 | 12 | 12 | 14.83801 | 14.47059 |
| 4 | 27 | 27 | 39 | 27 | 28.09132 | 26.44706 |
| 7 | 43 | 43 | 68.33333 | 43 | 40.00094 | 36.74679 |
| 8 | 55 | 55 | 91 | 55.00002 | 50.76135 | 45.8352 |
| 11 | 63 | 63 | 100.6 | 63.00054 | 60.53124 | 54.00046 |
| 14 | 67 | 67 | 105.3333 | 67.00421 | 69.44136 | 61.43418 |
| 5a | 80 | 80 | 128 | 80.02157 | 77.60041 | 68.27097 |
| 7a | 87 | 87 | 136 | 87.06175 | 85.09952 | 74.60952 |
| 9a | 94 | 94 | 148.2222 | 94.1502 | 92.01565 | 80.52464 |
| 15 | 101 | 101 | 159.5 | 101.3017 | 98.41423 | 86.07464 |
| 17 | 106 | 106 | 168.7273 | 106.535 | 104.3513 | 91.30606 |
| 19 | 110 | 110 | 175.0833 | 110.841 | 109.875 | 96.25672 |
| 20 | 116 | 116 | 183.3846 | 117.2354 | 115.027 | 100.9579 |
| 22 | 118 | 118 | 185.7857 | 119.6742 | 119.8437 | 105.436 |
| 23 | 121 | 121 | 189.1333 | 123.1787 | 124.3568 | 109.713 |
| 24 | 127 | 127 | 198.25 | 129.8548 | 128.5941 | 113.8082 |
| 25 | 130 | 130 | 203.4118 | 133.5835 | 132.5801 | 117.7378 |
| 26 | 134 | 134 | 206.7222 | 138.2452 | 136.3365 | 121.5162 |
| 10a | 136 | 136 | 209.8947 | 141.0535 | 139.8826 | 125.1558 |
| 11a | 145 | 145 | 225.75 | 151.3499 | 143.2357 | 128.6676 |
| 27 | 150 | 150 | 233.8095 | 157.4938 | 146.411 | 132.061 |
| 30 | 153 | 153 | 238.9091 | 161.6363 | 149.4223 | 135.3447 |
| 33 | 154 | 154 | 240.087 | 163.6408 | 152.282 | 138.5262 |
| 34 | 158 | 158 | 246.1667 | 168.908 | 155.0012 | 141.6123 |
| 36 | 159 | 159 | 247.32 | 170.9665 | 157.5902 | 144.6089 |
| 39 | 161 | 161 | 249.4615 | 174.0529 | 160.0579 | 147.5214 |
| 40 | 163 | 163 | 248.7037 | 176.7749 | 162.4128 | 150.3548 |
| 43 | 165 | 165 | 246.9643 | 179.2913 | 164.6623 | 153.1134 |
| 50 | 168 | 168 | 250.069 | 183.3653 | 166.8135 | 155.8012 |
| 55 | 169 | 169 | 251.1667 | 185.3857 | 168.8726 | 158.4218 |
| 56 | 170 | 170 | 250.3226 | 187.0721 | 170.8454 | 160.9785 |
| 59 | 173 | 173 | 253.4063 | 191.1388 | 172.7373 | 163.4744 |
| 66 | 174 | 174 | 253.5152 | 193.0444 | 174.553 | 165.9121 |
| 69 | 179 | 179 | 260.5294 | 199.2622 | 176.2972 | 168.2942 |
| 70 | 179 | 179 | 259.6286 | 200.0601 | 177.9739 | 170.623 |
| 72 | 180 | 180 | 261.6667 | 202.2966 | 179.587 | 172.9007 |
| 77 | 180 | 180 | 259.7838 | 202.8309 | 181.1401 | 175.1293 |
| 78 | 180 | 180 | 256.9211 | 203.2113 | 182.6364 | 177.3105 |
| 79 | 181 | 181 | 257.9744 | 205.1683 | 184.079 | 179.4462 |
| 14a | 181 | 181 | 256.075 | 205.6149 | 185.4708 | 181.5378 |
| 16a | 185 | 185 | 264.0244 | 211.5587 | 186.8143 | 183.5869 |
| 83 | 187 | 187 | 268.0238 | 215.0868 | 188.1121 | 185.5948 |
| 85 | 187 | 187 | 265.1395 | 215.1997 | 189.3664 | 187.5628 |
| 87 | 188 | 188 | 265.2045 | 216.8666 | 190.5794 | 189.4921 |
| 21a | 190 | 190 | 266.2667 | 219.642 | 191.7531 | 191.3839 |
| 88 | 192 | 192 | 270.2609 | 223.0742 | 192.8894 | 193.2391 |
| 93 | 194 | 194 | 273.2766 | 226.1533 | 193.99 | 195.0588 |
| 97 | 196 | 196 | 276.2917 | 229.494 | 195.0567 | 196.8439 |
| 25a | 197 | 197 | 277.3265 | 231.4743 | 196.0908 | 198.5953 |
| 98 | 199 | 199 | 281.32 | 234.8915 | 197.094 | 200.3137 |
| 26a | 202 | 202 | 286.3137 | 239.6287 | 198.0675 | 202 |