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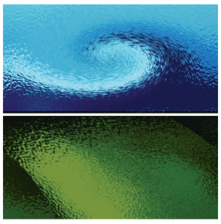

RESEARCH ARTICLE

Ecological quality of Bahrekan coast, by using biotic indices and benthic communities

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Abstract

1 - The aim of this study was identifying macrobenthos biodiversity and an assessment of the ecological quality status of Bahrekan coast in Persian Gulf, using AMBI, Bentix indices according to soft-bottom marine benthic communities. Other ecological indices, such as theShannon diversity index (H`) and the species richness (S) were also applied and evaluated comparatively.

2 - In total, 111 genus/species were recognized, divided into 17 groups with gastropodas always dominant and the substrate in all of the stations was characterized as muddy bottom.

3 - The macrobenthic animals according to their sensitivity to an increasing stress gradient, were classified in 5 ecological groups.

4 - Due to the high dominance of species such as *Pyrgohydrobia sp*., *Tornatina sp*., *Melinna sp*., *Cossura sp*. and *Sternaspis sp*, diversity values were reduced.

5 - According to the results of AMBI, BI, Bentix, and H`indices Bahrekan coast is classified in slightly to moderate pollution status.

Keywords: Bahrekan coast, Ecological status, Biotic index, Diversity, Macrobenthos, Persian golf .

Introduction

Benthic invertebrates are often used as bioindicators to detect and monitor environmental changes, because of their rapid responses to natural and/or anthropogenic stress (Pearson and Rosenberg, 1978; Grall and Glemarec, 1997; Simboura and Zenetos, 2002; Perus *et al.*, 2004). Benthic species are relatively long-living sessile organisms unable to avoid unfavorable conditions. In this way, they integrate water and sediment quality condition over time and their presence/absence indicates temporal as well as spatial disturbances (Reiss and Krncke, 2005). Marine biotic indices play an important role in regard to the ecological status assessment of aquatic ecosystems (Diaz *et al.*, 2004).

A number of biotic indices based on benthic community health have been developed to classify the ecological status of coastal and transitional waters such as AMBI (Borja *et al.*, 2000; Muxika *et al.*, 2007) and Bentix (Simboura & Zenetos, 2002) in accordance with the requirements of Water Framework Directive 2000/60/EC.

The objectives of the present study were to use different biotic indices to assess macrobenthic diversity, density and composition, compare different indices and assess the ecological quality status of the Bahrekan coast in Persian gulf.

Materials and Methods

Benthos is one of the most studied aquatic elements, with the most accurate methodological available (Borja *et al.*, 2009). Soft bottom macrobenthic communities were sampled seasonally from 21 stations, ranging from 2 to 7 meter water depth located in Bahrekan coast in the Persian gulf during autumn 2008 to summer 2009. A map of the sampling sites can be seen in Figure 1.

The main source of pollution in this area is oil, organic matter, heavy metals and sewage pollutions respectively. At each of these stations, 3 replicates of benthos were collected using Van Veen grab (./285 m^2). All samples were sieved on board through a 1 mm mesh size sieve and animals were preserved in the field with 4% formalin solution in seawater and dyed with Rose Bengal.

In the laboratory, the benthic organisms were subsequently sorted out from the sediment

All benthic species were classified into the main benthicgroups (foraminifera, polychaeta, gastropoda, bivalvia and other minor phyla) and consequently identified into s pecies level where possible. Damaged or juvenile forms not identifiable to species level were assigned to a higher taxonomic unit (Simboura *et al.*, 2007). After computing the mean abundance of each taxon, at each sampling station, the macrobenthic community structure was described calculating the following descriptors (Washington, 1984): species richness (number of identified taxa); abundance (N: ind m^2) and Shannon - Wiener diversity index H` (Shannon and Wiener, 1963). The biotic index Bentix was used to estimate the ecological status of communities (Simboura and Zenetos, 2002). The AMBI index was also applied. For AMBI, the current version of the free calculation software can be found

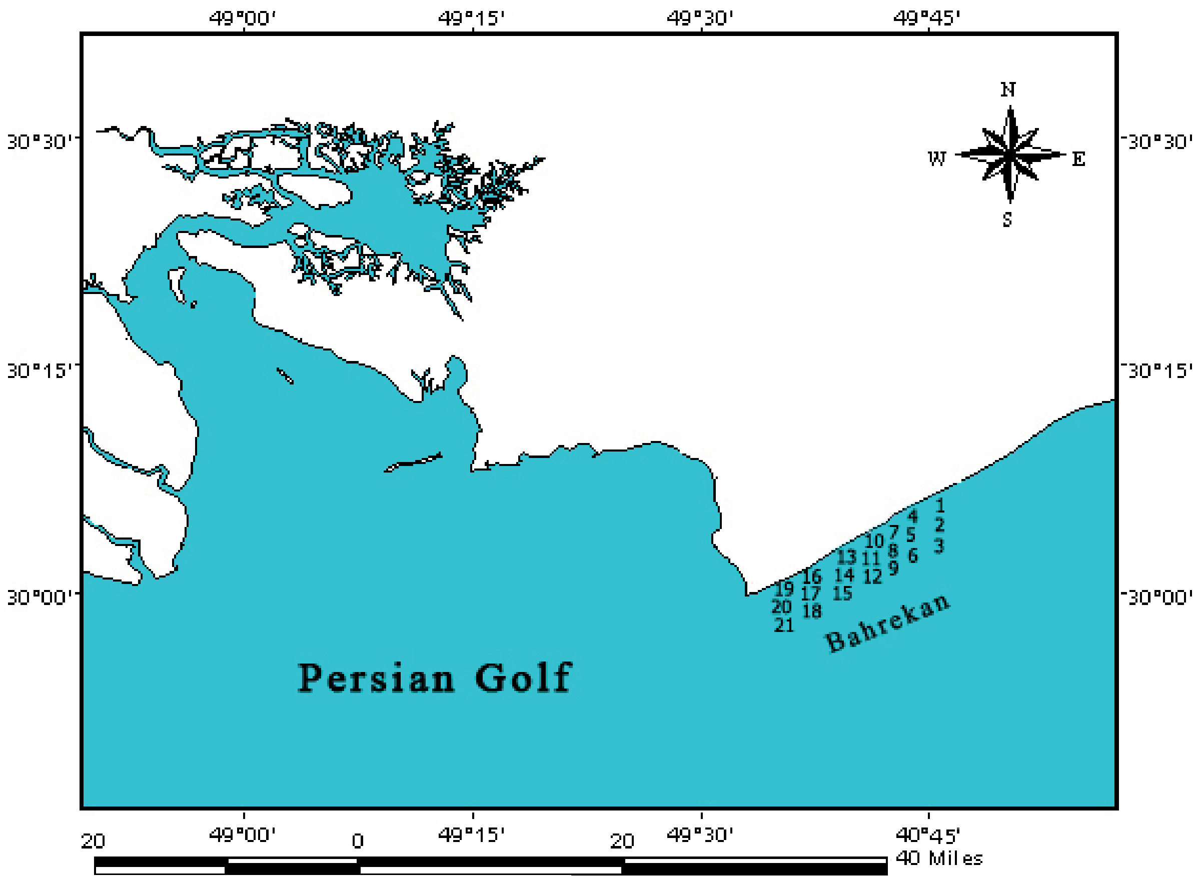

Table 1 - Classification of EQS according to ranges of H`and AMBI (cited in Albayrak *et al*., 2006)

Pollution classification	H`(UNEP/ MAP.2004)	AMBI (Muxika et al 2005)	EQS
Unpolluted/ normal	H`> 4.6 - 5	BC ≤ 1.2	High
Slightly polluted	4 < H` ≤ 4.6- 5	1.2< BC ≤ 3.3	Good
Moderately polluted	3 < H`≤ 4	3.3 < BC ≤ 4.3	Moderate
Heavily polluted	1.5 < H`≤ 3	4.3 < BC ≤ 5.5	Poor
Extremely polluted/Azoic	H`≤ 1.5	5.5 < BC ≤ 6	Bad

Table 2 - Classification scheme of bottom benthic habitats based on the Bentix index cited in Simboura *et al*., 2002

Pollution classification	Bentix	EQS
Normal/pristine	4.5 ≤ Bentix < 6	High
Slightly polluted, transitional	3.5 ≤ Bentix< 4.5	Good
Moderately polluted	2.5 ≤ Bentix < 3.5	Moderate
Heavily polluted	2 ≤ Bentix < 2.5	Poor
Azoic	0	Bad

Version of the AMBI software was used in the calculation of the AMBI (Borja and Muxika (2005), Muxika et al., (2007). For Bentix calculations the newly developed Add-in v.09 (beta version) software package for MS Excel 2007 which can be freely downloaded from www.bentix.ath.hcmr.gr has been used. When the species composition by replicate was available, the AMBI was calculated for each of the replicates, then averaged for the entire station. The average AMBI been used to show, in a simple format: the spatial pollution gradient; the evolution of the effect on the communities; and the sensitivity of BC to different impact s ources (Borja et al., 2003). The classification of ecological status based on H` and AMBI was undertaken according to Table 1.

The formulas of the biotic indices are given below (GI-GV, Group I-GroupV, respectively; GS, sensitive taxa; GT, tolerant taxa):

$$AMBI = \frac{(0 \times \%GI) + (1.5 \times \%GII) + (3 \times \%GIII) + (4.5 \times \%GIV) + (6 \times \%GV)}{100}$$

$$BENTIX = \frac{6 \times \%GS + 2 \times \%GT}{100}$$

where

$$GS = GI + GII$$

$$GT = GIII + GIV + GV$$

The theoretical ecological groups defined by Glemarec and Hilly (1981), Hilly, (1984), Majeed (1987), Grall and Glemarec (1997) and Borja *et al*., (2000) are GI (sensitive), GII (indifferent), GIII (tolerant), GIV (second-order opportunistic) and GV (first-order opportunistic). To calculate the BENTIX index the same groups were used, but were proportioned differently. GI and GII were placed in a single group GS, and GII, GIV and GV were placed in a second group GT. The results of the AMBI calculation can vary between 0 (high ecological status) and 7 (bad ecological status) (Borja *et al*., 2003). The results for the Bentix index can either be equal to 0 (bad ecological status) or can vary between 2 (poor ecological status) and

6 (high ecological status). The classification scheme of soft bottom benthic habitats on the Bentix index is shown in (Table 2).

Results

Over the whole study period, after the analysis of 84 sample stations, 11 benthic species were identified and 293031 specimens were counted in the Bahrekan coast.

and all three biotic indices, the EQS status represented by the macrobenthic communities was assessed.

Nevertheless, depending on the biotic index chosen the pattern was different and thus the overall assessment of the EQS status (Figure 3) differed among the various indices. The quality status calculated by the AMBI and Bentix reached their maximum in the

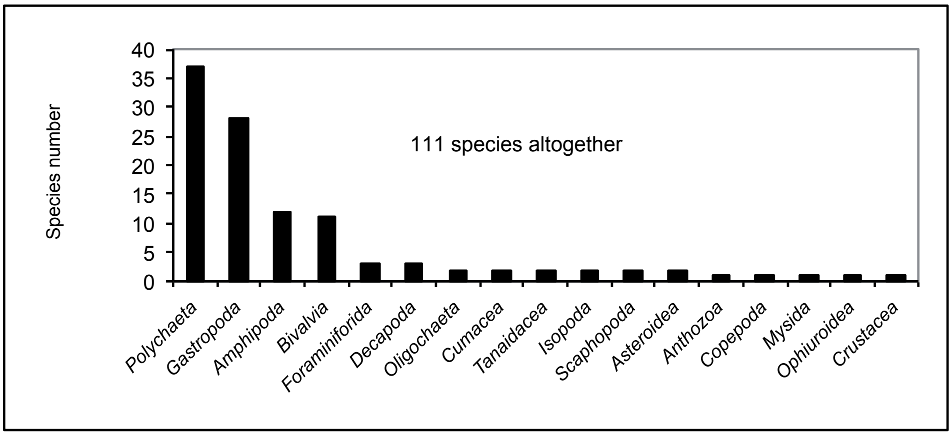

Figure 2. Macrobenthos composition in the Bahrekan coast based on 84 station sampled between 2008 and 2009

Polychaetes showed the highest biodiversity (37 species), followed by gastropods (28 species), amphipods (12 species) and bivalves (11 species). Diversity of other groups such as foraminiforida and crustaceans was clearly lower (1-3 species) (Figure 2).

The list of dominant species in the survey is shown in (Table.3).

Taking into account all sampling stations category "Good'' whereas the EQS status when using the Shannon-Wiener was mainly "Poor". The Bentix index was more balanced and showed values in between the two others. Figure 4 shows the range of the 3 indices over the stations studied. The Bentix index over the stations, covering the classes from moderate to high. The AMBI and Shannon-Wiener indices over the stations, covering

Table 3 - Dominant species/genus in Bahrekan coast (2008-2009)

Autumn 2008	Winter 2008	Spring 2009	Summer 2009
Pyrgohydrobia sp.	*Pyrgohydrobia sp.*	*Pyrgohydrobia sp.*	*Pyrgohydrobia sp.*
Osangulariidae sp.	*Tornatina sp.*	*Eulima sp.*	*Melanela sp.*
Tornatina sp.	*Paphia sp.*	*Turbonilla sp.*	*Tornatina sp.*
Eulima sp.	*Osangulariidae sp.*	*Paphia sp.*	*Eulima sp.*
Melanela sp.	*Melanela sp.*	*Tornatina sp.*	*Umbonium sp2*
Oligochaeta sp1	*Vallaceae sp.*	*Osangulariidae sp.*	*Vallaceae sp.*

the classes good and poor respectively.

Discussion

Macrobenthic communities are considered good indicators of ecosystem health because of their strong link with sediments, which, at the same time, are linked to the water column (Daur *et al*., 2000). Hence, benthos shows the real effects of pollution over the communities, being an integrator of the recent pollution history in the sediment and of different kinds of pollutions, which can act synergically: as such, they are a good indicator (Occhipinti-Ambrogi and Forni, 2004). The benthic communities respond to improvements in habitat quality in three progressive steps: the abundance increases; species diversity increases; and dominant species change from pollution-tolerant to pollution-sensitive species (Borja *et al*., 2000). The stress on the biological communities can be explained in terms of an excess of nutrients, heavy metals, hydrocarbons and some organic compounds associated with waste-water (both industrial and urban), etc (Balls, 1992; Windom, 1992; Bock *et al*., 1999; Lee and Arega,1999; White *et al*., 2004).

Dauvin (1987, 1998) notes that among the sensitive species, crustaceans, especially amphipods, form a particularly sensitive zoological group, not only to significant increases in organic matter but also to increases in other kinds of pollution including heavy metals and hydrocarbons (Dauvin and Ruellet, 2007). In the present study many amphipods (such as *Maera sp*. and *Ampithoe sp*.) were observed that Maximum density of them has been reported in station 6 and 8. Acording to Bentix and Shannon-Wiener indices these stations were characterized as moderate and poor respectively.

During the recent past the interest in benthic indicators has increased dramatically, with a long list of new indicators proposed (see Diaz *et al*., 2004, for a revision). Particularly in impact monitoring studies, the ecological indicators based on "indicator species" such as the AMBI and Bentix have lead workers to evaluate taxa according to their sensitivity to given stressors (Albayrak *et al*., 2006).

Bahrekan coast is an eutrophicated area subjected to organic pollution from wastes and in this area there is heavy metals (such as Pb, Cu and Cd), hydrocarbons, waste-water pollution (only urban) and biological impacts (i.e fisheries).

The amount of organic matter and mud in this area was very high then all of the stations characterized as muddy bottom.

In this survey we used different metrics (species abundance and richness, Shannon-Wiener diversity, AMBI and Bentix). When using the AMBI the EQS status of macrozoobenthic communities in this area were categorized as "Good". The AMBI classification is mainly based on literature data regarding organic matter enrichment (Borja *et al*., 2000).

For the AMBI, thetolerance/sensitivity level of species is assessed using a classification of five ecological groups (I-V). Within a group each species has been classified according to its reported tolerance/sensitivity to an environmental stress gradient. This classification is mainly based on published data or experience of the authors (Crall and Glemarec, 1997; Borja *et al*., 2000; Borja *et al*., 2003; Muxika *et al*., 2005). The AMBI index is very stable throughout the year (in absence of anthropogenic impacts) and is not subjected to seasonality (Salas *et al*., 2004; Reiss and Kroncke, 2005). Simboura *et al* (2007) state that the Biotic indices, such as AMBI and Bentix, based on the ecological grouping species, are generally considered as a promising approach for ecological quality assessment in order to avoid drawbacks due to the seasonal variability of the benthic communities and dependence from other factors (Reiss and Kroncke, 2005; Salas *et al*., 2006).

The AMBI values obtained mainly ranged between 1.31 to 2.75 indicating a "good" status (Table 1) and a dominance of tolerance/sensitivity species assigned to Group III (see also Borja and Muxika, 2005). For the AMBI the species number is not important but the ecological group the species belongs to (in most cases III) and its abundance (Zettler *et al*., 2007).

Bentix values obtained mainly ranged between 2.85 to 4.56 (Table 1) and could distinguish three quality classes ranging from moderate to high. As the two indices are similar in philosophy, discrepancies in the ecological assessment produced by employing the AMBI and Bentix in this study are attributed to different assignment of the species to ecological groups as well as to different classification scales and weighting of the ecological groups thus, the final EQS of two indices differs. In Station 1 and 21 the Bentix, AMBI and Shannon-Wiener indices, present high, good and moderate status, respectively. It is due to the presence of ecological group I (sensitive species), that become more important contributing to more than 50% of abundance and also due to the presence of a small percentage of species of ecological group V (0-10%).

In station 4 in summer ecological group I becomes more than 67% and ecological groups IV and V were absent. Station 8 according to Bentix and Shannon-Wiener indices is classified to moderate and poor respectively, due to ecological group V (opportunist species) accounting for more than 50% in autumn and also due to ecological group III (tolerant) with percentages of 65-85% in winter, spring and summer. In the present study due to the high dominance of species such as *Pyrgohydrobia sp*., Tornatina sp. , Melinna sp., Cossura sp. and Sternaspis sp., that are all well established pollution indicators, diversity values were reduced.

Conclusion

The biotic indices for evaluation the disturbance of benthic communities are reliable tool for categorization of the ecological status in accordance with the requirement of WFD 60/2000/EC.

As mentioned in the results, the different in the two methods lies to the different weighting of each ecological group in the formula and the different scaling of boundary among classes. This is clear indication that not one single index should be used when assessing the EQS and the use of AMBI, together with other metrics, should be employed in order to obtain a more comprehensive view of the benthic community.

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References

Albayrak S, Balkis H, Zenetos A, Kurnu A, Kubanc C, 2006. Ecological quality status of coastal benthic ecosystems in the Sea of Marmara, *Marine Pollution Bulletin* **52**: 790 - 799.

Balls PW, 1992. Nutrient behaviour in two contrasting Scottish estuaries, the forth and Tay. *Oceanologica Acta* **15**(3): 261 - 277.

Bock MT, Miller BS, Bowman AW, 1999. Assessment of eutrophication in the firth of clyde: analysis of coastal water data from1982 to 1996. *Marine Pollution Bulletin* **38**(3): 222 - 231.

Borja A, Bald J, Franko J, Larreta J, Muxika I, Revilla M, Rodrigues JG, Solaun O, Uriarte A, Valencia V, 2009. Using multiple ecosystem components in assessing ecological status in Spanish (Basque country) Atlantic marine waters. *Marine Pollution Bulletin* **59**: 54 - 64.

Borja A, Franco J and Perez V, 2000. A marine biotic index to establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments. *Marine Pollution Bulletin* **40**: 1100-1114.

Borja A, Muxika I and Franko J, 2003. The application of a Marine Biotic Index to different impact sources affecting soft-bottom benthic communities along European coasts. *Marine Pollution Bulletin* **46**: 835-845.

Borja A, Muxika I, 2005. Guidelines for the use of AMBI (AZTIs marine biotic index) in the assessment of the benthic ecological quality. *Marine Pollution Bulletin* **50**: 787-789.

Dauer DM, Weisberg SB, Ranasinghe JA, 2000. Relationships between benthic community condition, water quality, sediment quality, nutrient loads, and land use patterns in Chesapeake Bay. *Estuaries* **23**(1): 80-96.

Dauin JC, 1987. Evolotion a long terms (1978-1986) des populations Amphipods des sables fins de la Pierre Noire (Baie de Morlaix, Manche Occidentale) apres la castastrophe de I Amoco Cadiz. *Marine Environmental Research* **21**: 247 -273.

Dauin JC, 1998. The fine sand Abra alba community of the bay of Morlaix twenty years after the Amoco Cadiz oil spill. *Marine Pollution Bulletin* **36**(9): 669-676.

Dauin JC, Ruellet T, 2007. Polychaete/amphipod ratio revisited. *Marine Pollution Bulletin* **55**: 215-224.

Diaz RJ, Solan M, Valente RM, 2004. A review of approaches for classifying benthic habitats and evaluating habitat quality. *Journal of Environmental Mangement* **73**: 165-181.

Glemarec M, Hily C, 1981. Perturbations apportees a Ia macrofauna benthique de la baie de Concarneau par les effluents urbains et portuaires. *Acta Oecologica, Oecologia Applicata* **2**(2): 139-150.

Grall J, Glemarec M, 1997. Using biotic indices to estimate macrobenthic community perturbations in the Bay of Brest. *Estuarine, Coastal and Shelf Science* **44**(Suppl. A): 43-53.

Hilly C, 1984. Variabilite de Ia macrofauna benthique dans Ies millieeux hypertrophiquesde IaRade de Brest. These de Doctorate dEtat, Universte de Bretagne Occidentale. Vol.1: p. 359 and Vol. 2: p.337.

Lee JHW, Arega F, 1999. Etrophication dynamics of Tolo Harbour, Hong Kong. *Marine Pollution Bulletin* **39**(1-12): 187-192.

Majeed SA, 1987. Organic matters and biotic indices on the beaches of North Brittany. *Marine Pollution Bulletin* **18**(9): 490-495.

Muxika I, Borja A, Blad J, 2007. Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. *Marine Pollution Bulletin* **55**:16-29.

Occhipinti-Ambrogi A, Forni G, 2004. Biotic indices. *Biologia Marina Mediterranea* **11**(Suppl. 1): 545-572.

Pearson TH and Rosenberg R, 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment.

Oceanography and marine biology: An Annual Review **16**: 229-311.

Perus J, Back S, Lax HG, Westberg V, Kauppila P, Bonsdorff E, 2004. Coastal marine zoobenthos as an ecological quality element: a test of environmental typology and the European Water Framework Directive. *Coastline Report* **4**: 27-38.

Reiss H, Kroncke I, 2005. Seasonal variability of benthic indices: an approach to test the applicability of different indices for ecosystem quality assessment. *Marine Pollution Bulletin* **50**: 1490-1499.

Salas F, Neto JM, Borja A, Marques JC, 2004. Evaluation of the applicability of a marine biotic index to characterize the status of esturine ecosystems: the case of Mondego estuary (Portugal). *Ecological Indicators* **4**: 215-225.

Salas F, Patricio J, Marcos C, Pardal MA, Perez-Rufaza A, Marquez JC, 2006. Are taxonomic distinctness measures compliant to other ecological indicators in assessing ecological status? *Marine Pollution Bulletin* **52**: 817-829.

Shannon CE, Wiener W, 1963. In: The Mathematical Theory of Communication. University of Illinois Press, Urban, USA: P.117.

Simboura N, Argyrou M, 2010. An insight into the performance of benthic classification indices tested in Eastern Mediterranean coastal waters. *Marine Pollution Bulletin*: 1-9.

Simboura N, Papathanassiou E, Sakellariou D, 2007. The use of a biotic index (Bentix) in assessing long-term effects of dumping coarse metalliferous waste on soft bottom benthic communities. *Ecological Indicators* **7**: 164-180.

Simboura N, Reizopoulou S, 2007. A comparative approach of assessing ecological status in two coastal areas of eastern Mediteranean. *Ecological Indicators* **7**: 455-468.

Simboura N, Zenetos A, 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index. *Mediterranean Marine Science* **3**: 77-111.

UNEP/MAP, 2004. Marine pollution indicators Fact sheets. Document UNEP(DEC)MEDWG. 264/inf. 14.

Washington HG, 1984. Diverdity biotic and similarity indices. A review with special relevance to aquatic ecosystems. *Water Research* **18**: 653-694.

White DL, Porter DE, Lewitus A J, 2004. Spatial and temporal analyses of water quality and phytoplankton biomass in an urbanized versus a relatively pristine salt marsh estuary. *Journal of Experimental Marine Biology and Ecology* **298**(2): 255-273.

Windom H, 1992. Contamination of the Marine Environment from Land-based Sources. *Marine Pollution Bulletin* **25**(1-4): 32-36.

Zettler ML, Schiedek D, Boberiz B, 2007. Benthic biodiversity indices versus salinity gradient in the southern Baltic Sea. *Marine Pollution Bulletin* **55**: 258-270.

Appendix A

List of species/genus that have been found in all the stations along the whole studied period

species/genus	Phy	Ecological group	species/genus	Phy	Ecological group
Spiroloculina sp.	Foram	*I*	*Sabellaria sp.*	Pol	*I*
Osangulariidae sp.	Foram	*I*	*Cirratulidae sp.*	Pol	*IV*
Ammonia baccarii	Foram	*	*Sternaspis sp.*	Pol	*III*
Sea pen	Anth	*I*	*Paralvinella hessleri*	Pol	*II*
Oligochaeta sp1	Oligo	*V*	*Terebellides stroemii*	Pol	*II*
Oligochaeta sp2	Oligo	*V*	*Polycirrus sp.*	Pol	*IV*
Cossura sp1	Pol	*IV*	*Amphitritinae sp.*	Pol	*I*
Cossura sp2	Pol	*IV*	*Melinna sp.*	Pol	*III*
Clymenella sp1	Pol	*I*	*Pseudopolydora sp.*	Pol	*IV*
Clymenella sp2	Pol	*I*	*Prionospio sp.*	Pol	*IV*
Armandia sp.	Pol	*I*	*Calanopia sp.*	Cope	*
Ophelina sp.	Pol	*	*Majidae sp.*	Deca	*I*
Euphrosyne sp.	Pol	*I*	*Pagurus sp.*	Deca	*II*
Hesionidae sp.	Pol	*II*	*Peneidae sp.*	Deca	*I*
Nereis sp.	Pol	*III*	*Siriella sp.*	Mysi	*II*
Platynereis sp.	Pol	*III*	*Eocuma affine*	Cum	*II*
Odontosyllis sp.	Pol	*II*	*Heterocuma sp.*	Cum	*V*
Exogone sp.	Pol	*II*	*Apseudos sp.*	Tana	*III*
Glycera tridactyla	Pol	*II*	*Leptognathia sp.*	Tana	*I*
Glycera sp.	Pol	*II*	*Gnathia sp.*	Iso	*I*
Glycerlida sp.	Pol	*II*	*Paranthura sp.*	Iso	*III*
Glyceridae sp1	Pol	*IV*	*Amphipoda sp1*	Amphi	*II*
Glyceridae sp2	Pol	*IV*	*Amphipoda sp2*	Amphi	*II*
Nephthydidae sp1	Pol	*II*	*Amphipoda sp3*	Amphi	*II*
Nephthydidae sp2	Pol	*II*	*Amphipoda sp4*	Amphi	*II*
Nephthys sp1	Pol	*II*	*Amphipoda sp5*	Amphi	*II*
Nephthys sp2	Pol	*II*	*Amphipoda sp6*	Amphi	*II*
Nephtyidae sp1	Pol	*II*	*Amphipoda sp7*	Amphi	*II*
Nephtyidae sp2	Pol	*II*	*Maera sp1*	Amphi	*I*
Nephtyidae sp3	Pol	*II*	*Maera sp2*	Amphi	*I*
Amphinomida sp.	Pol	*I*	*Maera sp3*	Amphi	*I*
Schistomeringos sp.	Pol	*II*	*Ampithoe sp1*	Amphi	*I*
Lumbrinereis sp.	Pol	*II*	*Ampithoe sp2*	Amphi	*I*

species/genus	Phy	Ecological group	species/genus	Phy	Ecological group
Pupa sp.	Gas	*I*	*Truncatellidae sp.*	Gas	*III*
Tornatina sp.	Gas	*III*	*Littorina sp.*	Gas	*II*
Turbo marmoratus	Gas	*I*	*Umbonium sp1*	Gas	*II*
Nassaria sp1	Gas	*II*	*Umbonium sp2*	Gas	*II*
Nassaria sp2	Gas	*II*	*Turritella sp.*	Gas	*I*
Bulla sp.	Gas	*II*	*Anadara sp.*	Biv	*
Columbellidae sp.	Gas	*I*	*Vepricardium sp.*	Biv	*I*
Cylichna cylindracea	Gas	*II*	*Papyridea sp.*	Biv	*I*
Diaphana sp.	Gas	*I*	*Vallaceae sp.*	Biv	*II*
Atys sp.	Gas	*II*	*Angulus adenensis*	Biv	*I*
Marginella sp.	Gas	*II*	*Antigona sp.*	Biv	*I*
Melanela sp.	Gas	*I*	*Paphia sp.*	Biv	*I*
Nassarius castus	Gas	*II*	*Tellidora sp.*	Biv	*I*
Mitrella blanda	Gas	*I*	*Pandora sp1*	Biv	*I*
Eulima sp.	Gas	*I*	*Pandora sp2*	Biv	*I*
Naticidae sp.	Gas	*II*	*Gari maculosa*	Biv	*I*
Phasianellidae sp.	Gas	*I*	*Dentalium sp.*	Scaph	*I*
Cerithium atratum	Gas	*II*	*Fissidentalium sp.*	Scaph	*I*
Pyramidella sp.	Gas	*I*	*Axiognathus sp.*	Ophi	*II*
Pyramidellidae sp.	Gas	*I*	*Asteroidea sp1*	Astro	*
Turbonilla sp.	Gas	*I*	*Asteroidea sp2*	Astro	*I*
Pyrgohydrobia sp.	Gas	*III*	*Balanus amphitrite*	Cru	*
Tibia curta	Gas	*I*			

Ecological groups of species: GI: Sensitive, GII: Indifferent, GIII: Tollerant, GIV: Second-Ordes Opportunistic, GV: First-Order Opportunistic, *: Not assigned, Foram: Foraminifera, Anth: Anthozoa, Oligo: Oligochaeta, Pol: Polychaeta, Gas: Gastropoda, Biv: Bivalvia, Scaph: Scaphopoda, Ophi: Ophiuroidea, Astro: Astroidea, Cru: Crustacea.