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CURRENT STATUS OF THE BENTHIC COMMUNITIES IN THE ROMANIAN BLACK SEA WATERS

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ABSTRACT

The paper aims to present the latest information regarding the state of the benthic communities in the Romanian Black Sea waters, with reference to the ecological status of marine habitats. The paper presents information both on perennial, sensitive macroalgae species with key ecological role for the marine environment and and also for the opportunistic ones. The samples required for the assessment were collected from stations located along the entire Romanian Black Sea coast (from Portita to Vama Veche). Also the paper presents the assessment of the benthic invertebrate fauna and phytobenthic communities status from coastal water bodies based on the elaborated methods for assessing the GES in accordance with MSFD requirements.

Key-Words: phytobenthic communities, benthic invertebrates, marine habitats, assessment method, Ecological Index (EI), M-AMBI*(n)

AIMS AND BACKGROUND

Benthic communities play a particularly important role in the marine ecosystem. Over decades, along the Romanian Black Sea shore, benthic communities suffered a serious decline as a result of the cumulative action of some unfavourable natural and anthropogenic factors (Abaza et al., 2016). A strong impact on the zoobenthic communities occurred along with the deterioration of *Phyllophora* and *Cystoseira* areas, perennial habitat forming macroalgae. *Phyllophora* fields used to cover important areas in the northwest part of the Black Sea and represented the world's largest agglomeration of red algae, constituting into a complex substrate with numerous ecological niches populated by a rich associated fauna. The decline of these areas, even their disappearance in some parts of the Romanian seashore, led also to the decline of the zoobenthic populations. So, it can be said that the phytobenthic

associations are in close correlation with the zoobenthic ones, an area where perennial species dominate is able to maintain a much more diverse fauna comparing to one where the opportunistic species are dominant (Filimon et al., 2016).

Benthic communities are good indicators of the quality of the marine environment, responding more quickly (the case of the macroalgal associations) or slower (in the case of zoobenthic communities) to changes occurring as a result of the anthropogenic impact (Filimon & Abaza, 2015).

According to the Marine Strategy Framework Directive, good ecological status (GES) corresponds to the ecological status of marine ecosystems (defined by their biotic and abiotic components) as regards their structures, dynamic functions and processes that retain their adaptability (resistance) to the changes induced by human activities. It is important to note that the concept of GES implies the existence of human activities and does not therefore refer to an impactless state (in the sense of a reference state). For assessing the ecological status of benthic invertebrates and phytobenthic elements, several indices and approaches were proposed for the Black Sea, for the Romanian Black Sea coast - M-AMBI*(n) (for benthic invertebrates) and EI (for phytobenthic associations) being used (Abaza et al. 2018). These indices were tested for the Romanian coastal waters and the results are presented below.

EXPERIMENTAL

In the present paper, the assessment of phyto- and zoobenthic communities is based on data collected in 2017. The phytobenthic samples were collected from 11 stations, along the coastal strip Năvodari - Vama Veche (Năvodari, Pescărie, Constanta North, Cazino Constanța, Agigea, Eforie South, Tuzla, Costineşti, Mangalia, 2 Mai and Vama Veche), at depths between 1 and 3 meters (areas with maximum development along the Romanian Black Sea coast). Three samples per depth range, in three depth ranges (0-1 m, 1-2 m and 2-3 m) were collected from infralittoral macroalgal communities at each sampling station, by means of a square frame with a side of 20 cm.

The present study is based on the analysis of 85 samples, collected along the entire coastal zone. For the calculation of the EI Index, each identified species was included into ecological groups according to its tolerance to environmental conditions, namely ESG IA, ESG IB, ESG IC - perennial species indicator of less eutrophic areas, and ESG IIA, ESG IIB, ESG IICa, ESG IICb - opportunistic species able to thrive in eutrophic areas with a high reproductive capacity (eg. *Ceramium, Cladophora, Ulva*). Main criteria in differentiating the species into sensitivity groups was species morphology, biology and growth rates, as well as observational and experimental evidence of their sensitivity to eutrophication in the specific conditions of the Black Sea. The average biomass of sensitive (ESGI) and tolerant (ESGII) species from all the samples collected from replicate transects is calculated. The index is expressed as the proportion of sensitive and tolerant species average biomasses at each transect. As a value of EI, the biomass proportion of the most sensitive group is taken into consideration (Marin et al., 2015) (Table 1).

Table 1. EI index limits (threshold values) to define GES.

Biomass proportion for sensitive and perennial species	EI (value)	Ecological state
80-100 % ESGI	7.8 - 10	**GES**
60-80 % ESGI	6 - 7.8	
40-60 % ESGI	4 - 6	**non - GES**
0-40 % ESGI	2 - 4	
0 % ESGI	< 2	

In 2017, macrozoobenthos samples were collected from soft bottoms in 16 stations on 3 transects: Portita, East Constanta and Mangalia, at depths between 5 and 90 meters. Although the sampled transects did not covered the entire Romanian shelf, the main water bodies and broad habitats for which the reference conditions are available were included. In the sampled area, a total of 78 species were identified. On the soft-bottom sediments zoobenthic samples were collected using a Van Veen grab on 0.1 m^2, according to the methodology agreed at the Black Sea level (Todorova & Konsulova, 2005). Each sample was sieved through a set of stainless steel gauze sieves with a mesh size of 1.0 × 1.0 mm and 0.5 × 0.5 mm; the residue was collected in specimen containers and fixed in buffered 4% formaldehyde. The three major taxonomic groups in the Black Sea macrozoobenthos - Polychaeta, Mollusca and Crustacea are identified to the species level. Nemertini, Turbellaria and Oligochaeta, were identified to higher taxonomic level (Phylum or Class). Abundance is expressed in individuals/m^2. Macrozoobenthos data were analysed using abundance, species richness (S – as number of taxa per sample), the Shannon diversity index (H'), AMBI index and its five ecological groups (EG) as single metrics. For their calculation the AZTI AMBI software (http://ambi.azti.es) was used. As multimetric or multivariate method, M-AMBI*(n) was applied. The index M-AMBI*(n) is compatible with both the Water Framework Directive and the Marine Strategy Framework Directive showing the level of adverse effects of pressure on benthic invertebrates.

RESULTS AND DISCUSSION

During the summer 2017, the phytobenthic communities formed exclusively out of opportunistic species were quantitatively dominated by the green algae at most monitored stations. Among the *Ulva* species (common species for the summer season), *Ulva rigida* was the dominant one in the past years. *Ulva* species were a constant presence along the Romanian Black Sea coast, with high fresh biomass values at Pescărie (914 g/m^2) and Tuzla (850 g/m^2) (Fig.1). After the abundant development of summer 2010 and 2011, due to the high sea water temperatures, *Cladophora* species, although a constant presence during the summer season, did not show a significant development during summer 2017, with a maximum value of only 180 g/m^2 at Cazino Constanţa (Fig.1). Among the rhodophytes, similar to previous years, *Ceramium* species (mainly *C. virgatum* and *C. diaphanum var. elegans*) dominated the shallow waters, with a maximum biomass value of 600 g/m^2 at Pescărie (Fig. 1).

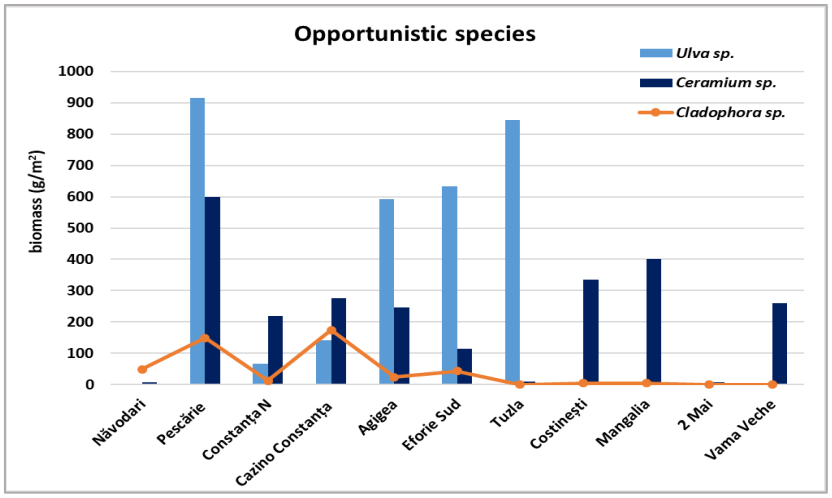
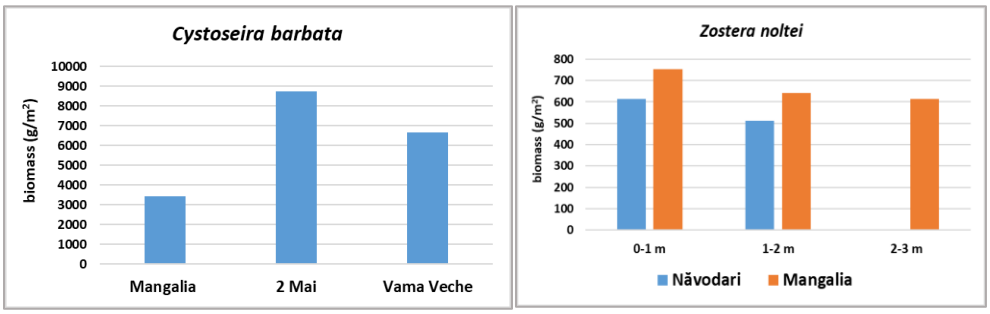


Fig. 1. Average biomass variation for the dominant opportunistic species during 2017.

Perennial species are an important component of phytobenthos, represented at the Romanian Black Sea coast by a small number of species belonging to the genera *Cystoseira, Phyllophora and Zostera.* All of these species are habitat forming species, shelter for an important associated fauna. *Cystoseira barbata* fields of various dimensions were identified in the past years at Mangalia, Jupiter-Saturn, 2 Mai and Vama Veche. The species developed high fresh biomass, ranging between 3400 - 8800 g/m^2, with a maximum value recorded at Marine Reserve 2 Mai-Vama Veche, (Fig. 2a). Regarding *Zostera noltei*, this species is recorded along the Romanian Black Sea coast at Năvodari (between 0.5 and 2 meters depth) and Mangalia (between 0.5 and 3 meters depth). The fresh biomass values have varied at Mangalia between 615 and 750 g/m^2 and at Năvodari between 500 and 615 g/m^2 (Fig. 2b).



a) Cystoseira barbata ***b) Zostera noltei***

Fig. 2. Average fresh biomass variation for the perennial species in 2017.

Based on the presence of perennial phytobenthic species and their condition, analyzed through a qualitative (aspect of the thalli, total epiphyte load,) and quantitative (fresh biomass values) assessment, the state of the benthic habitats can be established. Thus, biomass and relative abundance are proposed indicators in order

to determine the ecological status of the habitats 1170-8: Infralittoral rock with photophilic algae – *Cystoseira barbata* fields and 1110-1 *Zostera* meadows on clean or slightly muddy fine sands. Thus, the *Cystoseira barbata* fresh biomass (without epiphytes) greater than 3000 g/m^2 is an indication that *Cystoseira* habitat is in GES condition (Fig. 3).

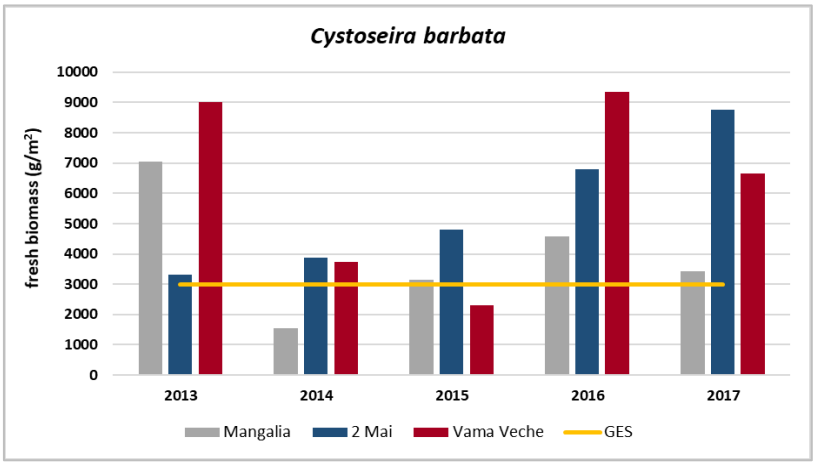


Fig. 3. *Cystoseira barbata* - average fresh biomass variation in relation to GES reference value.

Based on multi-metric indices for assessing the status and functionality of the benthic community, such as diversity and species richness, the ratio of opportunistic/perennial species the status of benthic habitats can be evaluated.

It is well known that macroalgae and marine phanerogams are good indicators of the state of the marine environment, so the Ecological Index (EI) was applied in order to characterize the ecological status of coastal water bodies based on the Marine Strategy Framework Directive principles.

Fig. 4. Establishing the ecological status based on MSFD principles (2017 evaluation).

The habitats 1170-8: Infralittoral rock with photophilic algae - *Cystoseira barbata* fields and 1110-1 *Zostera* meadows on clean or slightly muddy fine sands were assessed using EI according to Marine Strategy Framework Directive requirements. Both habitats were assessed as GES (Fig. 4).

Regarding the similarity between sampling stations, analyzed based on the type of algal associations and biomass values, a high similarity between 2 Mai and Vama Veche due to the clear dominance of *Cystoseira barbata* - *Ulva rigida* - *Ceramium virgatum* association was noticed. There is also a high similarity between Pescărie, Cazino Constanța, Agigea and Costinești, as a result of the clear dominance of the same algal associations' type, formed exclusively of opportunistic species of the genera *Ulva* and *Cladophora* (Fig. 5).

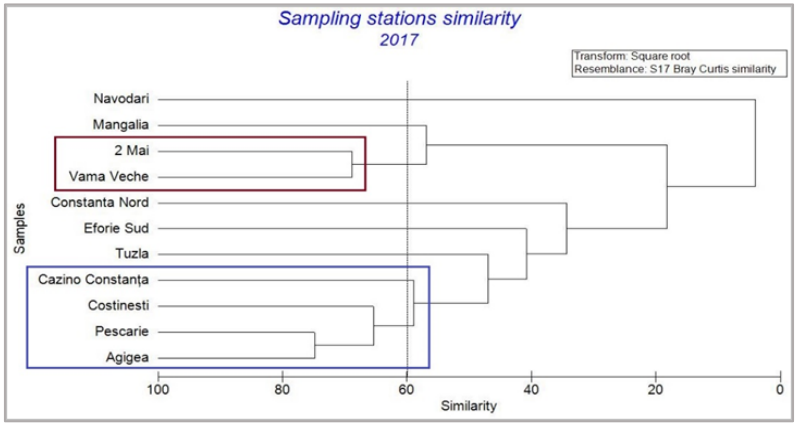


Fig. 5. Bray_Curtis similarity based on macrophytes biomass (2017).

The highest biomass values were registered in the southern part of the Romanian Black Sea coast, due to the presence of algal communities formed predominantly of perennial species (*Cystoseira* and *Zostera*) (Fig. 6).

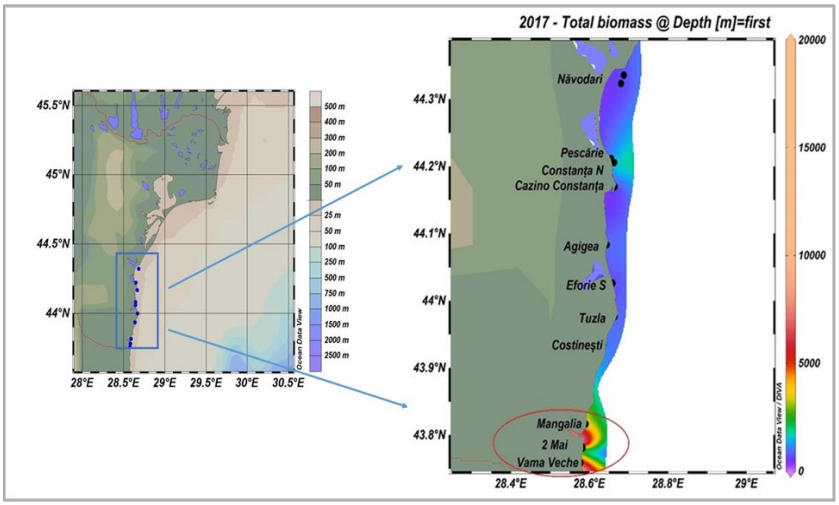


Fig. 6. Graphic representation of the fresh biomass distribution along the Romanian Black Sea coast in 2017.

The 78 benthic invertebrates identified in the studied area were distributed among water bodies and broad circalittoral habitats as follows: 23 in marine transitional waters (Portita transect), 31 in coastal waters (Constanta and Mangalia transects), 54 on the circalittoral sediments dominated by the bivalve *Mytilus galloprovincialis* (30 to 60 meters) and 33 on circalittoral mixed sediments and mud with *Modiolula phaseolina* (at 70 - 90 meters depth). In marine transitional waters bottom invertebrate fauna densities were dominated by the polychaetes *Heteromastus filiformis* (760 ind/m^2) and *Capitella capitata* (510 ind/m^2), bivalves *Anadara kagoshimensis* (540 ind/m^2) and *Abra prismatica* and the amphipod *Ampelisca diadema* (470 ind/m^2) among crustaceans. Maximum density values were registered at 5 m depth. By applying the M-AMBI*(n) index, the ecological status of marine transitional waters was assessed as Poor following the Water Framework Directive (WFD) principles (Fig. 7). This status is based only on the data resulted from Portita transect.

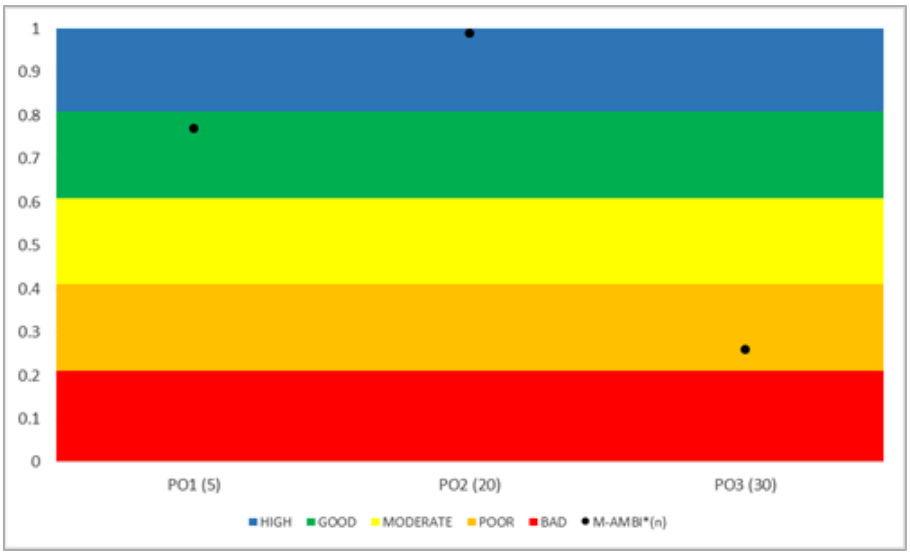


Fig. 7. Macrozoobenthos ecological status in the marine transitional waters in 2017 using M-AMBI*(n) index.

In the coastal waters densities of benthic invertebrates were dominated by *Heteromastus filiformis* (500 ind/m^2), *Nephtys hombergii* (480 ind/m^2) and *Prionospio cirrifera* (470 ind/m^2) among polychaetes, by *Chamelea gallina* (70 ind/m^2) and *Anadara kagoshimensis* (30 ind/m^2) among molluscs and same *Ampelisca diadema* (40 ind/m^2) among crustaceans. In the coastal water body, according to the same principle, the macrozoobenthos status was in Good ecological status, again on three samples only, collected on East Constanta and Mangalia transects (Fig. 8).

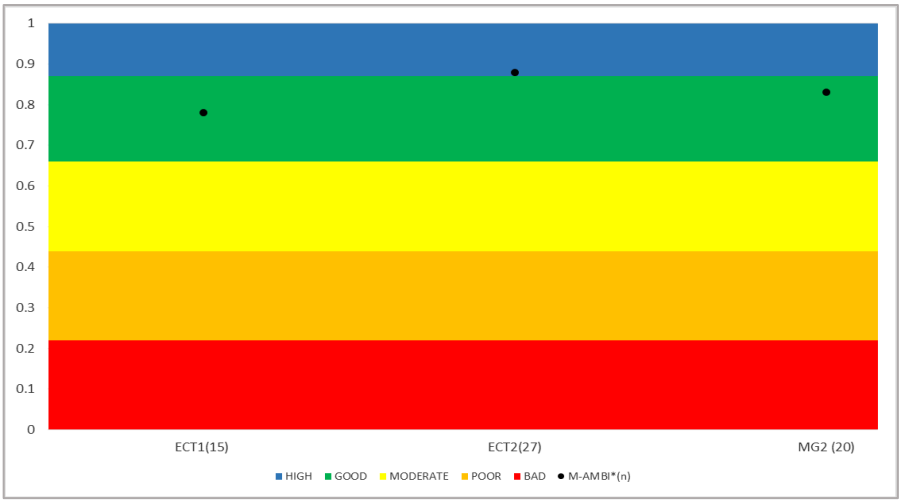


Fig. 8. Macrozoobenthos ecological status in the Romanian coastal water body in 2017 using M-AMBI*(n) index.

Circalittoral broad habitats, namely circalittoral muds and mixed sediments with *Mytilus galloprovincialis* (30 - 60 m depth) and circalittoral muds with *Modiolula phaseolina* (70 – 100m) were also assessed using M-AMBI*(n) for the environmental status according to the provisions of the Marine Strategy Framework Directive. Both habitats were assessed as GES, although the analysis was based on a rather small number of samples (7 on *Mytilus* and 3 on *Modiolula* habitats) (Fig .9 &10).

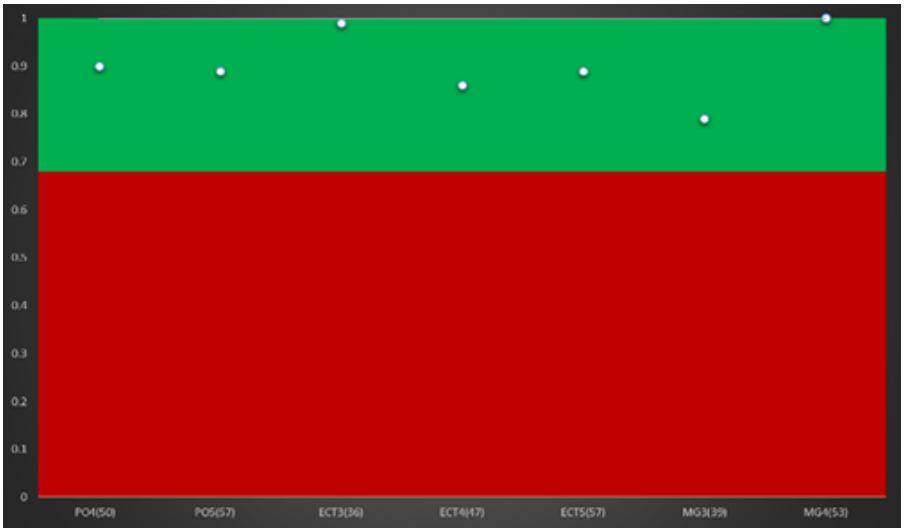


Fig. 9. Environmental status of the circalittoral muds and mixed sediments with *Mytilus galloprovincialis* in 2017 based on M-AMBI*(n) index.

Fig. 10. Environmental status of the circalittoral muds with *Modiolula phaseolina* (lower circalittoral) in 2017 based on M-AMBI*(n) index.

In the upper circalittoral habitat with *Mytilus galloprovincialis*, dominant species in terms of density were: *Mytilus galloprovincialis* (between 10 and 3110 ind/m^2), amphipod *Phtisica marina* (30-2300 ind/m^2) and three polychaetes (*Prionospio cirrifera, Heteromastus filiformis* and *Nephtys hombergii*) with maxim densities between 550 and 820 ind/m^2. Among frequent molluscs occurring in this habitat *Acanthocardia paucicostata, Spisula subtruncata* and *Abra prismatica* can be mentioned.

In the lower circalittoral habitat with *Modiolula phaseolina* the species abundances are quite low, highest density being displayed by *Modiolula phaseolina* (330 ind/m^2). Given the small size of this bivalve, biomass values, were also small in this habitat (<22g/m^2). In spite of its rather high species diversity, the benthos productivity is very low in the *Modiolula* habitat (113g/m^2 total biomass) as compared to *Mytilus* circalittoral muds, where total biomass exceeded 5000 g/m^2 at 57m depth.

CONCLUSIONS

The main conclusions for 2017 regarding the phytobenthic communities refer to the clear dominance of *Ulva* species during the summer season, among the opportunistic macroalgae and to the maintenance of the regeneration process of perennial species, with direct references to *Cystoseira barbata, Coccotylus truncatus* and *Zostera noltei.* These species have a particular ecological value and have suffered a continuous decline over decades along the Romanian Black Sea coast, and therefore require a very careful monitoring. The habitats 1170-8: Infralittoral rock with photophilic algae - *Cystoseira barbata* fields and 1110-1 *Zostera* meadows on clean or slightly muddy fine sands were assessed as GES (Good Environmental Status).

Regarding the zoobenthic communities - using M-AMBI*(n) index,

macrozoobenthos of marine transitional water body was assessed as Poor ecological status, while coastal water body was in Good ecological status. Based on the same index, circalittoral habitats (muds and mixed sediments with *Mytilus galloprovincialis* and muds with *Modiolula phaseolina*) were assessed as GES (Good Environmental Status).

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