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Ecological status of macrozoobenthic communities in Beloslav and Varna Lakes during the autumn of 1999

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Introduction

The Varna-Beloslav Lakes system was a fresh-water firth with a little flow into Black Sea up to 1909. After connecting the Varna Lake with two channels to the Black Sea (the first channel was dug in 1909 and the second in 1976) the salinity of the Varna-Beloslav Lakes system rose considerably (15-16 ‰ at present). Starting from the west, the following industrial complexes were constructed since 1954: Port Varna-West, Devnya chemical industrial complex, Varna Thermo-electric power station (TPS), Port Varna-East and Varna town sewage plant. As a consequence the system Beloslav Lake-Varna Lake become one of the areas along Black Sea coast strongly affected by human activities receiving pollutants from chemical industry, agricultural and sewage plants, TPS and port activities. The progressive anthropogenic impact up to 90-ies transforms the lakes into a buffer zone retaining the pollution and reduces their self-recovery ability and autumn is identified as the most critical period for macrozoobenthic communities (Konsulova, 1992).

Beloslav Lake is almost enclosed water basin with an area of 3.9 km^2 and volume $9.1 \cdot 10^5$ m^3 which determines low self-purifying capacity. The sediments are permanently polluted with heavy metals as a result of receiving industrial wastewater from Devnya chemical plants and heavy metal contamination is identified as the major environmental stress in the lake presently (Konsulova et al., 2000).

Varna Lake has 4-fold greater area and 19-fold greater volume than Beloslav Lake but it is characterised by significant organic load leading to oxygen deficiency in the bottom waters due to the limited vertical water exchange (Konsulova et al., 2000; Shtereva, Krastev, Hristova, 2000).

During the last three decades anthropogenic eutrophication has been identified as key ecological problem for the coastal Black Sea and marine ecosystem Varna Bay – Varna Lake - Beloslav Lake, resulted in dramatic alterations in the chemical and biological regimes (Mee, 1992; Zaitzev, 1992). Concerning the primary production the area is classified as hypereutrophic (Moncheva et al., 2001).

Macrozoobenthic communities have major advantages as indicators of the environmental quality being composed mainly of sessile or relatively immobile organisms and their status reflect exactly the integrated environmental conditions. Most of the dominant species are long-lived and indicating the environmental quality over a period of time rather than reflecting conditions just at the time of sampling (Gray, McIntire, Stirn, 1992).

Materials and methods

A total of 23 macrozoobenthic samples were collected from 23 stations situated in the area of Beloslav Lake, Varna Lake and the cannels connecting Beloslav Lake with Varna Lake and Varna Lake with Varna Bay in November 1999 at depths ranging from 1 to 15 m (fig. 1).

The samples were collected using Van Veen grab with sampling area 0.05 m^2, sieved through 0.6 mm mesh and preserved in 4 % formaldehyde. The laboratory analyses were

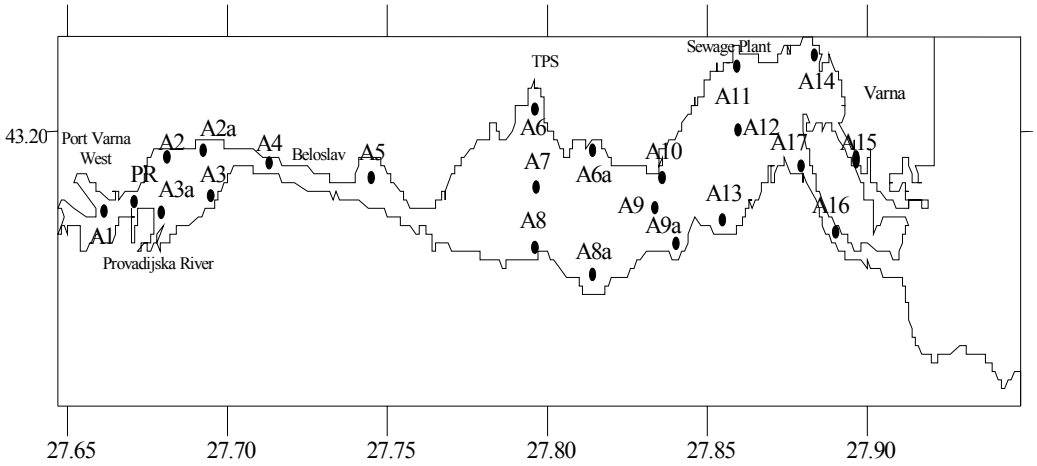

Fig. 1. Map of sampling stations in study area (November 1999)

accomplished according to FAO methodology (Gray, McIntire, Stirn, 1992; Holme, McIntyre, 1984). Abundance and biomass data were recalculated per square meter. The Shannon-Wiener community diversity index H' (Shanon, Wener, 1963) was calculated on the abundance and biomass data for each sample. Warwick's method of ABC-curves was applied for assessment of communities' disturbance (Warwick, Pearson, Ruswahyuni, 1987).

Results and discussion

On the basis of 23 samples a total of 44 species and groups are registered in the study area during November 1999, 15 of which are Polychaetes, 11 Crustaceans, 9 Molluscs and 9 Varia. A total of 20 species and groups are registered in Beloslav Lake, while in Varna Lake they are 40, i. e. the average number of species is 1.5-fold higher, which indicates that macrobenthic fauna inhabiting Varna Lake is characterized by higher species richness. The Polychaetes are present with the highest number of species in both lakes. For all taxonomic groups species richness tends to be 2-fold lower in Beloslav Lake in comparison with Varna Lake (fig. 2).

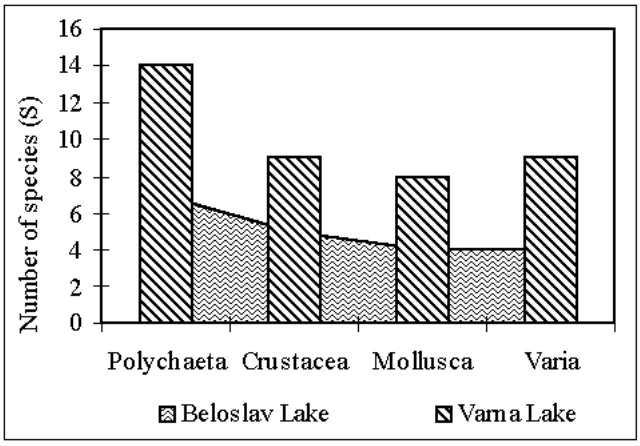

Fig. 2. Total number of species of taxonomic groups by lakes

The average number of species in the study area is 9. Macrozoobenthic community exhibits the highest species richness (S=24) in station A16 – the cannel connecting Varna Lake with Varna Bay where the water circulation in bottom layers is better. The sampled point in front of TPS (A6) showed total lack of macrobenthic fauna due to thermal contamination which provoke recurrent plankton "blooms" leading to hypoxia and anoxia combined with coal dust that is spilled to the bottom of Varna Lake in thick layer during the ports activities (K o n s u l o v a et al., 2000; T r a y a n o v, M o n c h e v a, S o l a k o v, 1991). Two of the sampled points (A2 and A2a) situated in northern part of Beloslav Lake are inhabited by a single species – polychaete *Polydora ciliata,* which is considered as indicator of organic pollution (P e a r s o n, R o s e n b e r g, 1978).

The average abundance established in the present study is 12 512 ind·m^{-2} with 78 % dominance of Polychaetes followed by Molluscs with 8 % and equal percentage of Crustacean and Varia (fig. 3).

The total average abundance in Beloslav Lake is 7 588 ind·m^{-2} and tends to be 2-fold lower than established in Varna Lake (fig. 4). The group of Polychaetes, which is the most abundant, shows the same tendency. The Crustaceans and Molluscs are also present with 7 and 5 - fold higher abundance in Varna Lake in comparison with Beloslav Lake. In contrary, the group Varia is more abundant in Beloslav Lake due to dominance of Oligochaetes accounted as indicator of organic pollution.

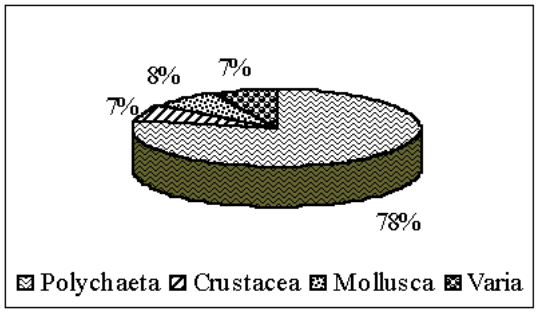

Fig. 3. Percentage share of taxonomic groups from average abundance

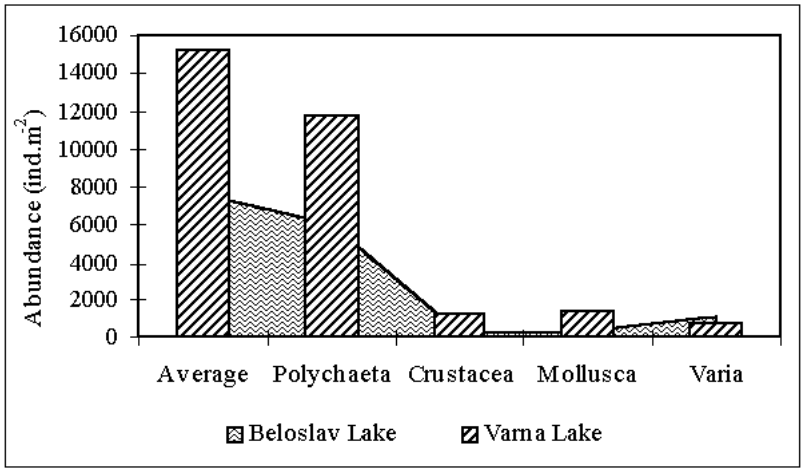

Fig. 4. Total average abundance and average abundance of taxonomic groups by lakes

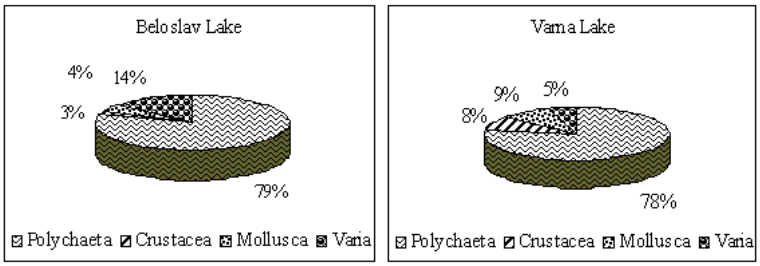

Fig. 5. Percentage share of taxonomic groups from total average abundance in Beloslav Lake and Varna Lake

The dominance of Polychaetes in both lakes is significant – 79 % and 78 % from total average abundance (fig. 5). The most abundant Polychaetes in Beloslav Lake are *Nereis diversicolor, Polydora ciliata* and *Nereis succinea*, while in Varna Lake the highest is contribution of *Polydora ciliata* followed by *Mercierella enigmatica* and *Nereis succinea.* The group Varia is better present in Beloslav Lake due to the high abundance of Oligochaetes, while in Varna Lake the Nematods are dominating.

The total average biomass is 714.99 $g \cdot m^{-2}$ formed by 83 % dominance of Molluscs (fig. 6). Group Varia and Crustacean take respectively 8 % and 7 % from the average biomass.

The average biomass in Varna Lake is 1031.24 $g \cdot m^{-2}$ and tends to be 8.5-fold higher than registered in Beloslav Lake (fig. 7). As

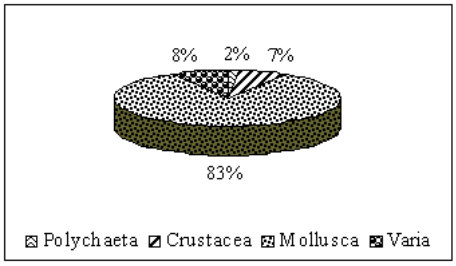

Fig. 6. Percentage share of taxonomic groups from average biomass

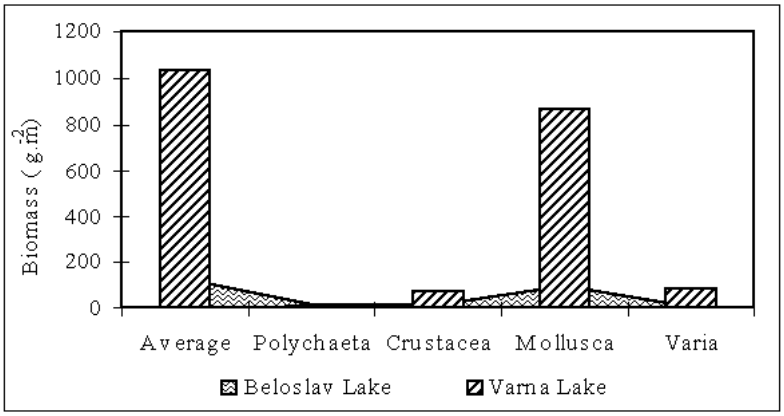

Fig. 7. Total average biomass and average biomass of taxonomic groups by lakes

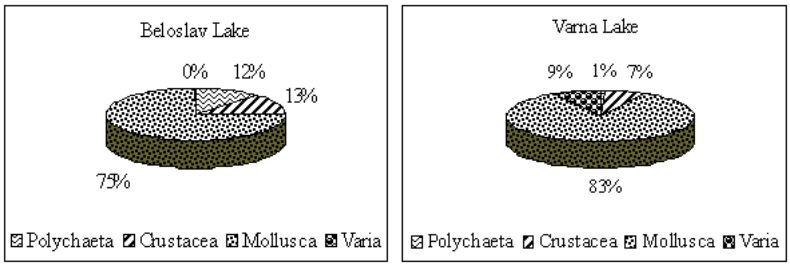

Fig. 8. Percentage share of taxonomic groups from total average biomass in Beloslav Lake and Varna Lake

obvious from the figure the Molluscs take the main part of the biomass in both lakes. The comparison between the lakes also reveals that Crustacean and group Varia have higher biomass in Varna Lake.

Percentage share of taxonomic groups shows that Molluscs dominate with 75 % in Beloslav Lake and with 83 % in Varna Lake, Crustaceans and group Varia share almost equal percentage from the average biomass in Beloslav Lake while in Varna Lake group Varia take 9 % followed by Crustaceans (fig. 8).

The mean value of Shannon-Wiener diversity index H' (A) is higher than H' (B) - 1.7 and 1.2 respectively which indicates relatively stable ecological status of macrozoobenthic community. In both lakes the tendency in the rate of community diversity index is the same (fig. 9).

The maximum of H' (A) - 3.36 is registered in station A16 situated in the second channel connecting Varna Lake with Varna Bay where better water circulation favour the environmental conditions on bottom but H' (B) is maximal in station A12, where biomass is shared between Polychaetes and Molluscs. The registered minimum of H' (A) – 0.43 in station A8a is due to domninance of polychaete *Plydora ciliata*, while H' (B) has minimal value in station A9 because of the dominance of mussel *Mytilus galloprovincialis* and barnacle *Balanus improvisus*. For station A6 (in front of TPS) that is barren of vital invertebrates and stations A2 and A2a (situated in Beloslav Lake) where macrozoobenthic community is present by a single species community diversity index cannot be calculated.

Application of ABC-curves accounting for the quantitative distribution of species and the patterns of biomass versus abundance dominance made known the ecological status of macrozoobenthic communities.

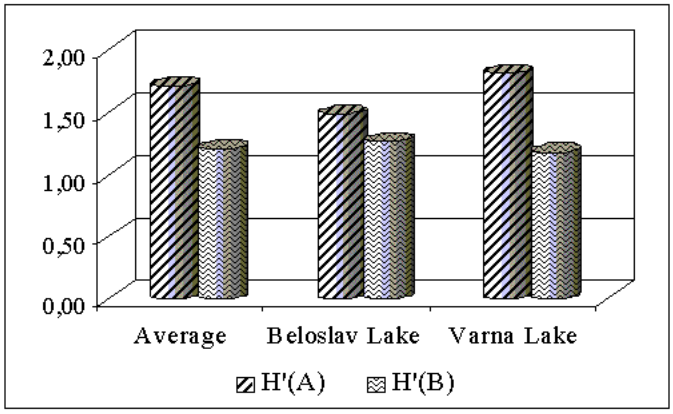

Fig. 9. Diversity index H'(A) and H'(B) - average and by lakes

The area of Beloslav Lake is characterised by poor benthic community - two of the six sampled points are inhabited by a single species, one by two species and the last three are categorised as moderately to grossly disturbed (fig. 10). In the sampled points A4 and A5 located in the channel between Beloslav Lake and Varna Lake the soft bottom community in characterised by ABC-curves as undisturbed (fig. 10).

The ecological status of macrozoobenthic community inhabiting Varna Lake is better and varies from grossly and moderately disturbed to undisturbed (fig. 11). The configuration of curves typifies the community in station A8 located along the south coast of Varna Lake at 3 m depth as severely disturbed. The sensitiveness of ABC-curves method to organic pollution and the extreme dominance in abundance of polychaete *Polydora ciliata* (indicator of organic pollution) indicate that the organic load in sediments is the most probable factor for the community disturbance. In the most of the sites macrobenhtic fauna is categorized as undisturbed and the ratio moderately disturbed/undisturbed is 40 %/60 % respectively.

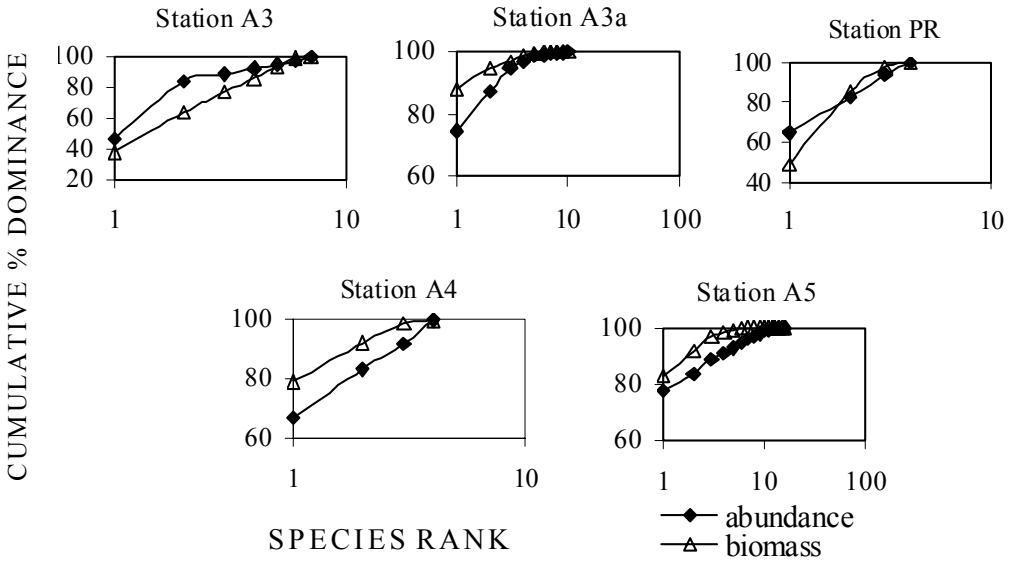

Fig. 10. Abundance Biomass Comparison curves of stations from Beloslav Lake and the cannel connecting it with Varna Lake

Conclusions

The comparison between Beloslav Lake and Varna Lake shows that macrobenthic fauna inhabiting Varna Lake is characterized by 2-fold higher species richness, average abundance is 2-fold higher than established in Beloslav Lake, while the average biomass is 8.5-fold higher.

The study area is characterized by significant dominance of Polychaetes in abundance and of Molluscs in biomass and highest species richness of Polychaetes.

The best is ecological status of macrozoobenthic community inhabiting the cannel connecting Varna Lake with Varna Bay, which exhibits the highest species richness, maximal value of community diversity index (H' (A)) as well as undisturbed status. The sampled point in front of TPS is a dead zone.

The mean value of Shannon-Wiener diversity index H' (A) is higher than H' (B) which indicates relatively stable ecological status of macrozoobenthic community.

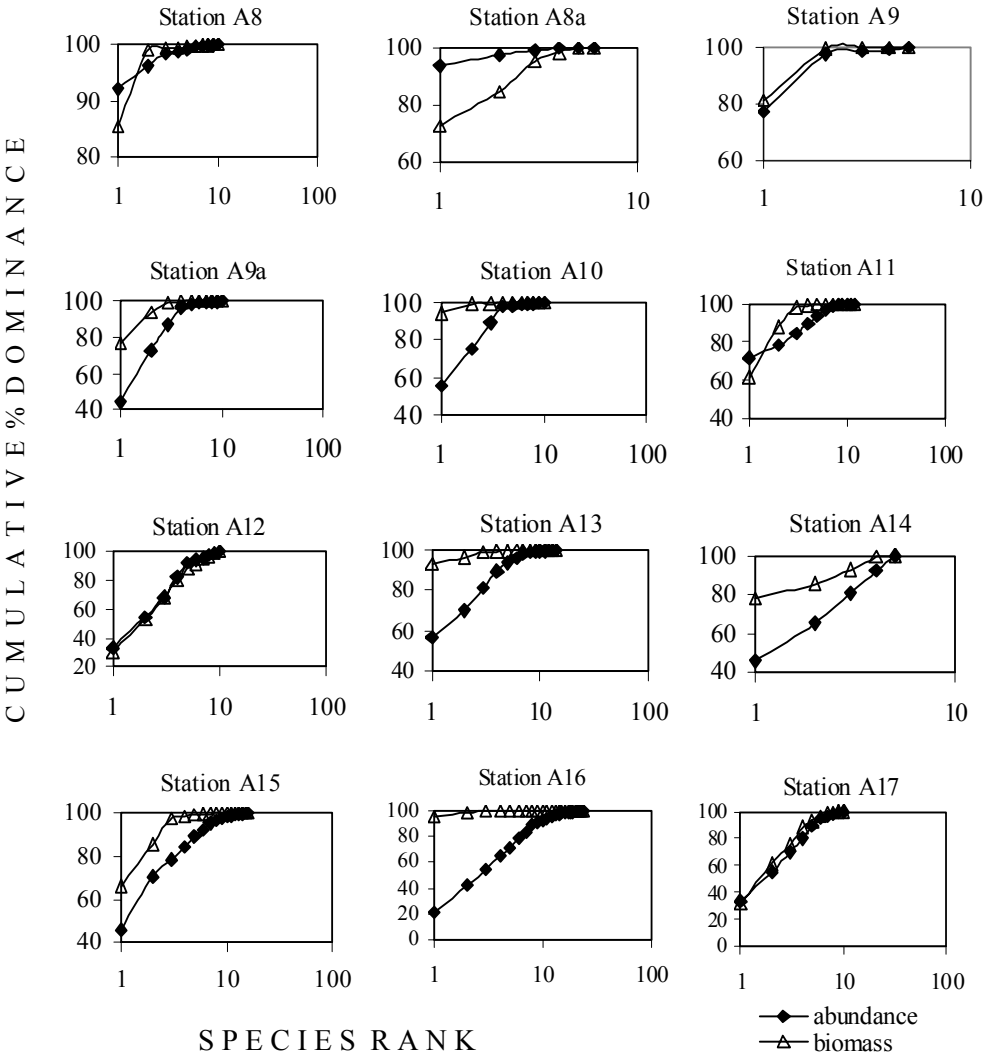

Fig. 11. Abundance Biomass Comparison curves of stations from Varna Lake and the cannel connecting it with Varna Bay

The ecological status of macrozoobenthic communities shows a tendency of improvement moving from Beloslav Lake to Varna Lake and away from the source of pollution.

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Екологично състояние на макрозообентосните съобщества в Белославското и Варненското езеро през есенния сезон на 1999 г.

Антоанета Т. Траянова

(Резюме)

На базата на изследвания на макрозообентоса, проведени през есенния сезон на 1999 г. настоящата публикация обобщава промените в структурата на макрозообентосните съобщества в Белославското и Варненското езеро.

Намесата на човешкия фактор върху двата водни обекта е толкова силна, че променя почти изцяло облика на езерната акватория. Прогресивното антропогенно въздействие върху езерата до 90-те години ги превръща в буферна зона, задържаща замърсяването, и намалява тяхната самопречиствателна способност, като есенният сезон се явява най-критичен за зообентосните съобщества.

Целта на настоящото изследване е да се оцени състоянието на макрозообентосните съобщества по отношение на видовото богатство, количествените параметри, индекса на Shannon-Weaver и метода на ABC-кривите на Warwick.

При прилагането на посочените показатели сравнението между двете езера показва, че Варненското езеро се намира в по-добро екологично състояние, изразяващо се в по-високо видово разнообразие, по-висока средна численост и биомаса на макрозообентоса.

В цялата изследвана акватория се наблюдава тенденция за подобряване на екологичното състояние на макрозообентосните съобщества в направление Белославско езеро - Варненско езеро, както и с отдалечаване от източниците на замърсяване.