DOI: 10.2478/cjf-2025-0010

CODEN RIBAEG ISSN 1330-061X (print)
1848-0586 (online)

sciendo

ASSESSMENT OF WATER QUALITY OF THE GOSTELJA RIVER BASED ON THE COMPOSITION OF MACROZOOBENTHOS COMMUNITIES

Mirnes Brkić, Alen Bajrić*, Isat Skenderović, Edina Hajdarević, Avdul Adrović

University of Tuzla, Faculty of Natural Sciences and Mathematics, Department of Biology, Urfeta Vejzagića 4, 75000, Tuzla, Bosnia and Herzegovina

*Corresponding Author: alenbajra@gmail.com

ARTICLE INFO

Received: 24 December 2024
Accepted: 6 March 2025

Keywords:
Macrozoobenthos
Gostelja
Water quality

ABSTRACT

The collection of macrozoobenthos from the Gostelja River was conducted in May 2022. Sampling was carried out at 7 locations. Through qualitative-quantitative analysis of macrozoobenthos, a total of 19 taxa or 355 individuals belonging to different taxonomic groups such as Mollusca, Turbellaria, Ephemeroptera, Plecoptera, Trichoptera, Diptera, and Odonata were recorded. Based on the conducted research and index calculations, we can conclude that different water quality classes can be observed along the course of the Gostelja River.

How to Cite

Brkić, M., Bajrić, A., Skenderović, I., Hajdarević, E., Adrović, A. (2025): Assessment of water quality of the Gostelja River based on the composition of macrozoobenthos communities. Croatian Journal of Fisheries, 83, 93-98. DOI: 10.2478/cjf-2025-0010.

INTRODUCTION

Water is the most widespread substance in nature, and due to its unique properties, it is essential for sustaining life on earth. Inland waters, which account for only 0.5% of the total volume (1.6 billion km^3), are distributed as surface and groundwater (Simić and Simić, 2009).

Inland waters differ significantly from seas and oceans as they do not form a continuous aquatic expanse but are isolated from each other and distributed across continents as numerous standing and flowing water bodies. Inland waters are of great importance to humans as they are used for drinking, household purposes, and industrial activities. However, only a small portion of freshwater (approximately 0.3%) is available to humans as drinking water (Vučijak et al., 2011).

Due to the global increase in population, industrialization, and urbanization, inland waters are under increasing stress, making these ecosystems some of the most endangered in the world (Dudgeon et al., 2006). All plant and animal species in aquatic ecosystems are grouped into populations, forming higher ecological systems known as biocenoses. Each hydrobiocenosis is characterized by its qualitative and quantitative composition, the temporal and spatial distribution of species, as well as the dynamics of these characteristics.

Zoobenthos is highly diverse. Based on the size of its members, this hydrobiocenosis is divided into microzoobenthos, whose body size is smaller than 62 µm, meiobenthos, whose body size ranges from 62 µm to 0.5 mm, and macrozoobenthos, whose body size exceeds 0.5 mm (Simić and Simić, 2009).

Aquatic ecosystems are in constant biochemical flux, with the intensity of this flux depending on both abiotic and biotic factors, including natural influences from the external environment and anthropogenic factors which predominantly have a negative impact on aquatic ecosystems. Pollution refers to any qualitative and quantitative alteration of the physical, chemical, and biological characteristics of the primary components of the environment, leading to ecosystem degradation (Cvijan and Fužinato, 2000).

With the emergence of pollution in water basins, due to the rapid development of industry and urban settlements, changes occur in the qualitative and quantitative structure of macrozoobenthos, which is otherwise prone to shifts under environmental pressure (Matoničkin and Pavletić, 1972).

Water quality assessment should ideally be based on studying the reactions and adaptations of all aquatic organisms to the existing conditions of the watercourse. However, with the development of water quality assessment methods, the focus has shifted to periphyton, plankton, macrozoobenthos, or fish, as these groups best reflect changes occurring in the water. Among these organisms, macrozoobenthos is most commonly used as a biological indicator in assessing the ecological status of aquatic ecosystems (Hussain and Pandit, 2012).

MATERIALS AND METHODS

The collection of macrozoobenthos from the Gostelja River was conducted in May 2022. Sampling was carried out at seven locations: two sites in the upper course of the water body (streams forming the Gostelja River - L6, L7), four sites in the inhabited area (two above and two below the Đurđevik coal mine - L2, L3, L4, L5), and one site at the confluence of the Gostelja and Oskova rivers (L1). The locations were marked from L1 to L7, starting upstream (Figure 1). During the investigation, 355 individuals were collected, representing 19 species.

The length of the sampled transect was 25 meters and macrozoobenthos sampling was conducted by moving through the water along the transect. At each location, three subsamples were taken, considering different microhabitats. Macrozoobenthos sampling was performed using a Surber net.

As mentioned, the study was conducted at seven sites along the Gostelja River. At all sites, basic geographical parameters (longitude, latitude, and altitude), as well as the physicochemical characteristics of the water (temperature, pH, oxygen saturation, and conductivity), were determined, which is presented in the research results (Table 3).

The collected material was preserved in 96% alcohol and stored in glass containers. The identification of the collected material was carried out using available identification keys (Kerovec, 1986) and included both qualitative and quantitative analyses.

Following the quantitative and qualitative analyses, the data were used to calculate relevant indices and parameters. Data on the structure of macrozoobenthos communities and water quality in the Gostelja River were obtained using Asterix software, in accordance with the Draft Water Management Plan for the Sava River Basin in the Federation of Bosnia and Herzegovina (2022-2027).

Within Asterix software, the following methods were applied to assess water quality and ecosystem status: Saprobic Index (Zelenika and Marvan, 1961), DSFI (group diversity), Simpson's Index, Shannon-Wiener Index, Margalef's Diversity Index, and the Biological Monitoring Working Party (BMWP) scoring system.

RESULTS

The biodiversity of macrozoobenthos in the explored area

A qualitative-quantitative analysis of the macrozoobenthos of the Gostelja River recorded a total of 19 taxa and 355 individuals, belonging to various higher taxonomic groups such as Mollusca, Turbellaria, Ephemeroptera, Plecoptera, Trichoptera, Diptera, and Odonata (Table 1 and 2). The largest number of individuals was collected at sites L6 and L7, with the highest number of identified macrozoobenthos taxa observed at site L6. At site L1, the dominant species were *Tubifex tubifex* and *Baetis* sp.

Table 1. Biodiversity of macrozoobenthos in the study area

Takson	L1	L2	L3	L4	L5	L6	L7
MOLLUSCA							
Physa acuta	6	1	1	1	0	0	0
TURBELARIA							0
Tubifex tubifex	11	6	15	0	0	0	0
Dugesia gonocephala	0	0	0	1	3	4	2
CRUSTACEA				0			
Gammarus sp.	0	0	0	2	3	4	6
EPHEMEROPTERA							
Heptagenia sp.	2	3	4	0	0	0	0
Baetis sp.	25	16	9	0	0	0	0
Caenis sp.	0	16	6	2	0	0	0
Ephemerella sp.	0	0	0	4	0	2	4
PLECOPTERA							
Nemoura sp.	0	0	0	0	0	0	0
Protonemura meyeri	0	0	0	0	0	2	3
Brachyptera risi	0	0	0	0	1	3	2
Leuctra sp.	0	6	0	0	0	2	0
TRICHOPTERA							
Hydropsyche sp.	0	1	2	2	4	8	6
Potamophylax latipennis	0	0	0	0	0	19	54
Philopotamus montanus	0	0	0	0	4	9	1
Glossosoma boltoni	0	0	0	6	4	9	2
Limnephilus lunatus	0	0	0	6	5	9	9
DIPTERA							
Pedicia sp.	0	15	0	0	0	0	0
ODONATA							
Gomphus vulatissimus	0	0	0	0	2	0	0
Total number of individuals	44	65	37	24	26	71	89
Total species	4	8	6	8	8	11	10

Table 2. Ecological status of the studied sites based on the established macrozoobenthic communities

Index	L1	L2	L3	L4	L5	L6	L7
Saprobic Index (Zelenika and Marvan, 1961)	2.756	2.255	2.837	1.69	1.395	1.269	1.293
ASPT- Average Score Per Taxon	5.5	5.714	5	6.33	7.33	7.167	6.6
BMWP- Biological Monitoring Working Party scoring system	22	37	27	44	59	65	55
DSFI – Diversity Groups of the Saprobic Functional Index	0	0	0	1	1	1	4
IBE Aqem- AQEM assessment system	4	5.4	5.4	5	5	5	5
BBI Index – Biotic Biotic Index	6	7	6	6	5	6	6
Simpson's Diversity Index	0.695	0.806	0.761	0.816	0.861	0.819	0.501
Shannon-Wiener Index	1.259	1.696	1.49	1.617	1.756	1.773	1.048
Margalef's Diversity Index	0.752	1.448	1.365	1.669	1.618	1.478	1.148
Number of sensitive taxa	1	1	1	1	3	4	3
Taxa attached to rocks	0	0	0	0	33	18	10
Class of water quality	III	II	III	I	I	I	I

At site L2, a notable presence of the species *Pedicia* sp. was recorded, which was only observed at this location. Site L3 was characterized by the dominance of *Tubifex tubifex*. The headwater sites of the Gostelja River (L6 and L7) were dominated by the species *Patamophylax latipennis*. The most abundant species at sites L4 and L5 (the middle course of the Gostelja River) was *Limnephilus lunatus*. The results of the physicochemical measurements are presented in the table (Table 3).

Assessment of the ecological status of the Gostelja River

Based on the conducted research and the calculation of indices, we can conclude that various classes of water quality are observed along the course of the Gostelja River, which undoubtedly depend on anthropogenic influences and the determined physicochemical parameters of the water (Figure 1). The lower reaches of this river are much more affected by anthropogenic factors, particularly pollution.

Table 3. Physicochemical characteristics of the water

Parameters	L1	L2	L3	L4	L5	L6	L7
pH	8.13	8.2	9	9.5	8.17	8	8
Temperature	17.5 °C	18 °C	18 °C	16.2 °C	15.4 °C	14.6 °C	14 °C
Oxygen Saturation	108.1% (10.45 mg/l)	106% (10.09 mg/l)	101% (10 mg/l)	103% (9.5 mg/l)	102% (9.92 mg/l)	103% (9.7 mg/l)	102% (9.8 mg/l)
Electrical Conductivity	404 mS/cm	324 mS/cm	328 mS/cm	254 mS/cm	237 mS/cm	223 mS/cm	217 mS/cm
Pressure	223 mBar	219 mBar	215 mBar	215 mBar	203 mBar	201 mBar	200 mBar

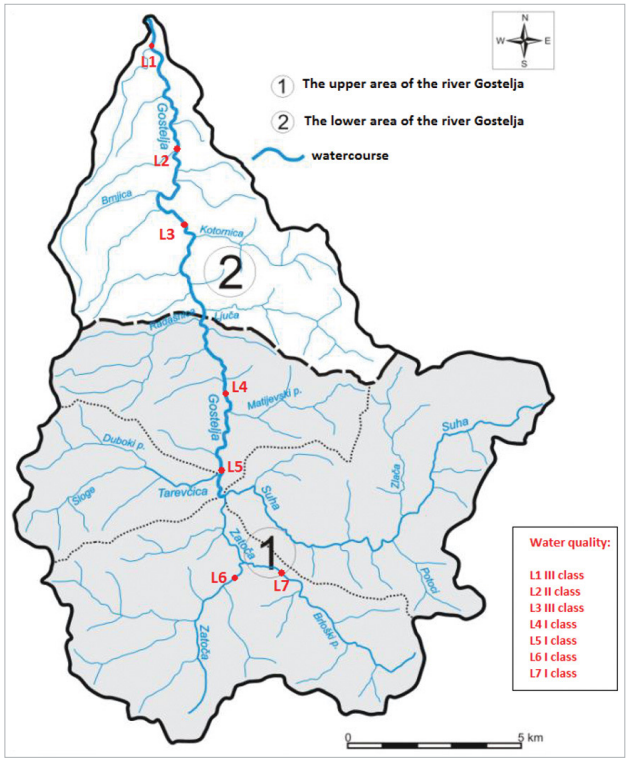

Fig 1. Water quality in the investigated localities (Modified from Ahmetbegović et al., 2016)

DISCUSSION

Based on the results of the physicochemical parameters, we can conclude that the Gostelja River is a typical mountain river, exhibiting all the characteristics common to small rivers with low levels of organic pollution in the upper reaches, and an increase in organic pollution due to human activities in its lower reaches and at the river's mouth.

The conducted research revealed that the composition of macrozoobenthos communities varies across the studied sites, which is linked to the ecological factors prevailing in the area. Additionally, the quality of water was determined based on macrozoobenthos communities, indicating that the water quality differs at various sites.

Ahmetbegović et al. (2016) also observed a distinct change in the longitudinal profile of the macrozoobenthos samples in the Gostelja River area, noting this conclusion through the synthesis of data from multiple studies conducted during their geoecological evaluation of the region. The mentioned authors also concluded that the lowest number of collected individuals was found at the site in Đurđevik, which aligns with our findings; this can be attributed to the proximity of the mine and its facilities, which impact the biota of the area, including macrozoobenthos communities.

Adrović et al. (2017) recorded 14 taxa in the Gostelja River and analyzed 165 individuals of macrozoobenthos, concluding that the conditions for life in this stream are relatively favorable. The aforementioned authors identified the highest number of individuals in the middle reaches and the lowest in the lower reaches of the river.

Comparing four sources based on the composition and density of macrozoobenthos, it was observed that a higher density and diversity of macrozoobenthos communities were present at sources with a constant surface flow compared to a source whose flow dries up during the summer months. At these sources, the dominant group was Amphipoda, followed by Coleoptera, Plecoptera larvae, Ephemeroptera larvae, Chironomidae larvae, and Gastropoda (Grbavac, 2015).

The worst water quality was recorded at sites L1 and L3 (Class III). Site L1 is located at the mouth of the Gostelja River and is most heavily influenced by anthropogenic factors due to its placement in a densely populated area. Moving upstream to site L2, we observed slightly better water quality (Class II). Site L3 is situated in Đurđevik, where the water quality corresponds to Class III. This site is located adjacent to the area exploited by the mine, indicating that this form of anthropogenic influence negatively affects water quality. Sites L4-L7 belong to Class I water quality, which is to be expected since the upper reaches of the Gostelja River have significantly fewer settlements, and the structures are generally located further from the riverbed, unlike the lower reaches where numerous residential and other structures are found along the banks.

According to Liebmann (1962), the water quality in the Radobolja and Lištica rivers in July is oligohumic, classifying it as Category I waters, i.e. unburdened or very lightly burdened waters, while in October, the water quality, according to Liebmann (1962), belongs to waters of Categories I-II, indicating oligohumic to beta-mesohumic waters, which denotes lightly burdened waters (Milić, 2020).

Literature data regarding this area also confirm that the upper reaches of the Gostelja River are characterized by typical and preserved geodiversity, representing a region with a relatively intact natural foundation, although there is a negative anthropogenic influence that threatens to reduce environmental quality (Ahmetbegović et al., 2016). These changes in the natural environment of the upper reaches of the Gostelja River are caused by direct anthropogenic impacts, primarily related to alterations resulting from the exploitation of mineral resources, forest resources, and the expansion of agricultural land and settlements.

Similar research results for the Gostelja River have also been recorded in earlier studies (Brkić, 2015). The highest biodiversity and presence of sensitive taxa were identified in the upper reaches of the river in the aforementioned study. The calculated biotic indices in our research indicated significantly better water quality in the lower reaches of the river than was determined in the 2015 study. Additionally, a higher number of taxa and generally richer diversity were observed at the studied sites.

CONCLUSION

The conducted research on the Gostelja River revealed differences in the composition and structure of macrozoobenthos communities across various segments of its flow. A total of 355 individuals of macrozoobenthos were analyzed, representing 19 taxonomic species.

The poorest water quality was observed at sites L1 and L3 (Class III). At site L2, we noted slightly better water quality (Class II). Sites L4 to L7 were classified as Class I water quality.

Based on the quantitative and qualitative composition of macrozoobenthos in the Gostelja River, we can conclude that the ecological status of the river is fairly good. Sites L1 and L3 belong to Class III quality, while site L2 falls under Class II quality. In contrast, all indicators at sites L4, L5, L6, and L7 indicate Class I water quality.

In the upper reaches of the Gostelja River, a moderate anthropogenic impact on the ecosystem was recorded, whereas the anthropogenic influence is significantly more intense in its lower reaches due to the size of the inhabited areas and the proximity to mines, as well as other industrial and craft activities. These factors undoubtedly affect the composition of macrozoobenthos communities and the overall ecological condition of the river.

PROCJENA KVALITETE VODE RIJEKE GOSTELJE NA OSNOVU SASTAVA ZAJEDNICA MAKROZOOBENTOSA

SAŽETAK

Uzorkovanje makrozoobentosa rijeke Gostelje provedeno je tijekom svibnja 2022. godine. Uzorkovanje je provedeno na 7 lokacija. Kvalitativno-kvantitativnom analizom makrozoobentosa rijeke Gostelje zabilježeno je ukupno 19 vrsta, odnosno 355 jedinki koje pripadaju različitim taksonomskim grupama kao što su Mollusca, Turbellaria, Ephemeroptera, Plecoptera, Trichoptera, Diptera i Odonata. Na osnovi provedenog istraživanja i izračunavanja indeksa, možemo zaključiti da se u istraživanom dijelu toka rijeke Gostelje uočava različita kvaliteta vode.

Ključne riječi: makrozoobentos, Gostelja, kvaliteta vode

REFERENCES

Adrović, A., Skenderović, I., Bajrić, A., Brkić, M., Adrović, R. (2017). Saprobiological Application Methods in the Evaluation of Water Quality of the Gostelja River. Tokovi. Journal for Scientific, Literary, and Social Issues, Berane, No. 1/2017, 84-95.

Ahmetbegović, S., Adrović, A., Babajić, E., Gutić, S., Stjepić Srkalović, Ž. (2012). Geoecological Evaluation of the Natural Basis of the Upper Gostelja River Basin. Acta Geographica Bosniae et Herzegovinae, 2016, 6, 81-92.

Brkić, M. (2015): Research on the macrozoobenthos of the river Gostelje. Graduation thesis. University of Tuzla. Faculty of Science and Mathematics. Tuzla

Cvijan, M., Fužinato, S. (2000). Ecology of Algae. Faculty of Biology, University of Belgrade.

Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z. I., Knowler, D. J., Lévêque, C., Naiman, R. J., Prieur-Richard, A.-H., Soto, D., Stiassny, M. L. J., Sullivan, C. A. (2006). Freshwater biodiversity: importance, threats, status, and conservation challenges. Biological Reviews, 81, 163-182.

Grbavac, F. (2015). Macrozoobenthos of Permanent and Temporary Karst Springs, Master's Thesis, University of Zagreb, Zagreb.

Hussain, Q. A., Pandit, A. K. (2012). Macroinvertebrates in Streams: A Review of Some Ecological Factors. International Journal of Fisheries and Aquaculture, 4, 114-123.

Kerovec, M. (1986). Handbook for Identifying Invertebrates in Our Streams and Rivers. University Publishing House Liber, Zagreb.

Liebman, H. (1962). Handbook of Freshwater and Wastewater Biology. Vol II. Oldenbourg, Munich.

Matoničkin, I., Pavletić, Z. (1972). The Life of Our Rivers: Biology of Running Waters. Školska knjiga, Zagreb.

Simić, V., Simić, S. (2009). Ecology of Freshwater (Hydrobiology I). Faculty of Natural Sciences and Mathematics, University of Kragujevac; Faculty of Biology, University of Belgrade, Kragujevac; Belgrade.

Vučijak, B., Ćerić, A., Silajdžić, I., Midžić Kurtagić, S. (2011). Water for Life: Fundamentals of Integrated Water Resources Management. Institute of Hydrotechnics, Faculty of Civil Engineering, Sarajevo.

Zelinka, M. Marvan, P., (1961): Zur Präzisierung der biologischer Klassifikation der Reinhert flissender Gewässer. Arch. Hydrobiol., 57: 389−407.