DETERMINATION OF THE ECOLOGICAL STATE OF BRIHENI WATER BODY → BRIHENI SOURCE-CONFLUENCE + TRIBUTARIES BASED ON THE BIOLOGICAL ELEMENTS

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Abstract

The purpose of this research is to determine the ecological status of Briheni water body→ Briheni source - confluence + tributaries having RW3.1.42.3_B2 code based on biologic elements. For surface waters, the biological elements to be taken into account are: aquatic flora – phytoplankton, phytobenthos and macrophytes(composition and abundance), composition and abundance of benthic invertebrate fauna (macrozoobenthos); fish fauna (composition, abundance and age structure). For this reason, in August 2013 water samples were collected from a reference section of the water body. The interpretation of the obtained data following the analysis of samples led to the conclusion that the ecological status of the water body is good.

Key words: hydrogeoecosystem, protected natural area, bioindicators

INTRODUCTION

Currently, in Romania, surface waters are assessed in accordance with the provisions of Order 161/2006, which carries the legal classification for all surface waters from an ecological and chemical point of view.

The surface water quality is defined as the conventional assembly of physical, chemical, biological and bacteriological characteristics expressed in terms of value that allow its inclusion in a particular category, thus gaining the feature to serve a particular purpose.(Gâstescu ,2009, Brezeanu, 2002)

For surface water, the ecological status is determined on the basis of biological, microbiological, physico-chemical quality elements and specific pollutants.(Giurma, 2006, Vicaş, 2010)

Ecological status represents the structure and functioning of aquatic ecosystems, as defined in accordance with Annex V of the Water Framework Directive, through the *biological quality elements, hydromorphological and general physico-chemical elements* with support function for the biological ones as well as through *specific pollutants (synthetic and non-synthetic).* (Mănescu, 1994, Mintaş, 2010)

The characterization of ecological status in accordance with the requirements of the *Water Framework Directive* is based on a classification system of five classes, namely: very good, good, moderate, poor and bad defined and represented as follows:

- **very good condition** is characterized by values of biological, hydromorphological and physico-chemical elements of the surface water associated with the unaltered areas (reference) or with minor anthropogenic alterations
- **good condition** is recorded when the values of the general biological and physicochemical elements are characterized by mild deviations from the values

characteristic to the unaltered areas (reference) or with minor anthropogenic alterations;

- **moderate condition** is recorded when the values of the biological elements for surface waters deviate moderately from the characteristic values of the unaltered areas (reference) or with minor anthropogenic alterations
- **poor condition** is caused by major alterations of the biological elements; relevant biological communities differ substantially from those normally associated with the unaltered conditions from the reference areas or with minor anthropogenic alterations;
- **bad condition** is determined when there are severe alterations of the biological elements, a large number of relevant biological communities being absent from those present in the unaltered areas (reference) or with minor anthropogenic alterations.

This approach is based on the principle according to which the *biological elements* are the integrator of all types of pressure, being thus taken into account in defining the five quality classes. (Pârvu , 2001)

MATERIAL AND METHODS

In assessing the ecological status, the prevailing quality elements are the biological ones(Dalea, 2003).For surface waters, the biological elements to be taken into account are:

a. aquatic flora – phytoplankton, phytobenthos and macrophytes (composition and abundance); (Gavrilescu, 2008)
b. composition and abundance of benthic invertebrate fauna (macrozoobenthos);
c. fish fauna (composition, abundance and age structure);

a)For the lotic aquatic systems (rivers), the aquatic flora assessment was performed by integrating the following *five quality indices* in the multimetric phytoplankton index: (Mălăcea,I.,1969)

- Saprobic index (SI) calculated by the method of Pantle - Buck (1955) as amended:,

  $S=\Sigma(s_i x h_i)/ \Sigma h_i \quad i=1,n$

  n = maximum number of identified taxa
  s = value characteristic to belonging to the saprobic area;
  h = absolute numerical abundance of the individuals of a particular taxon,
  i = taxon;
- Index of chlorophyll "a" (IC)
- Simpson diversity index (IDS) is the diversity of phytoplankton

  For the calculation of phytoplankton diversity the Simpson diversity index is proposed by using the formula described below:

$$D = 1 - \sum_{i=1}^{s} (p_i)^2$$

  where ,pi = ratio species „i" in community s= total number of species
- Index for taxa number (INT);

  Relative numerical abundance index is the ratio of the individuals number belonging to a species or group with respect to the total number of individuals of all species in that sample (IANR);

For each index, the *Ecological Quality Reports* (RCE) are calculated based on the value obtained and guide value for the corresponding reference condition. The lower value is always divided to higher value to meet a subunit ratio.

b) Assessment of the status / ecological potential of water bodies based on benthic invertebrates (macrozoobenthos) analyzed for anthropogenic rivers and lakes. (Botnariuc, 1999)

The assessment of the status / ecological potential of water bodies based on macrozoobenthos is performed by using multimetric index (MI) characteristic to invertebrates, which involves determination in advance of the values of the next seven indices: (Varduca , 2000)

1. Saprobic index (SI), calculated by using the formula:

$S=\Sigma(s_i x h_i)/ \Sigma h_i$ i=1,n n = maximum number of identified taxa
where s = value of biomarker taxa and h = absolute frequency,
i = index assigned to taxa from the sample.

2. Shannon-Wiener diversity index (ISH), calculated by using the formula:

$H =- \Sigma_i P_i x \ln P_i$, where s = number of species, Pi = number of individuals of species "i" in relation to the total number of individuals in the sample.

3. EPT_I Index - represented by the number of individuals in groups *Ephemeroptera-Plecoptera-Trichoptera* insects relative to the total number of individuals in the sample.

4. The *index* that represents the *number of families* belonging to the taxa identified in the sample (FAM).

Families belonging to the taxa identified in the sample are counted.

5. *Index OCH / O* which represents the ratio between the number of individuals in groups Oligochaeta-Chironomidae and the total number of individuals in the sample.

The ratio of the number of individuals in Oligochaeta- Chironomidae groups to the total number of individuals in the sample.

IOCH Index becomes IO for the streams in the mountain and hill areas and highlands (type: RO01,) and is calculated only on oligochaetes.

6. *Index of functional groups* (*feeding mode*) calculated by the ratio between the number of scraper, scrape-collectors and shredders (broken) individuals and number of individuals of all the trophic functional groups in each sample (IGF).

The ratio of the number of individuals among scraper, scrape- collectors and shredders (broken) ones by the number of individuals of all the trophic functional groups in each sample.

7. *Index of water flow*: *rheophilic (fast flow) and limnophilic (slow flow)* is the ratio between the number of individuals belonging to rheophilic or limnophilic forms and the total number of individuals in the sample.

In the calculation of rheophilic forms, some groups appearing as rheophilic-limnophilic enter.

Their share in the multimetric index (MI) depended on their importance within the invertebrate communities.

IM=0.3IS+0.2ISH+0.1IEPT_I+0.1FAM+0.1IOCH+0.1IGF+0.1REO/LIM

c) Assessment of the ecological status / potential of water bodies based on fish fauna (composition, abundance and age structure)

Evaluation of water bodies based on fish fauna was performed by using the method EFI (http://efi-plus.boku.ac.at/software / insert_data. Php) that were based on the following parameters:

- relative density of intolerant individuals with a size of less than 150 mm, the relative density of intolerant species to the reduction of dissolved oxygen (for bodies of salmonid waters);
- relative abundance of generative rheophilic species (requiring lotic type habitat for reproduction), relative density of litophilic species (for cyprinid water bodies).

RESULTS AND DISCUSSION

I) Evaluation of the water system quality based on phytoplankton

Phytoplankton samples were collected in August 2013, and the recorded average density was 14 individuals / l. (Momeu L,2011),(Neagu. A.,2008)

There have been identified:

- Bacillariophyta: Diatoma vulgar-3 s = 1.85, Synedra ulna-2 = 1.95, Pinnularia viridis-1 s = 2.1; Melosira varians-2 s = 2.85 s = 0.65 meridional circulation 3 , Tabellaria flocculose 1 s = 0.6, Asterionella gracillina 1 s = 1.2
- Clorophiceae: Cladophora glomerata-1 s = 1.65

a)Saprobic index

S=(3*1.85+2*1.95+1*2.1+2*1.85+3*0.65+1*0.6+1*1.2+1*1.65)/12

S=(5.55+3.9+2.1+3.7+1.95+0.6+1.2+1.65)/14

S=1.48

b)Simpson diversity index

D=1-(0.25*0.25+0.17*0.17+0.08*0.08+0.17*0.17+0.25*0.25+
0.08*0.08+0.08*0.08+0.08*0.08)=1-0.208

D=0.79

c) “taxa number” index

Number of taxa encountered in the analysed section is I = 8

d) Calculated relative numerical abundance index is shown in Table 1

Table 1

Relative numerical abundance index

Month	Group		
	Bacillariophyta	Clorophiceae	Euglenophyta
	93 %	7%	

For the selected indices, a weighting of their importance was proposed for phytoplankton community and to assess the ecological status, as it follows:

- saprobic index	30%
- Simpson diversity index	30%
- "taxa number" index	20%
- relative numerical abundance index	20%

The multimetric phytoplankton index is:

IM=0.3x0.67+0.3x0.86+0.2x0.28+0.2x0.93

IM=0.20+0.26+0.056+0.186

IM=0.702

II) Evaluation of quality state based on benthic macroinvertebrates

Samples were collected in August; the average density recorded was of 76 individuals / l: The identified species are shown in Table 2. (Godeanu, S.,2002, Grossu , A. V.,1993, Lothar K.,1980, Papadopol M.,1978, Petrovici M,2009)

Table 2

Identified species of benthic macroinvertebrates

Crt. no	Identified species	s	No of individuals	Mode of feeding	Ecologic type	Order	Percent	Saprobic index	EPT_Index	Diversity index
1	Perla bipunctata	1	3	predators	reofil	Plecoptera	0.04	0.04		-0.13
2	Perla marginata	1	1	predators	reofil	Plecoptera	0.01	0,01		-0.06
3	Tipula spp.	2	4	shredders		Diptera	0.05	0.11		-0.15
4	Atherix ibis	1	5	Predators	reofil	Diptera	0.06	0.06		-0.18
5	Chironomus cingulatus	3	7	scraper, scrape-collectors	reofil-limnofil	Diptera	0.09	0.24		-0.22
6	Echyonurus torrentis	1	17	scraper, scrape-collectors	reofil	Ephemeroptera	0.22	0.26		-0.33
7	Siphlonurus aestivalis	2	7	scrape-collectors		Ephemeroptera	0.09	0.18		-0.22
8	Hygrobates calliger	1	1	predators	reofil	Hygrobatidae	0.01	0.02		-0.06
9	Stylaria lacustris	2	8	herbivors		Oligochaeta	0.10	0.24		-0.23
10	Agapetus laniger	2	14	scraper, scrape-collectors	reofil	Trichoptera	0.18	0.27		-0.31
11	Phryganea grandis	2	9	shredders		Trichoptera	0.12	0.17		-0.25

a)Saprobic index

S=1.61

b)EPT_I Index

Numărul indivizilor din grupele de Ephemeroptera-Plecoptera-Trichoptera raportat la numărul total de indivizi din probă.

b) EPT_I index

The number of individuals in groups of Ephemeroptera-Plecoptera-Trichoptera with respect to the total number of individuals in the sample.

I_{EPT_I}=65.49 %

c)Shannon-Wiener diversity index

H =2.13

d)Number of families

NRF=10

e) OCH/O index

IO=11.84 %

f) Functional group index (mode of feeding)

IGF=76.32%

g) Water-rheophilic flow preference index (fast flow)

IPCAR=63.16%

Table 3

IM determination by comparing with the reference value of the calculated indices

	Reference value	Calculated value	Share	Multimetric index
Saprobe index	1.20	1.61	30.00	0.22
Index EPT_I	80.00	65.49	10.00	0.08
Index of diversity	2.30	2.13	20.00	0.09
Index OC	10.00	11.84	10.00	0.08
Family number index	20.00	10.00	10.00	0.05
Functional group index	90.00	76.32	10.00	0.08
Water-rheophilic flow preference index	90.00	63.16	10.00	0.07
IM				0.69

III) Evaluation of quality state based on fish fauna

The assessment and classification of water bodies based on fish fauna was performed by using the method EFI +.

Table 4

Assessment and classification of water bodies based on fish fauna

Variable	**Features, measurement units**
Site Code	NA
Longitude	561728.760
Latitude	298859.965
Day	17
Month	August
Year	2013
Country	RO
River Name	Crișul Varatecului
Site Name	Captare MHC
Altitude	406 m
Ecoregion	The Carpathians
Mediterranean Type	No
River Region	Danube
Method:	Wading
Fished Area	100 mp
Wetted Width	3-4 m
Flow Regime,	permanent
Natural Lake Upstream: yes, no	No
Geomorphology:	Sinuous
Former Flood Plain: yes, no	No
Water Source:	nival, pluvial
Upstream Drainage Area, kmp	3 kmp

Distance from Source	4 km
River Slope,	3.2 %
Air temperature	21 º C
Mean Annual	7.7 º C
Air temperature January	-1.3 º C
Air temperature July	19.4 º C
Former Sediment Size:	Gravel, Boulder
Sampling Location,	Mountain river
Species Name	Salmo trutta
Total number run1	3
Number Length Below 150	2
Number Length Over 150	1

Obs.dens.LITH	2.243254
Exp.dens.HINTOL.inf150	2.532693
Exp.dens.O2INTOL	0.784838
Exp.ric.RH.PAR	2.47982
Exp.dens.LITH	0.779206
Ids.dens.HINTOL.inf.150	0.898988
Ids.dens.O2INTOL	0.895508
Ids.ric.RH.PAR	0.777477
Ids.dens.LITH	0.839097
Aggregated.score.Salmonid.zone	0.839097
Aggregated.score.Cyprinid.zone	0.836493
FishIndex	0.839097
FishIndex.class	2

The results indicate the water type, namelu quality class 2 type salmonids-good state.

CONCLUSIONS

Based on the analyzed biological elements, it can be concluded that the ecologic condition of the water body *Briheni water body→ Briheni source - confluence + tributaries* with code Briheni RW3.1.42.3_B2 is good.

Although the biological elements are considered the integrator of all types of pressure, in assessing the ecological status, the analysis of some support elements is needed, consisting of: general physico-chemical indices, specific pollutants and hydromorphologic elements. These items will be the subject of the following studies.

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