Biotechnology & Biotechnological Equipment

ISSN: 1310-2818 (Print) 1314-3530 (Online) Journal homepage: https://www.tandfonline.com/loi/tbeq20

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To cite this article: S. Cheshmedjiev, D. Belkinova, R. Mladenov, I. Dimitrova-Dyulgerova & G. Gecheva (2010) Phytoplankton Based Assessment of the Ecological Status and Ecological Potential of Lake Types in Bulgaria, Biotechnology & Biotechnological Equipment, 24:sup1, 14-25, DOI: 10.1080/13102818.2010.10817803

To link to this article: https://doi.org/10.1080/13102818.2010.10817803

Published online: 15 Apr 2014.

PHYTOPLANKTON BASED ASSESSMENT OF THE ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL OF LAKE TYPES IN BULGARIA

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ABSTRACT

Research has been carried out of the main characteristics of phytoplankton communities in order to assess the ecological status and ecological potential of the types of lakes in Bulgaria, according to the requirements of WFD 2000/60/EC. Eighty lakes/reservoirs have been researched on the territory of the Republic of Bulgaria. The assessment was made on the basis of four main metrics (phytoplankton biovolume; Algae Groups Index; transparency, chlorophyll a) and three additional metrics (% Cyanobacteria; intensity of algal "bloom" and presence of toxic species). More than half of the researched lakes in Bulgaria are in compliance with the WFD requirements for good ecological state (high and good ecological status, maximum and good potential). A classification system for assessment of ecological status or potential has been developed using above-mentioned phytoplankton metrics. The existing 17 types of lake in Bulgaria are classified in two main groups: oligotrophic lake types and mesotrophic lake types.

Keywords: Bulgaria**,** ecological status, ecological potential, lake, phytoplankton, Water Framework Directive

Abbreviations used: AGI - Algae Group Index, BEQ - biological element of quality, BSRBD - Black Sea river basin district, DRBD - Danube river basin district, EARBD-East Aegean river basin district, EP - ecological potential, ES – ecological status, EQR - ecological quality ratio, Ph – phytoplankton, WARBD-West Aegean river basin district, WB – water body, WFD - EU Water Framework Directive 2000/60/EC

Introduction

Phytoplankton is regarded as the most important of the biological quality elements for the assessment of ecological status or potential of lakes and reservoirs **(7**). Its ecological significance is determined by the fact that its productivity indicators are also indicators of the trophic status of water bodies (15).

Comparative studies of the structural parameters and quantitative characteristics of phytoplankton are limited for Bulgarian lakes and reservoirs. Some of them are research on the Srebarna Lake (10), on some lakes of the Black Sea Bulgarian coast (8, 11, 12), on high mountain lakes in the Rila Mountains (2, 9) and on some reservoirs (1, 3, 14). The survey of available data showed that the level of research on the phytoplankton in Bulgarian stagnant waters is unsatisfactory from the perspective of the WFD.

The present research of the main phytoplankton characteristics was carried out in accordance with existing international standards (ISO, CEN) and aims to assess the ecological status and ecological potential of the types of lakes in Bulgaria, according to the requirements of WFD (**7**). It is part of the research carried out in the country under EU-funded projects: "Determination of reference conditions and maximum ecological potential for the types of surface waters (rivers and lakes) on the territory of the Republic of Bulgaria" and "Development of a classification system for assessing the ecological status and ecological potential of the determined types of surface waters (rivers and lakes) on the territory of the Republic of Bulgaria (on the basis of a system "B" typology)".

Materials and Methods

There are four river basin districts for water management in Bulgaria as follows: the Danube RBD, the Black Sea RBD, the East Aegean RBD and the West Aegean RBD. Eighty lakes/reservoirs, located in these districts were the object of research work. In their selection attention was focused on existing stations under the Bulgarian surveilance monitoring programme, but additional stations were also added to cover more lake types or potential reference conditions. Sampling was done once from all stations during the summer season (July-September) of 2009.

Basic international standards were used in the sampling and analysis of phytoplankton related metrics (ISO 10260:1992, ISO 5667-3:2003, ISO 5667-1:2006, EN 15204:2006).

The assessment was made on the basis of 4 main and 3 additional metrics as follows:

Main metrics: total phytoplankton biovolume (mm^3/l); Algae Group Index (AGI, Catálan Index); transparency according to Secchi (m) and chlorophyll *a* (µg/l);

Additional metrics: % Cyanobacteria (towards total biovolume); presence of "bloom" and toxic species (*Anabaena, Microcystis, Aphanizomenon* and others).

Express taxonomic analysis was applied in determining the common phytoplankton groups (EN 15204:2006 - Utermöhl technique). The level of taxonomic determination has been consistent with the groups included in the algal group index or Catalán Index (4). The determination of biovolume (biomass) was carried out by means of Utermöhl (EN 15204:2006), using inverted microscopy. The total phytoplankton biovolume in each sample was determined after summing up the biovolumes of all taxa. The Algae Group Index (AGI, Catálan Index) was calculated for each sample by the relevant formula (4).

The intensity of the phytoplankton 'bloom' has been assessed on the basis of total biovolume (mm^3/l) on a 5-degree scale: I degree $\leq$ 2.5 mm^3/l; II degree $\approx$ 2.5 ÷ 10 mm^3/l; III degree $\approx$ 10 ÷ 500 mm^3/l; IV degree $\approx$ 500 ÷ 5000 mm^3/l; V degree („hyperbloom") > 5000 mm^3/l. In calculating % Cyanobacteria, some species/genus for oligotrophic waters have been excluded, focusing on toxic species and eutrophic indicators.

Two different scales for the basic metrics (**Table 1, 2**) have been used in the ecological assessment and interpretation of phytoplankton data, modified for the relevant types of lakes/reservoirs in Bulgaria. The scales according to Cardoso (5, 6) are presented in **Table 1** and **Table 2.**

It is assumed that for phytoplankton the referent conditions and the Maximum EP are the same, because of the relevant independence of this BEQ from the hydro-morphological modifications of the lakes (WFD-CIS Guidance Document No. 14: Guidance on the intercalibration process 2008-2011, 03 Dec 2009).

Results and Discussion

Danube river basin district (DRBD)

Forty-two target lakes were researched in the DRBD, representing actually all types of 'lakes' in the region. Of them 41 are reservoirs (heavily modified or artificial WB) and one – a natural lake (Srebarna Lake). The Rabisha reservoir was built on the basis of the former Rabisha Lake and is, by origin, a highly modified WB 'lake' type. All the remaining reservoirs are essentially highly modified WB 'river' types (i.e. modified rivers) or, more rarely, totally artificial WB (Res. Asparuhov val, Res. Kovachitsa, etc.).

The initial assessment of phytoplankton data showed that for this BEQ 12 reservoirs fall into the Maximum EP category and 7 have conditions close to Maximum EP (**Table 3, Table 4, Fig. 1**). Lake Srebarna is assumed to be a weakly modified WB and close to referent conditions. Two reservoirs have been drained to dry conditions - Res. Karaissen and Res. Ladzhenska bara (not included in the ecological assessment). The ecological potential of the remaining 20 reservoirs in the DR was not good (moderate, poor or bad) (**Table 3, Table 4, Fig. 2**).

Fig. 1. Reservoir Yovkovtsi – MEP according to phytoplankton (Photo: S. Cheshmedjiev)

TABLE 1

Oligotrophic type of lakes (L1, L2, L3, L11, L12, L13) – classification system for ecological status/potential according to phytoplankton

EQR (AGI)	AGI (Catalan Index)	Total biovolume, mm^3/l	Chl a, µg/l	Transparensy,m	% Cyano bacteria	"Bloom" toxic species	"Bloom" (intensity)
>0.998	<0.9	<1	<4	>4	<4	no	÷
0.995÷0.998	0.9÷2	1÷5	4÷10	2÷4	4÷15	no	÷
0.975÷0.995	2÷10	5÷8	10÷15	1,5÷2	15÷20	no	I
0.95÷0.975	10÷20	8÷10	15÷50	1÷1.5	>20	yes	II÷III
<0.95	>20	>10	>50	<1	>50	yes	III÷V

TABLE 2

Mesotrophic type "lakes" (L4, L5, L6, L7, L8, L9, L10, L14, L15, L16, L17) – classification system for ecological status/potential according to phytoplankton

EQR (AGI)	AGI (Catalan Index)	Total biovolume, mm^3/l	Chl a, µg/l	Transparensy,m	% Cyano bacteria	"Bloom" toxic species	"Bloom" (intensity)
<0.998	<1	<1.5	<4	>4	<4	no	÷
0.994÷0.998	1÷2.5	1.5÷7	4÷10	2÷4	4÷15	no	I
0.975÷0.994	2.5÷10	7÷15	10÷20	1÷2	15÷20	yes	II
0.95÷0.975	10÷20	15÷25	20÷50	0.5÷1	>20	yes	III
<0.95	>20	>25	>50	<0.5	>50	yes	IV÷V

TABLE 3

Allocation of the studied "lakes" by EP/ES in Danube RBD

Status/Potential	High/Maximum	Good	Moderate	Poor	Bad	Drained
%	30,9	16,7	26,2	14,3	7,1	4,8
Number	13	7	11	6	3	2

TABLE 4

Ecological potential and ecological status of Danube RBD's lakes according to phytoplankton

№	Name	Type	AGI (Catalan Index)	EQR (AGI)	% Cyano bacteria	Biovolume (mm3/l)	Algal bloom (degree)	Transparensy (m)	Chl *a*, (µg/l)	Status/ potential	Toxic species, presence
1	Res. Yarlovtsi	L2	0.83	0.998	0.00	0.30	no	2.3	0.61	Maximum ?	No
2	Res. Kula	L12	3.55	0.991	41.30	1.57	no	0.95	3.28	Moderate	Yes

№	Name	Type	AGI (Catalan Index)	EQR (AGI)	% Cyano bacteria	Biovolume (mm3/l)	Algal bloom (degree)	Transparensy (m)	Chl *a*, (µg/l)	Status/ potential	Toxic species, presence
3	Res. Poletkovtsi	L12	1.04	0.998	0.00	0.08	no	1	<0.2	Maximum	No
4	Res. Rabisha	L4	1.15	0.997	26.52	0.13	no	3.2	0.92	Good	Yes
5	Res. Drenovets	L16	4.78	0.988	74.54	1.65	no	0.7	3.51	Poor	Yes
6	Res. Hr. Smirnenski	L16	1.06	0.998	10.24	1.66	I Chloro	0.8	4,26	Good	Yes
7	Res. Rasovo	L16	4.31	0.989	18.58	10.87	II Chloro	0.3	19.77	Moderate	Yes
8	Res. Kovachitsa	L16	7.17	0.982	50.22	7.14	I Dino	0.7	12.31	Moderate	Yes
9	Res. Ogosta	L14	1.29	0.997	17.86	0.97	no	4	2.17	Good	Yes
10	Res. Srechenska bara	L2	0.40	0.999	0.00	1.01	no	4.5	1.34	Maximum	No
11	Res. Dabnika	L16	5.41	0.987	11.71	4.76	I Zygn	1	8.98	Moderate	Yes
12	Res. Tri kladentsi	L16	2.79	0.993	9.07	10.14	II Chloro	0.4	24.73	Moderate	Yes
13	Res. Barsina	L16	2.23	0.995	10.19	11.29	II Eugl	0.55	19.47	Moderate	Yes
14	Res. Asparuhoval	L16	0.03	1.000	0.01	23.82	III Dino	0.9	45.46	Poor	Yes
15	Res. Beli Iskar	L1	0.57	0.999	0.00	0.76	no	6.5	1.15	Maximum	No
16	Res. Iskar	L11	1.43	0.997	0.00	1.20	no	5.5	1.99	Maximum	No
17	Res.Pancharevo	L12	14.91	0.963	0.05	9.71	II Bacill	1.2	18.33	Poor	Yes
18	Res.Ognyanovo	L2	0.93	0.998	0.00	0.73	no	2.9	1.26	Maximum	No
19	Res.Bebresh	L2	0.38	0.999	5.14	2.14	no	3.25	3.82	Maximum	No
20	Res.Devets	L16	1.73	0.996	0.00	2.44	no	2	4.07	Good	No
21	Res.Enitsa	L16	10.77	0.973	49.21	30.20	II Chloro, Eugl	0.35	68.70	Bad	No

№	Name	Type	AGI (Catalan Index)	EQR (AGI)	% Cyano bacteria	Biovolume (mm3/l)	Algal bloom (degree)	Transparensy (m)	Chl *a*, (µg/l)	Status/ potential	Toxic species, presence
							Cyano				
22	Res. Sopot	L12	0.50	0.999	0.00	1.02	no	2.75	3.02	Maximum	
23	Res.Krushovitsa	L16	3.22	0.992	31.75	13.86	IICyano, Eugl Dino	0.6	22.60	Poor	Yes
24	Res.Telish	L16	5.04	0.988	2.68	9.33	I Chloro	1.6	18.21	Moderate	Yes
25	Res. Gorni Dabnik	L14	1.41	0.997	0.00	0.91	no	3	1.75	Maximum	
26	Res.Valchovets	L16	3.59	0.991	22.95	3.66	I Chloro	0.7	9.15	Moderate	Yes
27	Res.Aleksandrovo	L16	0.23	1.000	0.00	12.39	II Dino	0.8	23.69	Moderate	Yes
28	Res. Kamenets	L16	63.93	0.840	85.65	35.89	III Cyano	0.4	78.90	Bad	Yes*
29	Res.Ladzhenska bara	L16	÷	÷	÷	÷	÷	÷	÷	-	have been drained
30	Res.Hr. Smirnenski (Gabrovo)	L2	1.71	0.996	0.00	1.89	no	3.2	3.40	Maximum	
31	Res.Yastrebino	L12	0.44	0.999	5.10	1.99	no	3.2	2.91	Maximum	Yes
32	Res. Yovkovtsi	L2	0.72	0.998	0.25	0.40	no	7.5	0.62	Maximum	
33	Res.Al. Stambolijski”	L11	0.94	0.998	0,00	0,81	no	4,5	1,35	Maximum	
34	Res. Krapets	L12	1.11	0.997	71.43	0.04	no	2.5	<0.1	Good	Yes
35	Res. Karaissen	L16	÷	÷	÷	÷	÷	÷	÷		have been drained
36	Res. Beli Lom	L12	1.14	0.997	36.67	5.81	II Dino	2	15.33	Moderate	Yes*
37	Res. Lomtsi	L12	5.29	0.987	11.54	7.97	I Chloro	0.5	18.60	Moderate	Yes
38	Res. Kavatsite	L12	1.78	0.996	11.39	19.76	II Bacill, Cyano	1	38.22	Poor	Yes
39	Res. Boika	L12	18.10	0.955	10,05	8.26	II Cyano	0.5	29.20	Poor	Yes

№	Name	Type	AGI (Catalan Index)	EQR (AGI)	% Cyano bacteria	Biovolume (mm3/l)	Algal bloom (degree)	Transparensy (m)	Chl *a*, (µg/l)	Status/ potential	Toxic species, presence
40	Res. Baniska	L12	0.24	1.000	2,14	25.20	III Dino	1.5	50.30	Bad	
41	Res. Antimovo	L16	1.23	0.997	9.37	1.11	no	2.8	1.75	Good	Yes
42	Lake Srebarna	L5	2.50	0.994	7.80	3.50	II	0.9	5.81	Good	Yes

*toxic species in bloom; Bacill – Bacillariophyta, Chloro –Chlorophyta, Cyano-Cyanoprokaryota, Dino-Dinophyta, Eugl-Euglenophyta, Zygn- Zygnemaphyta

Fig. 2. Reservoir Kavatsite- bad ecological potential „Blooms" of diatom algae and blue-green Cyanobacteria (Photo: Y. Kutsarov)

Because of the one-time sampling the assessment by phytoplankton is indicative. We suppose that by sampling in the summer and early autumn we caught the "worst" Ph situation throughout the year. It is possible that, by taking two samplings in the beginning of the vegetative period (spring and summer), the average annual assessment could show a better EP for this basic BEQ for stagnant waters in the Danube region.

Black Sea river basin district (BRBD)

Twelve target lakes were researched in this region (5 lakes and 7 reservoirs) in order to determine their ecological status and potential by phytoplankton (**Table 6**).

The results from the analysis (**Tables 5, 6**) showed that half the water bodies are in Good and High (Maximum) ES/EP. These are: **Shabla lake** (weakly modified from ecological point of view) – close to referent conditions for ecological status for type L7; **Res. Eleshnitsa**– typical Maximum EP by Ph; **Res. Tsonevo**– typical Maximum EP by Ph; **Res. Poroy** - close to Maximum EP. Defining of Maximum EP for type L16 can be used; **Alepu lake** – we consider it close to referent conditions**; Res. Jasna polyana** – typical Maximum EP.

Summarising more than one third of the 'lakes' (33.3%) were not in a good status/potential (**Fig. 3**).

In the Black Sea RBD there are many lakes belong to so-called 'transitional' waters under WFD with various degrees of salinity such as: The freshwater (ahaline) coastal 'lakes' (type l7), <0.5‰ – Durankulak Lake, Shabla Lake, Res. Mandra (former Mandra Lake);

- The oligohaline coastal lakes (type L8), 0.5 to <5‰ – Alepu Lake;
- The hyperhaline lakes (type L10), >40‰ – Pomorijsko lake, Atanasovsko lake.

This type of waters has not yet been classified in Bulgaria and requires a separate special studies for referent conditions. The two hyperhaline lakes are highly modifies WB, artificially modified by humans for the extraction of salt, and their Maximum EP requires special modelling (special metrics for assessment).

Fig. 3. Durankulak Lake – visible phytoplankton "bloom" (Author: S. Cheshmedjiev). *Microcystis aeruginosa* - II class "bloom" (Photo: D. Belkinova)

TABLE 5

Allocation of the studied "lakes" by EP/ES in Black Sea RBD

Status/Potential	High/Maximum	Good	Moderate	Poor	Bad	Could not assess
%	25	25	8.3	16.7	8.3	16.7
Number	3	3	1	2	1	2

TABLE 6

Assessed ecological potential and ecological status of Black Sea RBD's lakes according to phytoplankton

№	Name	type	AGI (Catalan Index	EQR (AGI)	Total biovolume (mm^3/l)	Chl a, µg/l	Transparensy (m)	% Cyanobacteria	Algal bloom (degree)	Status/Potential	Toxic species (presence)
1	Durankulak swamp	L7	6.72	0.983	7.63	15.63	0.43	25.56	II Cyano	Poor	*Yes
2	Shabla lake	L7	1.4	0.997	1.24	2.54	1.95	2.5	No	Good	Yes (rare)
3	Res. Eleshnitsa	L12	1.17	0.997	0.48	0.98	1.2	0	No	Very good	
4	Res. Saedinenie	L12	11.08	0.973	4,48	9,2	1,2	46,21	I Cyano	Poor	*Yes
5	Res. Tsonevo	L14	1.07	0.998	0,31	0.48	5.15	0.00	no	Very good	
6	Res. Acheloy	L16	44.08	0.890	14.28	27.5	0.65	92.09	III Cyano	Bad	Yes
7	Res. Poroy	L16	1.03	0.998	1.77	3.56	1.10	5.08	no	Good	
8	Pomorijsko lake	L10	1.25	0.997	1.23	2.61	0.7	35.77	no	no possibility for assessment	
9	Atanasovsko lake	L10	0.4	0.999	12.47	31.2	0.25	0	II Chloro	no possibility for assessment	
10	Res.Mandra –east	L7b	1.17	0.997	4.21	9.79	1.1	0.2	I Bacill	Moderate	Yes
11	Alepu lake	L8	0.45	0.999	4.55	6.98	1.2	1.76	no	Good	
12	Res.Yasna polyana	L12	2.45	0.994	1.17	1.94	2.18	41.88	no	Very good	

*****toxic species in bloom; Bacill – Bacillariophyta, Chloro –Chlorophyta, Cyano-Cyanoprokaryota

East Aegean RBD (EARBD)

Sixteen water bodies in the Bulgarian part of EARBD were researched, all of them reservoir ecosystems. They were used in our research for determining of ecological potential because of the lack of major natural lakes in the region. The analysis of Ph metrics (**Table 7**) showed the following results for this region:

1. Seven reservoirs exhibited typical Maximum EP (Belmeken, Toshkov chark, Zhrebchevo, Assenovets, Kardzhali, Ivaylovgrad and Studen kladenets). For Res. Kardzhali analogical results in phytoplankton research were obtained **(1).**
2. A good EP (close to Maximum EP) was shown for 5 reservoirs (Batak, Krichim, Pyasachnik, Koprinka and Borovitsa - **Fig. 4**). Algae 'blooms' II degree were found in the Krichim, Pyasachnik and Borovitsa reservoirs. Previous research of Res. Borovitsa found presence of toxic cyanobacteria (12). This shows that longer-term monitoring studies are necessary so that the above mentioned reservoirs could be used for defining Maximum EP by Ph.
3. Moderate EP was shown for Res. Vacha (with33,62% presence of *Aphanizomenon flos-aquae)* and Res. Ovcharitsa (II degree „bloom" from diatom algae and presence of the toxic species *Aphanizomenon flos-aquae* and *Microcystis aeruginosa)*;
4. Two reservoirs are with a very bad EP – Res. Ovchi kladenets and Res. Daskal Atanasovo (**Fig. 5)**. The Ovchi kladenets reservoir showed very high eutrophication, very high % Cyanobacteria - 81,88% and presence of toxic species (*Aphanizomenon flos-aquae* in I degree of „bloom" and *Cylindrospermopsis rasiborskii*). The Daskal Atanasovo reservoir had the highest value for the total biovolume of Ph from all the researched reservoirs in the EAR.

Fig.4. *Tabellaria fenestrata var. asterionelloides* (Bacillaryophyta) – 92% of total biovolume of res. Batak (Photo: D.Belkinova)

Fig.5. *Anabaena scheremetievi* (Cyanoprokaryota) - II degree bloom in reservoir Daskal Atanasovo (Photo: D. Belkinova)

The results for stagnant water bodies in the East Aegean region show that 75% of them have Maximum EP or Good EP **(Table 8**). Twenty-five percent of the 'lakes' have moderate to poor EP.

West Aegean RBD (WARBD)

Five natural lakes and 5 reservoirs (a total of 10 stagnant water bodies) were researched in the West Aegean RBD, in order to define ecological status and potential. Only in this region 4 high mountain glacial lakes were researched for determining the referent conditions for this alpine type.

The analysis of metrics by Ph (**Table 9**) shows the following results in the WAR:

- The 4 high-mountain lakes (Redzepsko, Chernoto, Gyorgiysko and Bezbog) and Choklyovo marshland have typical reference conditions;
- The three reservoirs (Studena, Stoykovtsi, Dyakovo) show Maximum EP.

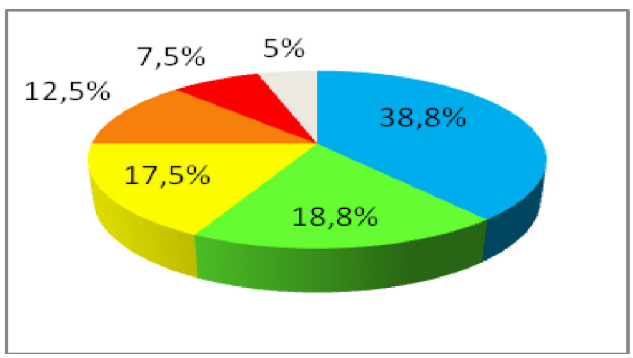

Fig.6. Percent allocation of studied lakes/reservoirs in Republic Bulgaria according to ecological status/potential.

The Bistraka quarry lake and Res. Pchelina have Poor EP.

Out of all researched river basins in the country the Danube region has the largest number of WBs in poor condition – 20 (**Table 10**). For the other regions the number is considerably smaller- from 2 to 6.The analysis of the summarised results for the whole country shows (**Fig.6**) that 57,6 % (46 lakes) were in a very good and good ecological status/potential, 37,5% (30 lakes) were not in a good status/potential – moderate, poor or bad ES/EP and 5% (4 lakes) have either dried out or cannot be correctly assessed because of hypersaline conditions.

TABLE 7

Assessed ecological potential of „lakes"in EARBD according to phytoplankton

№	Name	Type	AGI	EQR (AGI)	Total biovolume (mm^3/l)	Chl, (µg/l)	Transparensy (m)	% Cyanobacteria	Algal bloom (degree)	Status/ potential	Toxic species (presence)
1	Res. Belmeken	L13	0.51	0.999	0.79	2.60	4.0	0.00	no	Very good	no
2	Res. Batak	L3	1.99	0.995	0.49	3.50	3.2	4.08	no	Good	yes
3	Res. Toshkov chark	L3	1.04	0.998	0.18	2.20	3.5	0,00	no	Very good	no
4	Res. Vacha	L11	6.24	0.985	2.29	3.50	1.3	33.62	no	Moderate	yes
5	Res. Krichim	L11	8.37	0.979	4.77	14.50	1.1	0.00	II Bacill	Good	no
6	Res. Pyasachnik	L15	0.23	1.000	6.23	26.80	1.0	0.96	II Dino	Good	yes
7	Res. Daskal Atanasovo	L12	15.44	0.962	26.48	41.80	0.4	28.78	II Cyano, Chloro, Eugl	Bad	yes
8	Res. Ovchi Kladenets	L12	15.85	0.961	21.58	32.89	1.0	81.88	II Cyano	Bad	* yes
9	Res. Ovcharitsa	L12	1.2	0.997	6.37	7.32	2.3	2.97	II Bacill	Moderate	yes
10	Res. Koprinka	L11	7.55	0.981	7.57	6.29	1.2	13.33	II Chloro	Good	yes
11	Res. Zhrebchevo	L11	1.1	0.997	0.21	3.24	2.2	0.00	no	Very good	no
12	Res. Assenovets	L13	0.73	0.998	0.53	2.32	2.7	0.00	no	Very good	no
13	Res. Kardzhali	L11	1.27	0.997	0.42	1.82	3.6	0.00	no	Very good	no

№	Name	Type	AGI	EQR (AGI)	Total biovolume (mm^3/l)	Chl, (µg/l)	Transparensy (m)	% Cyanobacteria	Algal bloom (degree)	Status/ potential	Toxic species (presence)
14	Res. Studen kladenets	L11	1.04	0.998	1.16	2.44	2.4	0.00	no	Very good	no
15	Res.Ivay-lovgrad	L11	0.92	0.998	2.02	4.02	2.6	2.18	I Chloro	Very good	yes
16	Res. Borovitsa	L13	6.04	0.985	4.37	6.93	1.5	0.14	II Bacill	Good	no

Bacill – Bacillariophyta, Chloro –Chlorophyta, Cyano-Cyanoprokaryota,Dino-Dinophyta,Eugl-Euglenophyta; *toxic species in bloom

TABLE 8

Allocation of the studied "lakes" by EP/ES „lakes" in EARBD

Status/Potential	High/Maximum	Good	Moderate	Poor	Bad
%	43.8	31.3	12.5	0	12.5
Number	7	5	2	0	2

TABLE 9

Assessed ecological potential of „lakes"in WARBD according to phytoplankton

№	Name	Type	AGI	EQR (AGI)	Total biovolume mm^3/l	Chl a, µg/l	Transparency (m)	% Cyanobacteria	Algal bloom (degree)	Status/Potential	Toxic species, presence
1	Redzhepsko lake	L1	0.66	0.999	0.94	<0.2	>16.0	0	No	Very good	no
2	Bezbog lake	L1	1.09	0.998	0.95	<0.2	>7.0	0.74	No	Very good	no
3	Res. Studena	L3	0.61	0.999	0.83	1.1	2.0	2.53	No	Very good	no
4	Res. Pchelina	L4	0.02	1.000	63.2	119.3	1.1	0.01	III Dinophyta	Poor	yes
5	Res Dyakovo	L13	0.24	1.000	1.96	3.02	3.0	0	No	Very good	no
6	Choklyovo marshland	L4	0.94	0.998	1.32	2.04	1.6	9.10	No	Very good	yes
7	Chernoto lake	L1	0.55	0.999	0.57	<0.2	>15.5	0	No	Very good	no

8	Res. Stoykovtsi	L13	0.92	0.998	0.16	<0.2	6.5	0	No	Very good	no
9	Bistraka lake	L6	0.88	0.998	30.58	63.71	1.2	0	II (5 algal groups)	Poor	no
10	Gyorgiysko lake	L1	0.9	0.998	0.06	<0.2	16.1	0	No	Very good	No

TABLE 10

Allocation of the studied "lakes" by EP/ES in Bulgaria

Status/Potential Water basin Region	High/Maximum	Good	Moderate	Poor	Bad	Drained/ Could not assess
Danube RBD	13	7	11	6	3	2
Black Sea RBD	3	3	1	2	1	2
East Aegean RBD	7	5	2	0	2	0
West Aegean RBD	8	0	0	2	0	0

Conclusions

For the first time in Bulgaria research was carried out on the phytoplankton of 80 lakes according to WFD requirements. An orientative picture was derived about the ecological status or ecological potential of stagnant waters in the country, which can serve as a basis for further researches and surveillance or operational lake monitoring.

The ecological assessment showed that the largest number of WBs in a bad ecological status have been identified in the Danube river basin district. A probable reason for the WBs' bad status/potential is the multitude of small fishery reservoirs (incl. intensive aquacultures), whose water quality is frequently compromised. In the Black Sea district the status/potential of WBs is better. The 'lakes' with a poor potential/status are about one third of the district's total. In the East and West Aegean RBDs the 'lakes' with high and good status/potential predominated. In the research, the water bodies in the West Aegean river basins showed the highest ecological status/potential.

As an end-result of the present research we could summarise that over half of the researched stagnant WBs in Bulgaria meet the requirements for good ecological status or ecological potential (high and good ecological status; maximum and good ecological potential).

Acknowledgments

This work was supported by EU- funded projects under Operational Programme "Environment" 2007-2013, Priority Axis I:
"Determination of reference conditions and maximum ecological potential for the types of surface waters (rivers and lakes) on the territory of the Republic of Bulgaria" and "Development of a classification system for assessing the ecological status and ecological potential of the determined types of surface waters (rivers and lakes) on the territory of the Republic of Bulgaria (on the basis of a system "B" typology)".

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