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Macrophyte-Based Assessment of the Ecological Status of Lakes in Bulgaria

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Abstract. The aquatic macrophytes of lakes, situated in the whole territory of Bulgaria, were monitored during 2009. Six lake groups were established using differences in characteristics reflecting altitude, high calcium content and salinity, and altered hydromorphology and/or artificial origin. Abundance and species composition were assessed at each lake according to the requirements of the EU Water Framework Directive, using the assessment procedure of macrophyte-based assessment system, proposed by the Bavarian Environment Agency. The procedure included calculation of the 'ecological quality ratio' (EQR) for each of 78 water bodies, based on transect monitoring data. For 31 of these lakes, a macrophyte assessment system was applied, for the remaining 47 lakes macrophyte quantity was insufficient or depopulation was assessed. Ecological status classification of lakes is based on the calculation of a Reference Index value. The Reference Index quantifies the deviation of species composition and abundance from reference conditions and classifies sites as one of the five possible ecological quality classes specified in the Directive. The EQR indicating Good and High (Maximum) Ecological Status/Potential for macrophytes was achieved in 12 of the 31 lakes which fulfilled the criteria for assessment. The water quality parameters in lake types were discussed.

Key words: aquatic macrophytes, lakes, ecological status, Water Framework Directive

Introduction

The study summarized the implementation and adaptation of macrophyte-based assessment system in lakes in Bulgaria for assessment of ecological status, including eutrophication impacts, based on species composition and abundance of aquatic macrophytes.

For this purpose Reference Index (SCHAUMBURG *et al.*, 2007) was chosen to be applied and adapted in Bulgaria, while classifies water bodies by regional approach and reflects different kinds of ecological stresses. Reference Index (RI) methodology has been established to determine the ecological status/potential via integrative way as required by the Water Framework Directive (EUROPEAN UNION, 2000). The method is based on the occurrence and abundance of submerged species assigned to type specific species groups (A, B and C). The RI system has been generally applied in practice and implemented by governmental institution (e.g. Bavarian Water Management Agency). Additionally set of 14 water parameters was elaborated and was tested within lake groups.

Basic study of aquatic vegetation in Bulgaria had been accomplished 30 years ago by KOCHEV & JORDANOV (1981). In

recent years the inventory of about 9000 wetlands with their biodiversity was conducted (MICHEV & STOYNEVA, 2007). The assessment of 80 water bodies 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) by CHESHMEDJIEV *et al.* (2010). Trophic state index for scaling the eutrophication along the Bulgarian Black Sea coastal zone was applied by MONCHEVA *et al.* (2002). High-mountain lakes in Rila Mountain were studied by Kalchev et al. (2004), particularly the variables biomass and size structure of bacterio- phyto- and zooplankton, and occurrence of three fish species, and multivariate statistical methods were tested for pollution assessment from SIMEONOVA *et al.* (2010).

The study aimed at assessment of ecologcal status/potential of lakes on the Bulgarian territory, representative for all lake types. For the first time dataset for 78 water bodies was collated for the calculation of the 'ecological quality ratio' (EQR) based on macrophytes as a component of the "Macrophytes and Phytobenthos" biological quality element, as demanded by the Directive.

Material and methods

Aquatic vegetation was studied in the period June – September 2009 at 78 water bodies on the Bulgarian territory, sub-ecoregion 12-1 (Danube); sub-ecoregion 12-2 (Black Sea) and ecoregion 7 (Eastern Balkans).

All submerged, floating-leafed, helophyte and amphiphyte species (Charophytes, Bryophytes and Tracheophytes) were recorded at each lake. At each lake, 1–15 sites were investigated according to the lake size. Sampling was carried out following the recommendations of SCHAUMBURG *et al.* (2007). Nomenclature accepted in GROLLE & LONG (2000) for liverworts and HILL *et al.* (2006) for mosses was followed. Taxonomy of vascular plants followed Flora Europaea (TUTIN *et al.*, 1968–1980; 1993). The abundance of each species was noted according KOHLER (1978). Calculated Reference index was transformed in EQR, where value „1" reflects the best possible ecological status in terms of the Water Framework Directive (WFD), i.e. high ecological status/potential (ecological status class 1); value of "0" stands for poor ecological status/potential. The unreliable status class 5 which reflects the highest degree of degradation of a water system is designated in case of a proven macrophyte depopulation (e.g. due to mowing, clearing, high input of nutrients, introduction of herbivorous fish, etc.). Index limits for attribution of the ecological status class were related to river types.

In order to describe the environmental conditions affecting aquatic vegetation, thirteen parameters of anthropogenic pressure and water quality were used. *In situ* were measured acidity (pH), electrical conductivity (C in μS cm^{-1}), dissolved oxygen (mg L^{-1}), Secchi disc reading (SD), and turbidity (FNU). Chemical analysis of river water was performed just after sampling on spectrophotometer NOVA 60 (MERCK) following adopted standards: ammonium nitrogen - ISO 7150/1, nitrite and nitrate nitrogen - EN 26777 and ISO 7890-1, total nitrogen (TN) - EN ISO 11905-1, phosphate phosphorus - EN ISO 6878, total phosphorus (TP) - EN ISO 6878, biochemical oxygen demand - EN 1899-1,2, and chemical oxygen demand - ISO 15705.

Results and Discussion

Lake types and pressure parameters

The main descriptors of the biocoenotic lake types for the assessment with macrophytes according to the WFD are the following: ecological region; geology by calcium content; stratification. Based on them and additional descriptors (altitude, salinity and altered hydromorphology and/or artificial origin), the reported seventeen lake types for Bulgaria (CHESHMEDJIEV et al., 2010) were assigned to the following six groups: high mountain glacial lakes; mountain and semi-mountain lakes & reservoirs; carst and other natural lakes; lowland and riparian lakes and swamps (wetlands); lowland reservoirs

and transitional waters (Table 1). The last lake group included six water bodies with varying salinity (from 0.2 at Shablensko to 63.4‰ at Atanasovsko Lake). Mean depth and water parameters measured values varied significantly both between the lake groups and among water bodies in the same group (Table 1).

Ecological status/potential

The total number of aquatic macrophyte species observed in a single lake ranged between 1 and 27. Twenty-six were registered indicator species, while number of accompanying species was 44 (Table 2). A number of indicator species were specifically occurring in one or two lakes only, such as *Lemna trisulca*, *Nymphaea alba* and *Stratiotes aloides* (Srebarna lake), *Nuphar lutea* (Shabla lake), *Potamogeton pusillus* (Ovchi kladenets), *Myriophyllum verticillatum* and *Elodea canadensis* (Batak reservoir, Choklyovo swamp), *Spirodela polyrrhiza* (Pchelina reservoir, Srebarna lake), *Zannichellia palustris* (Kovachitsa and Aleksandrovo reservoirs). Of the more common indicator species (*Myriophyllum spicatum*, *Ceratophyllum demersum*, *Potamogeton pectinatus*, etc.), most species showed high abundance.

Ecological classification was restricted to 31 lakes with sufficient macrophyte abundance. Extreme eutrophication leading to depopulation of submerged macrophytes is integrated in the RI by assigning sites with very low or missing vegetation to bad status (unreliable), if natural reasons for low macrophyte abundance such as coarse substrate, changeable water level, presence of herbivorous fish (*Ctenopharyngodon idella*), etc. can be excluded. While natural reasons for low macrophyte abundance can not be excluded at the rest 47 assessed lakes, the assessment of their ecological status/potential based on macrophytes was not possible and further researches are recommended.

Only three reservoirs from the vast majority of lakes in Bulgaria classified as 'heavily modified and artificial water bodies' had 'maximum ecological potential' (Table 2). The major part of the lakes assessed was in moderate ecological status/potential based on macrophytes.

Conclusions

Based on abiotic typology parameters and the database of Bulgarian lakes, six types of macrophyte-based lake classification have been identified: high mountain glacial lakes; mountain and semi-mountain lakes & reservoirs; karst and other natural lakes; lowland and riparian lakes and swamps (wetlands); lowland reservoirs and transitional waters.

The method for the macrophyte-based assessment of the ecological status of lakes relies on the Reference Index which comprises indicators of the taxonomic composition and macrophyte abundance of water bodies.

Existing monitoring data can be a starting point to assessment of possible trends in lakes in Bulgaria.

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Table 1. *The morphometric characteristic and water quality parameters in lake types.*

	High mountain glacial (n = 5)			Mountain and semi-mountain lakes & reservoirs (n = 40)			Carst and other natural lakes (n = 3)		Lowland and riparian lakes and swamps (wetlands) (n = 2)		Lowland reservoirs (n = 22)			Transitional waters (n = 6)		
Lake features	Min	Max	Med	Min	Max	Med	Min	Max	Min	Max	Min	Max	Med	Min	Max	Med
Max depth (m)	7	16.05	16	3.7	110	19	8.5	13	5	7	1.5	42	15.75	0.25	7.5	1.45
Water quality indicators																
pH	7.19	7.8	7.47	6.65	9.5	8.35	8.04	9.11	7.72	9.08	7.95	9.29	8.67	8.42	8.89	8.48
Conductivity (μS cm^{-1})	9.7	19.8	15	29	863	275	202	564	558	593	201	1044	423.5	584	105003	1537
Dissolved oxigen (mg L^{-1})	7.2	8.71	7.9	4.4	11.1	7.86	8	13.1	8.15	9.9	4.9	18.4	8.6	1.14	8.64	5.88
COD (mg L^{-1})	3	6.8	6.35	<4	43.8	12.3	10.4	44.5	20	61	5.5	62	20.15	0.005	71	33.15
BOD_5 (mg L^{-1})	<1	1		<1	12.4	2.275	2.5	12.7	7.1	17	1	15.8	5.4	1.3	7.5	4.85
PO4-P (mg L^{-1})			<0.01	<0.01	0.223	0.026	<0.01	0.029	<0.01	0.021	<0.01	0.044	0.023	0.005	0.317	0.045
TP (mg L^{-1})	<0.01	0.002		<0.01	0.334	0.0305	0.017	0.198	0.108	0.147	<0.01	0.218	0.057	0.055	0.364	0.1105
NH4-N (mg L^{-1})	<0.01	0.032	0.022	<0.01	0.664	0.04	0.019	0.029	0.045	0.108	0.01	0.002	0.08	0.042	0.17	0.074
NO2-N (mg L^{-1})	<0.002	0.003	0.003	<0.002	0.039	0.005	0.002	0.041	0.029	0.058	1.55	0.067	0.81	0.007	0.025	0.0155
NO3-N (mg L^{-1})			<0.20	<0.2	0.89	0.16	0.23	0.63	<0.2	0.38	<0.2	0.0085	0.25	<0.2	0.6	0.4
TN (mg L^{-1})			<0.5	<0.5	2	1.2	<0.5	1.5	1.1	1.3	<0.5	4.1	1.2	0.5	3	0.7
SD (m)	6.5	16.05	11.275	0.4	7.5	2.3	1.1	3.5	0.9	1.2	0.3	5	0.8	0.25	1.95	0.9
Turbidity (FNU)	<1	1		<1	28	3	1	7	12	20	2	61	10	2	83	7

Table 2. *Species composition and assessed ecological status/potential at studied 78 lakes during 2009.*

Lake	BG Type	Latitude	Longitude	Height a.s.l. [m]	RI	ES/EP	Indicator Species	Accompanying species
High mountain glacial								
Redzhepsko lake (Rila mountain)	L1	42.04461	23.30064	2344				
Bezbog lake	L1	42.31586	23.09073	2240				*Drepanocladus sendtneri* (Schimp. ex H.Müll.) Warnst. *Racomitrium microcarpon* (Hedw.) Brid.
Chernoto lake	L1	41.58508	22.58254	2375				
Dolno Georgiysko lake	L1	41.44465	23.22531	2294				
Beli Iskar reservoir	L1	42.08145	23.3408	1875				
Mountain and semi-mountain lakes & reservoirs								
Yarlovtsi reservoir	L2	42.80352	22.54049	798	0	moderate	*Elodea nuttallii* (Planch.) H.St.John *Lemna minor* L. *Myriophyllum spicatum* L. *Potamogeton natans* L.	*Alisma plantago-aquatica* L. *Bidens cernua* L. *Bidens tripartita* L. *Juncus effusus* L. *Lycopus europaeus* L. *Lythrum salicaria* L. *Utricularia vulgaris* L.
Srechenska bara reservoir	L2	43.12223	23.12162	458				
Ognyanovo reservoir	L2	42.61465	23.74166	619	-4.5	moderate	*Ceratophyllum demersum* L. *Myriophyllum spicatum* L. *Potamogeton nodosus* Poir	*Phragmites australis* (Cav.) Trin. ex Steud. *Potamogeton trichoides* Cham. & Schltdl. *Typha latifolia* L.

							Potamogeton pectinatus L.	
Bebresh reservoir	L2	42.84675	23.78154	522				
Hristo Smirnenski reservoir (Gabrovo)	L2	42.81748	25.26554	533				
Yovkovtsi reservoir	L2	42.92175	25.79592	335	-47	moderate	*Ceratophyllum demersum* L. *Myriophyllum spicatum* L. *Potamogeton nodosus* Poir *Potamogeton pectinatus* L.	*Alisma gramineum* Lej. *Eleocharis palustris* (L.) Roem. & Schult. *Juncus effusus* L. *Lycopus europaeus* L. *Lythrum salicaria* L. *Mentha aquatica* L. *Mentha pulegium* L. *Mentha spicata* L. *Najas graminea* Delile *Potamogeton trichoides* Cham. & Schltdl. *Typha angustifolia* L.
Batak reservoir	L3	42.01152	24.12086	1103	-42	moderate	*Ceratophyllum demersum* L. *Elodea canadensis* Michx. *Myriophyllum verticillatum* L. *Myriophyllum spicatum* L. *Potamogeton natans* L. *Potamogeton crispus* L. *Potamogeton nodosus* Poir	*Najas minor* All.
Toshkov chark reservoir	L3	41.48544	24.1088	1419				
Studena reservoir	L3	42.51934	23.15144	848				
Vacha reservoir	L11	41.5604	24.26194	529				

Krichim reservoir	L11	41.5933	24.2757	419				
Koprinka reservoir	L11	42.4349	25.2938	386				
Zhrebchevo reservoir	L11	42.3701	25.175	259				
Kardzhali reservoir	L11	41.37915	25.20391	317				
Studen kladenets reservoir (wall)	L11	41.3714	25.3818	218	-50	moderate	*Myriophyllum spicatum* L.	*Najas minor* All.
Ivaylovgrad reservoir (wall)	L11	41.35057	26.06425	118	-50	moderate	*Myriophyllum spicatum* L.	
Iskar reservoir	L11	42.45753	23.5592	821				
Stamboliyski reservoir	L11	43.12031	25.16564	183	52	maximum	*Najas marina* L. *Potamogeton gramineus* L. *Potamogeton nodosus* Poir	*Alisma gramineum* Lej.
Eleshnitsa reservoir	L12	43.00333	27.46606	58				
Saedinenie reservoir	L12	43.32393	26.59885	172	10	good	*Lemna minor* L. *Potamogeton perfoliatus* L. *Potamogeton trichoides* Cham. & Schltdl.	*Bidens tripartita* L. *Lycopus europaeus* L. *Mentha aquatica* L. *Mentha pulegium* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Polygonum hydropiper* L. *Typha angustifolia* L.
Yasna polyana reservoir	L12	27.344157	42.142399	84			*Myriophyllum spicatum* L.	
Daskal Atanasovo reservoir	L12	42.20484	25.55089	117	-50	moderate	*Myriophyllum spicatum* L.	*Phragmites australis* (Cav.) Trin. ex Steud.

							Scirpus lacustris L.	*Polygonum hydropiper* L. *Scirpus litoralis* Schrad. *Typha angustifolia* L.
Ovchi kladenets reservoir	L12	42.14084	26.14477	134	36	good	*Ceratophyllum demersum* L. *Lemna minor* L. *Myriophyllum spicatum* L. *Potamogeton crispus* L. *Potamogeton natans* L. *Potamogeton pusillus* L.	*Polygonum* sp. *Phragmites australis* (Cav.) Trin. ex Steud. *Scirpus litoralis* Schrad. *Typha angustifolia* L. *Veronica beccabunga* L.
Ovcharitsa reservoir	L12	42.14597	26.08234	134			*Myriophyllum spicatum* L.	*Cyperus longus* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Scirpus litoralis* Schrad. *Typha angustifolia* L.
Kula reservoir (wall)	L12	43.91435	22.52832	202	-44	moderate	*Ceratophyllum demersum* L. *Chara* sp. *Elodea nuttallii* (Planch.) H.St.John *Myriophyllum spicatum* L. *Najas marina* L. *Potamogeton gramineus* L. *Potamogeton nodosus* Poir *Potamogeton trichoides* Cham. & Schltdl.	*Alisma gramineum* Lej. *Alisma lanceolatum* With. *Typha angustifolia* L.
Poletkovtsi reservoir	L12	43.85505	22.5138	203			*Myriophyllum spicatum* L. *Najas marina* L.	

							Potamogeton crispus L.	
Pancharevo reservoir	L12	42.58853	23.42169	608			*Ceratophyllum demersum* L. *Myriophyllum spicatum* L.	*Alisma plantago-aquatica* L. *Bidens tripartita* L. *Eleocharis acicularis* (L.) Roem. & Schult. *Eleocharis palustris* (L.) Roem. & Schult. *Typha angustifolia* L. *Typha latifolia* L. *Typha laxmannii* Lepech.
Sopot reservoir (wall)	L12	43.01123	24.42663	369	78	maximum	*Potamogeton gramineus* L. *Potamogeton pectinatus* L.	*Alisma gramineum* Lej. *Polygonum amphibium* L.
Yastrebino reservoir	L12	43.1547	26.27278	345				
Krapets reservoir	L12	43.05647	24.88699	406	36	maximum	*Chara* sp. *Elodea nuttallii* (Planch.) H.St.John *Myriophyllum spicatum* L. *Potamogeton gramineus* L. *Potamogeton pectinatus* L.	*Alisma gramineum* Lej.
Beli Lom reservoir	L12	43.40926	26.6836	280	-12.9	good	*Elodea nuttallii* (Planch.) H.St.John *Myriophyllum spicatum* L. *Potamogeton perfoliatus* L.	
Lomtsi reservoir	L12	43.44894	26.34388	214				
Kavatsite reservoir	L12	43.33687	26.25256	210			*Myriophyllum spicatum* L. *Potamogeton perfoliatus* L.	*Lycopus europaeus* L. *Lythrum salicaria* L. *Polygonum amphibium* L.

Boyka reservoir	L12	43.33102	26.00642	242			*Myriophyllum spicatum* L.	
Baniska reservoir	L12	43.43017	25.90641	166				
Belmeken reservoir	L13	42.10224	23.48575	1896				
Asenovets reservoir	L13	42.43055	26.1537	404				
Borovitsa reservoir	L13	41.45278	25.08367	483				
Dyakovo reservoir	L13	42.34589	23.08281	666			*Myriophyllum spicatum* L.	
Stoykovtsi resrvoir	L13	41.58508	22.58254	617				
Carst and other natural lakes								
Pchelina reservoir	L4	42.50905	22.82951	637	-52	poor	*Ceratophyllum demersum* L. *Elodea nuttallii* (Planch.) H.St.John *Lemna minor* L. *Myriophyllum spicatum* L. *Najas marina* L. *Potamogeton pectinatus* L. *Spirodela polyrrhiza* (L.) Schleid.	*Bidens cernua* L. *Bidens tripartita* L. *Polygonum amphibium* L. *Sparganium erectum* L. *Typha latifolia* L.
Choklyovo swamp	L4	42.39673	22.83257	875	46	high	*Ceratophyllum demersum* L. *Chara* sp. *Elodea canadensis* Michx. *Lemna minor* L. *Myriophyllum verticillatum* L. *Potamogeton natans* L. *Potamogeton trichoides* Cham. & Schltdl.	*Lycopus europaeus* L. *Mentha aquatica* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Ricciocarpos natans* (L.) Corda *Sparganium erectum* L. *Typha latifolia* L. *Utricularia minor* L.

							Utricularia vulgaris L.	
Rabisha reservoir	L4	43.73215	22.58757	295			*Myriophyllum spicatum* L.	
Lowland and riparian lakes and swamps (wetlands)								
Srebarna lake	L5	44.11258	27.07499	10	2	good	*Ceratophyllum demersum* L. *Lemna minor* L. *Lemna trisulca* L. *Nymphaea alba* L. *Potamogeton crispus* L. *Spirodela polyrrhiza* (L.) Schleid. *Stratiotes aloides* L. *Utricularia vulgaris* L.	*Alisma plantago-aquatica* L. *Berula erecta* (Huds.) Coville *Bidens tripartita* L. *Calystegia sepium* (L.) R.Br. *Epilobium hirsutum* L. *Hydrocharis morsus-ranae* L. *Lycopus europaeus* L. *Lythrum salicaria* L. *Mentha aquatica* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Polygonum amphibium* L. *Polygonum hydropiper* L. *Rumex hydrolapathum* Huds. *Scirpus lacustris* L. *Solanum dulcamara* L. *Thelypteris palustris* Schott *Typha angustifolia* L. *Typha latifolia* L. *Vallisneria spiralis* L.
Bistraka lake/reservoir	L6	41.58375	23.04298	317				
Lowland reservoirs								
Tsonevo reservoir	L14	43.02502	27.41758	52	-50	moderate	*Butomus umbellatus* L. *Ceratophyllum demersum* L. *Myriophyllum spicatum* L.	*Alisma gramineum* Lej. *Bidens tripartita* L. *Najas minor* All.

							Najas marina L. *Potamogeton pectinatus* L. *Potamogeton perfoliatus* L.	*Polygonum hydropiper* L. *Typha angustifolia* L.
Ogosta reservoir (wall)	L14	43.38837	23.21495	191			*Myriophyllum spicatum* L. *Potamogeton nodosus* Poir	*Polygonum hydropiper* L.
Gorni Dabnik (wall)	L14	43.3524	24.33945	171	2	good	*Butomus umbellatus* L. *Ceratophyllum demersum* L. *Myriophyllum spicatum* L. *Najas marina* L. *Potamogeton crispus* L. *Potamogeton gramineus* L. *Potamogeton pectinatus* L. *Potamogeton perfoliatus* L. *Potamogeton trichoides* Cham. & Schltdl.	*Alisma lanceolatum* With. *Bidens tripartita* L. *Echinochloa crus-galli* (L.) P.Beauv. *Lycopus europaeus* L. *Najas minor* All. *Polygonum hydropiper* L.
Pyasachnik reservoir	L15	42.24129	24.35034	286				
Aheloy reservoir	L16	42.4238	27.3056	142				
Poroy reservoir	L16	42.4312	27.3724	28				
Drenovets reservoir	L16	43.69652	22.91433	177				
Hristo Smirnenski reservoir	L16	43.61538	23.01136	151				
Rasovo reservoir	L16	43.71423	23.24729	131				
Kovachitsa reservoir	L16	43.79377	23.34953	114			*Myriophyllum spicatum* L. *Zannichellia palustris* L.	*Alisma gramineum* Lej. *Lycopus europaeus* L. *Typha latifolia* L.
Dabnika reservoir	L16	43.20752	23.59096	346	-90	poor	*Elodea nuttallii* (Planch.)	

							H.St.John *Myriophyllum spicatum* L. *Potamogeton nodosus* Poir *Potamogeton pectinatus* L.	
Tricladentsi reservoir	L16	43.43251	23.63823	159				
Barzina reservoir	L16	43.57552	23.73506	84	0	good	*Myriophyllum spicatum* L. *Potamogeton crispus* L.	*Echinochloa crus-galli* (L.) P.Beauv. *Polygonum hydropiper* L.
Asparuhov val reservoir	L16	43.44538	23.37546	96				
Devets reservoir (wall)	L16	43.30598	23.95645	201	-68	moderate	*Ceratophyllum demersum* L. *Elodea nuttallii* (Planch.) H.St.John *Myriophyllum spicatum* L. *Potamogeton nodosus* Poir *Potamogeton pectinatus* L. *Potamogeton trichoides* Cham. & Schltdl.	*Alisma plantago-aquatica* L. *Epilobium hirsutum* L. *Lycopus europaeus* L. *Lythrum salicaria* L. *Typha angustifolia* L.
Enitsa reservoir (wall)	L16	43.36668	24.01623	171				
Krushovitsa reservoir (wall)	L16	43.3582	24.40803	115	-64	moderate	*Najas marina* L. *Potamogeton crispus* L. *Potamogeton nodosus* Poir *Potamogeton pectinatus* L.	
Telish resrvoir (wall)	L16	43.31923	24.23747	226				
Valchovets reservoir (wall)	L16	43.47443	24.49603	89	-62	moderate	*Ceratophyllum demersum* L. *Myriophyllum spicatum* L.	*Echinochloa crus-galli* (L.) P.Beauv. *Lycopus europaeus* L.

							Najas marina L.	*Najas graminea* Delile *Najas minor* All. *Polygonum hydropiper* L.
Aleksandrovo reservoir (wall)	L16	43.26968	24.92104	123	0	good	*Najas marina* L. *Potamogeton pectinatus* L. *Potamogeton trichoides* Cham. & Schltdl. *Zannichellia palustris* L.	*Alisma gramineum* Lej.
Kamenets reservoir	L16	43.35551	25.01291	95	0	good	*Butomus umbellatus* L. *Myriophyllum spicatum* L.	*Alisma gramineum* Lej. *Polygonum hydropiper* L. *Typha angustifolia* L. *Typha laxmannii* Lepech.
Antimovo reservoir	L16	43.98737	26.69923	98	-62	moderate	*Ceratophyllum demersum* L. *Elodea nuttallii* (Planch.) H.St.John *Lemna minor* L. *Myriophyllum spicatum* L. *Sparganium erectum* L.	*Typha angustifolia* L. *Typha latifolia* L.
Transitional waters								
Durankulak swamp	L7	43.67898	28.53981	4	-44	moderate	*Butomus umbellatus* L. *Ceratophyllum demersum* L. *Lemna minor* L. *Myriophyllum spicatum* L.	*Berula erecta* (Huds.) Coville *Calystegia sepium* (L.) R.Br. *Lycopus europaeus* L. *Mentha aquatica* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Polygonum hydropiper* L. *Scirpus lacustris* L. *Scirpus maritimus* L. subsp.

								maritimus
Shabla lake	L7	43.56788	28.56175	-3	-44	moderate	*Ceratophyllum demersum* L. *Lemna minor* L. *Myriophyllum spicatum* L. *Nuphar lutea* Sm.	*Typha angustifolia* L. *Typha latifolia* L. *Calystegia sepium* (L.) R.Br. *Hydrocharis morsus-ranae* L. *Lycopus europaeus* L. *Phragmites australis* (Cav.) Trin. ex Steud. *Solanum dulcamara* L. *Sparganium erectum* L.
Mandra reservoir	L7	42.2622	27.2554	5	-34	moderate	*Myriophyllum spicatum* L. *Najas marina* L. *Potamogeton perfoliatus* L.	*Alisma plantago-aquatica* L. *Ruppia maritima* L.
Alepu lake	L8	42.2118	27.4229	-0.5	-42	moderate	*Ceratophyllum demersum* L. *Potamogeton crispus* L.	*Hydrocharis morsus-ranae* L. *Trapa natans* L.
Pomoriisko lake	L10	42.3416	27.3802	0				
Atanasovsko lake	L10	42.30297	27.203296	0				