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Assessment of ecological status of the Dovinė river catchment area lakes according to phytoplankton data

Jūratė Kasperovičienė

Institute of Botany,
Žaliųjų Ežerų 49,
LT-08406 Vilnius, Lithuania
E-mail: jurate.kasp@botanika.lt

On the basis of the recently developed typology and classification of Lithuanian water bodies and accepted criteria of reference and good quality conditions of lakes, the ecological status of the Dovinė river basin lakes Amalvas, Dusia, Simnas and Žuvintas was assessed with respect to the phytoplankton quality element values with regard to the implementation of the WFD requirements.

All phytoplankton quality elements as well as water transparency parameters for the deep Lake Dusia showed a good, while for the shallow lakes Amalvas and Simnas a bad status. The shallow Lake Žuvintas makes an exception. In accordance with phytoplankton biomass and chlorophyll a content Lake Žuvintas should be estimated as a good water quality lake. Lake Žuvintas obviously does not meet the Lithuanian shallow lake type proposed by the DANCEE project. This lake, according to phytoplankton biomass, chlorophyll a and especially species composition, should be ranked as a separate lake type.

Key words: phytoplankton parameters, ecological status, Dovinė river basin lakes, EU Water Framework Directive

INTRODUCTION

Algae and cyanobacteria are sensitive to changes of pollution load in water ecosystems. Therefore, phytoplankton is often used in studies related to water quality. Different methods have been developed; some of them are based on the saprobic system and others on the structure of the phytoplankton community. Trophic and saprobic indicator species were listed in many works (Kümmerlin, 1990; Трифонова, 1990; Lepistö & Rosenström, 1998), numerous indices were developed (Sládeček, 1973; Wegl; 1983, Tremel, 1996), however, none became widely accepted. Application of phytoplankton community structure in the assessment of water quality is possible using also different diversity indices. Commonly, three indices are employed to measure biodiversity at the species level: Species Richness, Simpson Index and Shannon–Wiener Index. High values of diversity indices reflect the stability of phytoplankton community. However, development of uniform treatment for phytoplankton analyses is complicated due to a large number of taxa that might be potentially encountered in a water sample. Therefore, besides different indices, the values of phytoplankton abundance and biomass (wet weight, chlorophyll *a* content) generally are used for assessment of water quality in freshwaters.

In EU Water Framework Directive (WFD) (2000/60/EC, OJ L327 22.12.2000), phytoplankton is one of the five groups suggested for ecological status assessment of surface waters. In Lithuania, numerous attempts were made to find phytoplankton parameters, indicator groups, their values that fulfil WFD requirements, however, available published documents are limited.

Ecological studies of Lithuanian water bodies according to WFD were carried out within the framework of the PIN-Matra project No. 2003/040 in 2003. The purpose of the project was to produce a Management and Restoration Plan for the Dovinė river basin as an input into the Integrated River Basin Management Plan of the Nemunas River Basin District. With reference to the DANCEE project "Implementation of EU Water Framework Directive in Lithuania", the water body typology, classification and estimation of the main criteria for achieving a good ecological status were studied. Through this plan, an appropriate tuning of achieving Good Ecological Status of the lakes (according to the WFD) was predicted.

The purpose of this study was to evaluate the ecological status of the Dovinė river basin lakes Amalvas, Dusia, Simnas and Žuvintas with respect to the phytoplankton quality element according to the EU WFD, and to refine the existing Lithuanian typology of surface water bodies and their classification, setting the reference conditions and quality boundaries of Lithuanian lakes. In this study, we focused on the following parameters: phytoplankton species composition, abundance and biomass, species with problems (toxic or invasive).

MATERIALS AND METHODS

Study area. The investigation was carried out in the Dovinė river basin lakes Amalvas, Dusia, Simnas and Žuvintas (Figure) during phytoplankton summer intensive vegetation period on 11–12 August 2004. Water samples were collected at the deepest point of the lakes. Sampling site coordinates: Amalvas – 54°32′06″ N, 23°34′48″ E; Dusia – 54°18′43″ N, 23°41′34″ E; Simnas – 54°23′58″ N, 23°38′44″ E; Žuvintas – 54°27″35′ N, 23°38′07″ E. The morphometric characteristics of the lakes as well as some physico-chemical data determined during the investiagations are presented in Table 1.

Sample collection and analysis. Water samples (0.5 l) in all lakes were taken from the surface (to 0.5 m) water layer, in the stratified Lake Dusia – also from meta- and hypolimnion, and in Lake Simnas from near-bottom layers, using a Ruttner bottle. Samples were preserved immediately with 40% formaldehyde (4% final concentration) and concentrated to the volumes of 20–30 ml.

The phytoplankton was analysed on a 'Biolar' light microscope at ×600 magnification. Algae were counted (more than 500 counting units) in a Nageotte chamber (volume 0.05 cm^3), biomass was estimated from cell numbers and specific volumes (Olrik et al., 1998). The counting unit of colonial species was a colony, of filamentous

Table 1. **Morphometrical characteristics and physical–chemical data on the study lakes, 11–12 August 2004**

Lakes	Basin area, km^2	Lake area, km^2	Depth, m		Volume m^3·10^6, m	t°C	S_h, m	pH	O_2, mg/l	Conductivity, µS/cm
			max	mean						
Amalvas	128.5	1.9	2.9	1.0	1.9	22.2	0.6	8.34	6.72	502
Dusia	107.8	23.3	32.4	14.6	338.2	21.9	4.0	8.69	9.6	300
Simnas	176.8	2.4	4.6	2.9	5.1	22.0	0.7	8.48	8.64	405
Žuvintas	344.9	9.3	2.5	0.67	10.5	32.1	tb	8.22	6.4	465

tb – till bottom.

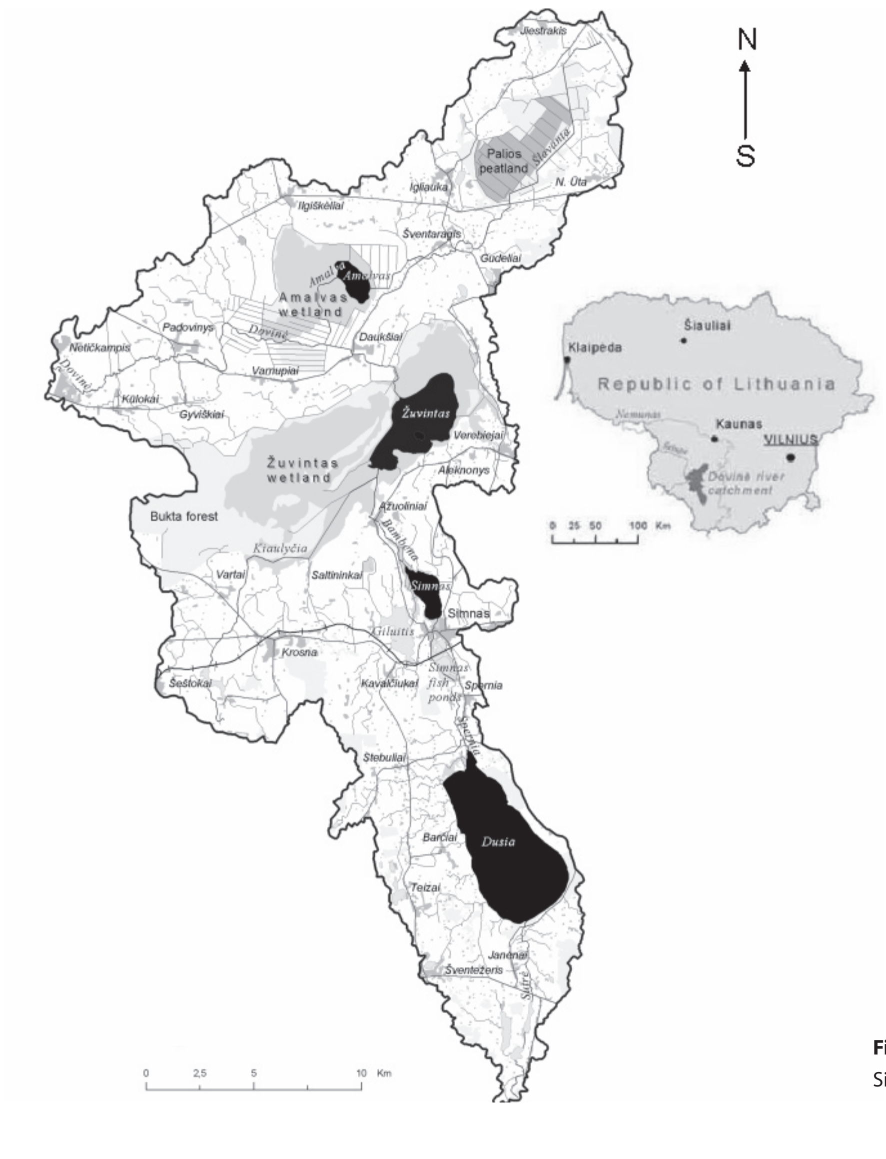

Figure. Location of lakes Amalvas, Dusia, Simnas and Žuvintas in the Dovinė river basin species – 100 μm, others – a cell. As a measure for the total phytoplankton biomass, chlorophyll a (Chl a) content was determined in all samples. To analyse Chl a, different volumes of water were filtered onto membrane filters (Vladipor No. 9) in triplicate, pigments were extracted with acetone (90%) and quantified spectrophotometrically according to S.W Jeffrey and G.F. Humphrey (1975).

The physical (water temperature, pH, conductivity) characteristics were measured *in situ* using a portable MultiLine F/Set-3 universal meter. Transparency was measured with a Secchi disk. Dissolved oxygen concentration was evaluated by the Winkler method.

RESULTS AND DISCUSSION

Lake typology. In terms of WFD, according to the DANCEE project classification of–Lithuanian lakes, they were ranked into three types separated by the following mean depth rangers: – deep lakes >9 m (type I), deep lakes 3–9 m (type II) and shallow lakes <3 m (type III) (DANCEE, 2004). The lakes studied in the Dovinė river catchment were assigned to two types: Lake Dusia to type I and lakes Simnas, Žuvintas, Amalvas to type III. The lakes of the Dovinė river basin can be ranked not only by their depth, but also by surface area, water colour / transparency and alkalinity. The area of lakes Dusia and Simnas, is >0.5 km^2, they are transparent / clear, oligohumic, moderately hard, while lakes Amalvas and Žuvintas (area >0.5 km^2) are humic / brown, polyhumic, moderately hard.

Species composition. A total of 171 algal and cyanobacteria species and varieties mainly belonging to *Chlorophyceae* (53%) and *Cyanophyceae* (24% of all species) were registered during the present study (Table 2). The amount of species varied a lot among the lakes

Table 2. **Phytoplankton species in Dovinė river basin lakes, 11–12 August 2004**

Taxa	Lakes			
	Amalvas	Dusia	Simnas	Žuvintas
1	2	3	4	5
CYANOPHYCEAE				
Anabaena spiroides Klebahn			*	
Anabaena lemmermanii P. Rich	*		**	
Anabaena flos-aquae (Lyngbye) Brèbisson			*	
Aphanizomenon flos-aquae (Linnaues) Ralfs ex Bornet & Flahault			***	
Aphanizomenon gracile (Lemmermann) Lemmermann	****	*		
Aphanocapsa conferta (W. W.&G.S.West) Komárková-Legnerová et Cronberg				*
Aphanocapsa delicatissima W & G. S. West	*		***	*
Aphanocapsa holsatica (Lemmermann) Cronberg & Komárek	*		***	
Aphanocapsa inserta (Lemmermann) Cronberg & Komárek	*		**	*
Aphanocapsa planctonica (G.M.Smith) Komárek & Anagnostidis			**	
Aphanocapsa sp.	*			*
Aphanothece clathrata W. W. & G.S.West			*	*
Aphanothece minutissima (W. West) Komárková-Legnerová & Cronberg			**	
Coelosphaerium kuetzingianum Nägel		*		*
Chroococcus aphanocapsoides Skuja			*	
Chroococcus dispersus (Keissler) Lemmermann				*
Chroococcus limneticus Lemmermann	*			*
Chroococcus minimus (Keissler) Lemmermann			*	**
Chroococcus minutus (Kützing) Nägeli			*	*
Chroococcus turgidus (Kützing) Nägeli			*	
Cyanodyction imperfectum Cronberg & Weibull			*	**
Cyanodyction planctonicum Meyer	*		*	**
Cyanodyction reticulatum (Lemmermann) Geitler			*	***
Cyanodyction tubiforme Cronberg	*			*
Cyanodyction sp.	*			
Limnothrix redekei (Van Goor) Meffert	***		***	
Lyngbya sp.$_1$		**	**	
Lyngbya sp.$_2$		*	**	
Merismopedia glauca (Ehrenberg) Nägeli	**			
Merismopedia punctata Meuen			*	
Merismopedia tenuissima Lemmermann	*		*	
Merismopedia warmingiana Lagerheimann	*		*	
Microcystis aeroginosa (Kützing) Kützing			*	*
Microcystis flos-aquae (Wittrock) Kirchner	*			
Microcystis viridis (A.Brébison in Rabenhorst) Lemmermann	*			
Microcystis wesenbergii (Komárek) Starmach	*		*	*
Phormidium tenue (C. A. Agardh) Anagnostidis & Komárek	*			

Table 2 continued

1	2	3	4	5
Planctolyngbya contorta (Lemmermann) Anagnostidis & Komàrek	***			
Planctolyngbya limnetica (Lemmermann) Anagnostidis & Komàrek	****			
Pseudanabaena limnetica (Lemmermann) Komàrek	*			
Raphidiopsis mediteranea Skuja			**	
Romeria elegans (Woloszynska) Koczwara			**	
Romeria sp.			**	
Snowella lacustris (Chodat) Komárek & Hindák				**
Snowella litoralis (Hayren) Komárek & Hindák			**	
Woronichinia compacta (Lemmermann) Komárek & Hindák			**	
CRYPTOPHYCEAE				
Cryptomonas ovata Ehrenberg			*	*
Rhodomonas lacustris Pacher & Ruttner				*
CHRYSOPHYCEAE				
Chromulina sp.$_1$				****
Chromulina sp.$_2$				*
Dinobryon bavaricum Imhof			*	*
Dinobryon divergens Imhof				*
Dinobryon sociale Ehrenberg	*			*
Kephyrion ovale (Lackey) Huber –Pestalozzi		*		
Kephyrion rubri-claustri Conrad			*	*
Pseudokephyrion pseudospirale Bourelly		*	*	*
Ochromonas sp.			*	
Dinobryon spore (diameter 6)		*		
Chrysophyceae spp. (diameter 2)		*		
DINOPHYCEAE				
Ceratium hirundinella (O. F. Muller) Schrank		*		
Glenodinium gymnodinium Penard				
Gyrodinium hyalinum (Schilling) Kofoid & Swezy		**		
Peridinium aciculiferum Lemmermann			**	
Peridinium cinctum (O. F. M.) Ehrenberg		***	**	
Peridinium sp.		*		
EUGLENOPHYCEAE				
Euglena proxima Dangeard			*	
Euglena acus Ehrenberg			*	
Phacus pleuronectes (Ehrenberg) Dujardin			*	
Trachelomonas planctonica Swirenko	*		*	
Trachelomonas hispida (Perty) Stein				
Trachelomonas volvocina Ehrenberg			*	
Trachelomonas sp.			*	
BACILLARIOPHYCEAE				
Amphora ovalis Kützing				*
Asterionella formosa Hassal		*		*
Aulacoseira ambigua (Grunow) Simonsen			*	
Cocconeis placentula Ehrenberg				*
Cyclotella sp.			*	*
Cymbella affinis Kützing				*
Diatoma tenue C. A. Agardh				*
Eunotia lunaris (Ehrenberg) Grunow				*
Fragilaria brevistriata Grunow	*		*	***
Fragilaria construens (Ehrenberg) Grunow	*		*	*
Fragilaria construens var. *venter* (Ehrenberg) Hustedt				
Fragilaria crotonensis Kitton	*	****	*	
Fragilaria sp.	*			
Navicula radiosa Kützing				*
Nitzschia acicularis (Kützing) W. Smith			*	
Nitzschia recta Hantzsch	*			
Stephanodiscus hantzschii Grunow			*	

Table 2 continued

1	2	3	4	5
Stephanodiscus rotula (Kützing) Hendely				**
Synedra acus Kützing	*	*		*
Synedra acus var. *angustissima* Grunow		*		
Synedra ulna (Nitzch) Ehrenberg	*			*
CHLOROPHYCEAE				
Acannthosphaera zachariasii Lemmermann	*			
Ankistrodesmus densus Korshikov	*			
Ankistrodesmus falcatus (Corda) Ralfs			**	
Ankistrodesmus fusiformis Corda	*			
Ankyra judayi (G. M. Smith) Fott				*
Botryococcus terribilis Komárek & Marvan	*			
Carteria sp.			*	
Chlamydomonas sp. 1	*			
Chlamydomonas sp. 2	*			
Chlorella vulgaris Beij			***	**
Chlorococcus sp.				
Crucigenia tetrapedia (Kirchner) W. & G. S. West	*		*	*
Crucigenia quadrata Morren			*	
Coelastrum astroideum De-Not				
Coelastrum microporum Nägeli	*	*	*	*
Coelastrum proboscideum Bohlin	*			
Cosmarium sp.			*	*
Dactylosphaerium jurisii Hindák			*	
Dictyosphaerium ehrenbergianum Nägeli			*	
Dictyosphaerium pulchellum Wood			*	
Dictyosphaerium tetrachotomum Printz	*		*	
Elacatothrix gelatinosa Wile	*	*	*	
Francea echidna (Bohlin) Bourrelly	*			
Golenkinia radiata Chodat	*		*	
Golenkiniopsis sp.	*			
Granulocystopsis coronata (Lemmermann) Hindák	*			
Kirchneriella lunaris (Kirchner) Moebius	*			
Kirchneriella obesa (W. West) Schmidle			*	*
Lagerheimia ciliata (Lagerheim) Lemmermann	*		*	
Lagerheimia subsalsa Lemmermann	*		*	*
Lagerheimia wratislaviensis Schröder	*		*	
Micractinium pusillum Fresenius	*			
Monoraphidium contortum (Thuret) Komárková-Legnerová				
Monoraphidium grifithii (Berk.) Komárková-Legnerová	*			
Monoraphidium irregulare (G. M. Smith) Komárková-Legnerová	*		**	
Monoraphidium komarkovae Nygaard		****	*	
Monoraphidium minutum (Nägeli) Komárková-Legnerová	*		*	
Monoraphidium tortile (W. et G. S.West) Komárková-Legnerová	*			
Nefrochlamis wileana (Printz) Korshikov	*			
Oocystis lacustris Chodat	*		*	
Oocystis parva W. & G. S. West	*			
Oocystis sp. 1		*		*
Oocystis sp. 2				*
Pediastrum boryanum (Turpin) Meneghin	*			*
Pediastrum boryanum var. *longicorne* A. Braun	*		*	
Pediastrum angulosum (Ehrenberg) Meneghin	*			
Pediastrum kavraiskyi Schmidle	*			
Pediastrum duplex Meyen	*		**	*
Pediastrum duplex var. *gracillimum* W. & G. S. West	*			
Pediastrum integrum Nägeli	*			
Pediastrum tetras (Ehrenberg) Ralfs	*		*	*
Pediastrum simplex Meyen	*			

Table 2 continued

1	2	3	4	5
Phacotus lenticularis (Ehrenberg) A. Stein		****	**	
Selenastrum bibraianum Reinsch	*			
Scenedesmus acuminatus (Lagerheim) Chodat		*	*	
Scenedesmus acuminatus var. *minor* G. M. Smith	*			
Scenedesmus acuminatus var. *tetradesmoides* G. M. Smith	*			
Scenedesmus armatus Chodat	*			
Scenedesmus obliquus (Turpin) Kützing	*		*	
Scenedesmus opoliensis P. G. Richt	*			
Scenedesmus quadricauda (Turpin) Brébisson	*		*	*
Scenedesmus spinosus Chodat	*			
Scenedesmus subspicatus Chodat	*			
Scenedesmus striatus Dedus	*			
Scenedesmus tenuisspina Chodat	*		*	*
Schroederia setigera (Schröd) Lemmermann	*			
Siderocelis ornata (Fott) Fott	*			
Siderocystopsis fusca (Korshikov) Swale	*			
Sphaerocystis planctonica (Korshikov) Bourrelly	*			
Sphaerocystis shroterii Chodat			*	
Staurastrum tetracerum Ralfs		*		
Staurastrum sp.		*	*	
Tetraedron caudatum (Corda) Hansgirg		*	*	
Tetraedron incus (Teiling) G. M. Smith	*			
Tetraedron minimum (A. Braun) Hansgirg	*		*	*
Tetraedron triangulare Korshikov	*			
Tetrastrum staurogeniaforme (Schröd) Lemmermann			*	
Treubaria triopendiculata F.Bernard	*			

Shaded species – potentially toxic species; **** – dominants (more than 10% of total abundance or biomass); *** – very common species (5–10%); ** – common species (2–5%);* – rare species (less than 2%).

Amalvas, Dusia, Simnas and Žuvintas (81, 25, 84 and 67 species, respectively). About 19 species were dominants or very common and contributed up to 90% of the total biomass. The species list itself is not a good indicator for classification, but it can be used in relation to species with 'problems' (toxic or invasive species).

Lake ecological status. Phytoplankton values corresponding to the reference conditions and good status of different lake types were established in DANCEE project reports based on Lithuanian scientific research data, as well as experts' opinion and calculations (DANCEE, 2004, Valatka, 2004). During this study, preliminary phytoplankton parameter values, also values ranked after revision in accordance with newly received monitoring data (Margerienė, 2007) were compared with analogous data for the lakes of the Dovinė river basin.

As for water transparency, Chl a content and the number of nuisance species in the deep Lake Dusia, the lake meets the requirements of a good ecological status (Table 3). Only the total phytoplankton biomass values exceed three times the parameter value for good status. On the other hand, in accordance with reference values for deep lakes, proposed by Lithuanian Environmental Protection Agency (EPA) (Margerienė, 2007), Lake Dusia meets the requirements for reference conditions.

Despite the fact that phytoplankton data were obtained during a single summer sampling, Lake Dusia was characterised as a good quality water basin according to earlier phytoplankton data (Mardosaitė & Minkevičius, 1958; Kavaliauskienė, 1996). The lake was characterized by a high water transparency (to 10 m) and the stability of the dominant algal species composition. The annual mean values of total biomass did not reach 1 mg/l. Diatom species (*Aulacoseira, Cyclotella, Fragillaria crotonensis*), dinophytes (*Ceratium hirundinella, Gymnodinium*), and sometimes golden-brown (*Dynobrion*) species dominated in plankton in all vegetation periods of 1970–1986 and showed a similar annual development (Kavaliauskienė, 1996).

All quality parameters for the shallow clear Lake Simnas showed a much worse status as compared with those for the good status (Table 3). Phytoplankton parameters for this lake exceeded good water quality parameters for shallow lakes several to tenfold times. Instead of diatoms (*Fragilaria, Asterionella, Stephanodiscus*), dinophytes and cryptophytes that prevailed in the lake during investigations of 1952–1986 (Markevičienė, 1962; Kavaliauskienė, 1996), cyanobacteria *Aphanizomnon, Anabaena, Aphanocapsa* and green algae species characteristic of highly eutrophic waters became dominant. The phytoplankton biomass raised to 32.8 mg/l, and cyanobacteria and green algae biomass reached 57% and 38% of the total biomass (Tables 2, 4). They accumulated into dense, visible patches near the surface, formed scum near the shoreline. Eighteen identified potentially toxic cyanobacteria species and two green algae taxa were mainly responsible for the bloom in the lake. The invasive potentially toxic species *Raphidiopsis mediterranea* also started developing in Lake Simnas.

Table 3. **Comparison of water quality parameters for reference and good quality conditions in Lithuanian lakes (*Margerienė, 2007; **Valatka, 2004) with those in Dovinė river basin lakes Dusia, Simnas, Amalvas, Žuvintas**

Deep, hard watered and oligohumic lake					
Quality elements	**Parameters**	***Reference conditions**	****Reference conditions**	****Good status**	**Dusia**
Phytoplankton	Chlorophyll *a* (μg/l)	<4	<2	2–5	3.3
	Total biomass (mm³/l)	<3	<0.5	0.5–1.0	2.84
	Number of nuisance species	<3	<3	3–4	2
Chemistry	P total (μg/l)	<20	<12.5	12.5–25	–
	Secchi depth, m	>6.0	>6.0	4.0-6.0	4

Shallow, hard watered and oligohumic lake					
Quality elements	**Parameters**	***Reference conditions**	****Reference conditions**	****Good status**	**Simnas**
Phytoplankton	Chlorophyll *a* (μg/l)	<6	<10	10–20	81.8
	Total biomass (mm³/l)		<0.5	0.5–1.0	32.82
	Number of nuisance species	<2	<2	2–3	20
Chemistry	P total (μg/l)	<40	<25	25–50	–
	Secchi depth, m	>3	>3.4	2.0–3.4	0.7

Shallow, hard watered, brown lakes						
Quality elements	**Parameters**	***Reference conditions**	****Reference conditions**	****Good status**	**Amalvas**	**Žuvintas**
Phytoplankton	Chlorophyll *a* (μg/l)	<6	<5	10-20	51.53	3.2
	Total biomass (mm³/l)	<4	<0.5	0.5–1.0	40.23	0.054
	Number of nuisance species	<2	<2	2–3	12	10
Chemistry	P total (μg/l)	<40	<12.5	12.5–25	–	–
	Secchi depth, m	>3	>3.4	2.0–3.4	0.6	tb

– – no data.

tb – till bottom.

Table 4. **Total abundance and biomass of phytoplankton in the Dovinė river basin lakes, 11–12 August 2004**

	Dusia			**Simnas**		**Amalvas**	**Žuvintas**
	Depth, m						
	0.5 m	**10 m**	**20 m**	**0.5 m**	**3.5 m**	**0.5 m**	**0.5 m**
Abundance, thous.units/l							
Cyanophyceae	133.81	6.80	–	3116.71	1490.31	102023.2	848.25
Cryptophyceae	–	2.72	–	–	7.47	–	21.75
Chrysophyceae	13.46	4.08	–	64.57	7.47	1473.68	1167.25
Dinophyceae	114.42	20.41	–	38.74	–	–	–
Euglenophyceae	–	–	–	–	44.85	–	–
Bacillariophyceae	161.54	333.33	114.71	103.31	74.76	4715.78	116.00
Chlorophyceae	1567.60	151.02	–	2027.52	1061.68	7663.15	420.50
Total	1990.83	518.37	114.71	5350.86	2686.57	115875.8	2573.75
Biomass, mg/l							
Cyanophyceae	0.046	0.009	–	11.162	0.950	30.605	0.011
Cryptophyceae	–	0.005	–		0.027	–	0.005
Chrysophyceae	–	0.003	0.014	0.893	0.003	0.409	0.015
Dinophyceae	1.633	5.065	0.008	3.594	–	–	–
Euglenophyceae	–	–	–		0.076	–	–
Bacillariophyceae	0.664	15.759	0.178	1.910	0.049	2.128	0.020
Chlorophyceae	0.495	0.449	0.023	15.261	2.362	7.086	0.003
Total	2.838	21.291	0.222	32.819	3.467	40.227	0.054

– – not found.

Water quality in the shallow brown-watered Lake Amalvas was also bad (Table 3). In Lake Amalvas, all water quality parameters studied (phytoplankton biomass, Chl a content, transparency) more than ten times exceeded good water quality values for shallow lakes. Cyanobacteria and green algae plankton species characteristic of highly eutrophicated waters were dominant. Twelve nuisance algae species were found (Table 2). In Lake Amalvas, phytoplankton investigations were carried out for the first time, therefore more biological and chemical parameters were necessary to assess the quality status of this water basin.

Based on phytoplankton research results, the shallow brown-watered Lake Žuvintas makes an exception.

According to phytoplankton biomass and Chl a content (Table 3) it should be determined as a good water quality lake. However, it is not so because of the high number of nuisance species (10 species, Table 2) and characteristic prevailing species in Lake Žuvintas plankton. The dominants have been generally the same, and the biomass and Chl a concentration have not undergone large fluctuations since 1952 (Markevičienė, 1962; Jankavičiūtė, 1968; Jankevičius et al., 1993; Kavaliauskienė, 1996). The prevailing species community was formed mainly by chrysophytes and diatoms. The high biomass of epiphytic and epipsamic diatoms found in the plankton characterizes Lake Žuvintas as an overgrown aquatic ecosystem. Only in 1960–1961 a high abundance of cyanobacteria *Microcystis aeruginosa* was observed, however, they were supplanted by small (1–2 µm in diameter) colonial cyanobacteria of the genera *Aphanocapsa, Aphanothece, Cyanodyction* in later phytoplankton investigations. Toxic algae, despite their large number (10 species), in Lake Žuvintas (Table 2) occurred only sporadically. It is clear that Lake Žuvintas does not meet the shallow lake type proposed by the DANCEE project. It must be ranked as a separate lake type.

Results of investigations of potentially toxic algae in plankton indicate the remaining gaps and needs for changes in nuisance algal species quality parameter values with regard to the implementation of the WFD requirements. The *Cyanophyceae* is the class with the most numerous toxic species in Lithuanian lakes (Kavaliauskienė, 1996), and occasionally blooms caused by them make trouble the livestock and people in 'swimming lakes' (Codd et al., 1989, 1999; Carmichael, 1994). Generally, the development of toxic algae increases with increasing the nutrient level, but also other factors may influence formation of blooms. The weather is especially important: the calm and warm weather will favour blue-green algae.

Twenty-seven algal species found in the Dovinė river basin lakes were referred by Codd et al. (1989, 1999), Carmichael (1994) and others as potential toxin producers responsible for the harmful effect in aquatic ecosystems (Table 2). Not necessarily all members of a genus or species produce toxins. Depending on species strains occurring in the lakes, these species may produce hazardous products (toxins). Therefore toxic species are often called potentially toxic. Plankton toxic algae species have a very wide ecological amplitude, therefore it was questioned how indicative they are for assessing the intensity of eutrophication processes in surface waters. In general, not only hazardous phytoplankton algae species number but also other parameters should be involved in quality assessment, e. g., hazardous algae biomass, their relative values in total phytoplankton biomass.

CONCLUSIONS

This assessment was only the first step in improving the water environment through an integrated river basin management. Information will continually be improved and upgraded to make the next step of lake characterisation more accurate than this first assessment. The next stage will be to further develop the characterisation by refining our information on the ecological status of lakes from all sources, including additional scientific and monitoring data.

The question is whether this frequency is corresponding to the needs of the WFD. The recommended parameters for water quality evaluation are the average values of different seasons. A single annual sample, even taken during a summer seasonal maximum, may have a low assessing value, especially for impacted water bodies, such as lakes in the Dovinė river basin, in which biotic community structure, their abundance and nutrient concentrations may vary through orders of magnitude within the annual cycle. The timing of seasonal maximum can be difficult to predict. Limited finances were the key issue for the density and frequency of our investigations. However, with regard to data obtained in earlier investigations in lakes of the Dovinė river basin, we consider that phytoplankton taken during a summer seasonal maximum is appropriate for assessing the ecological status of lakes.

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Jūratė Kasperovičienė

DOVINĖS UPĖS BASEINO EŽERŲ EKOLOGINĖS BŪKLĖS ĮVERTINIMAS PAGAL FITOPLANKTONO TYRIMŲ DUOMENIS

Santrauka

Remiantis DANCEE projekto atlikta Lietuvos vandens telkinių klasifikacija, tipologija bei nustatytais biologinių parametrų preliminariais etaloninių ir geros kokybės ežerų kriterijais, buvo atliktas Dovinės upės baseino keturių ežerų – Amalvas, Dusia, Simnas, Žuvintas – ekologinės būklės įvertinimas pagal fitoplanktono tyrimų duomenis. Darbe analizuojami fitoplanktono tyrimų rezultatai, gauti 2004 m. intensyvios vasaros vegetacijos laikotarpiu, bei lyginami su anksčiau ežeruose atliktų fitoplanktono tyrimų duomenimis. Pagal įvertintą ežerų vandens skaidrumą bei fitoplanktono biomasės, chlorofilo *a* kiekio ir potencialiai toksinių rūšių skaičiaus vertes tik giliame Dusios ežere nustatyti geros ekologinės būklės rodikliai. Sekliuose Amalvo ir Simno ežeruose šie rodikliai nuo keletos iki kelių dešimčių kartų viršija geros vandens kokybės vertes. Išimtį sudaro seklus Žuvinto ežeras, kuriame fitoplanktono parametrai, išskyrus toksinių rūšių skaičių, atitinka gerą seklių ežerų būklę. Fitoplanktono biomasės, pigmentų kiekio duomenys, ypač dumblių ir cianobakterijų rūšių įvairovė, susisteminti ankstesnių tyrimų rezultatai leidžia daryti prielaidą, kad pagal ES Bendrosios vandens politikos direktyvos reikalavimus šis ežeras turėtų būti išskirtas į atskirą Lietuvos ežerų tipą.

Raktažodžiai: