SUMMER SCHOOL

ECOLOGICAL STATE OF LAKE DUROWSKIE BASING ON ALGAE

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Table of Contents:

1. Introduction

Phytoplankton gather photosynthesizing microscopic organisms, adapted to live partly or continuously in the open of the seas, of lakes, ponds and river waters, where they contribute part or most of the organic carbon available to pelagic food webs. Phytoplankton obtains energy through the process of photosynthesis and must therefore live in the well-lit surface layer.

Accessory pigments may color the algae red, blue or golden-brown, if they are not green with chlorophyll as the dominant pigment. (R. Jan, Max L, and Rex L, 1996, Algal ecology, fresh water benthic ecosystem). It is a good biological indicator about the status of the lake.

Phytoplankton account for half of all photosynthetic activity on Earth and also counts the largest number of species known to response to environmental conditions like nutrients, organic pollution, acidification, salinity and makes it a very important ecological indicator.

Algae have a very important role in the evaluation of the eutrophication especially downstream where the flow rate is less. The advantages of using algae for the evaluation of the ecological state of waters are: are good indicators for short periods of time; are primary producers; sampling requires the involvement of a small number of specialists, it's cheap and easy to realise it; there are also standard methods for describing the algae communities; are also sensitive at pollutants.

According to Water Frame Directive, algae response first to environmental changes therefore are good indicators for the water quality.

2. Materials and Methods

2.1. Investigated area

Durowskie Lake is located in Wagrowiec, Greater Poland, 60 km away from Poznan. It coveres the area of 143,7 ha.

Table 1 Main characteristics of lake Durowskie

Surface	**143,7 ha**
Volume	11 322 900 m^3
Maximum depth	14,6 m
Average depth	7,9 m
Main tributary	Struga Golaniecka
Surface of the sampling area	2361,1 km^2
Surface of catchment area	1,581 ha
Share of agricultural area	58,26 %
Share of forests	33,52 %
Urban area	8,25 %

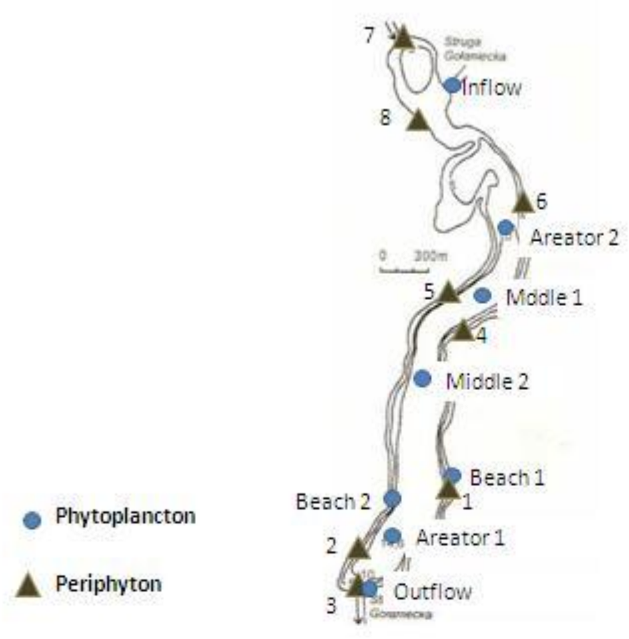

Figure 1 Map of sampling sites on Durowskie lake

2.2. Methodology

In order to the analysis of the phytoplankton, the water samples were collected from the lake Durowskie from the 1st July 2013 to the 6th July of 2013 for six days. The samples were taken from eight stations of the lake namely Aerator 1, Aerator 2, Middle 1, Middle 2, Inflow and Outflow, Beach 1 and Beach 2. Water sampler was used to collect samples. It is one of the most popular instruments in hydrobiology to collect samples from the lake. The depth of the samples that were collected was from 0 m, 1m and 2m. Periphyton samples were also collected from eight stations. From each station periphyton material was scratched from two stones from the bank of the lake. All samples were preserved with Lugol solution and brought to the laboratoty of Adam Mickiewicz Univerity for further investigation.

In the laboratory, phytoplanktonic and periphytic diatom species were identified to their respective species and the biomass of each species was calculated (Edler L. 1979). After the analysis the mixed trophic index of phytoplankton and the Diatom index (Bąk M., Witkowski A., Żelazna-Wieczorek J., Wojtal A.Z., Szczepocka E., Szulc K., Szulc B. 2012) at the periphytic sites was predicted to give a suggestion of the trophic state of Lake Durowskie. Moreover, the Jaccard and Shannon-Weaver index (Kawecka B., Eloranta P. 1994) were determined to compare the variations of phytoplankton communities between 2008 and 2011.

3. Results and Discussion

3.1. Number of Species

The laboratory analysis of all the samples collected during the field work in the year 2013 resulted in a total number of 71 algae species. Comparing this result with the one from 2012, an increase of species number can be observed. As can be seen in figure 2 the number of species was rising from 50 in 2008 to 84 in 2011. The sudden drop in year 2012 was explained by two factors. First one was an unusually rainy and cold June which led to colder water with higher turbidity that caused late development of the green algae which are adapted to warm and clear waters. Second explanation for the backdrop was the higher grazing pressure by zooplankton in the lake that can be attributed to the introduction of pike which control the predators of the zooplankton. In the year 2013 we observed significant increase in number of species. This can be caused by the drop in the piscivorous fish population and dominance of fish grazing on zooplankton. This led to diminished population of large zooplankton species that could control the phytoplankton population.

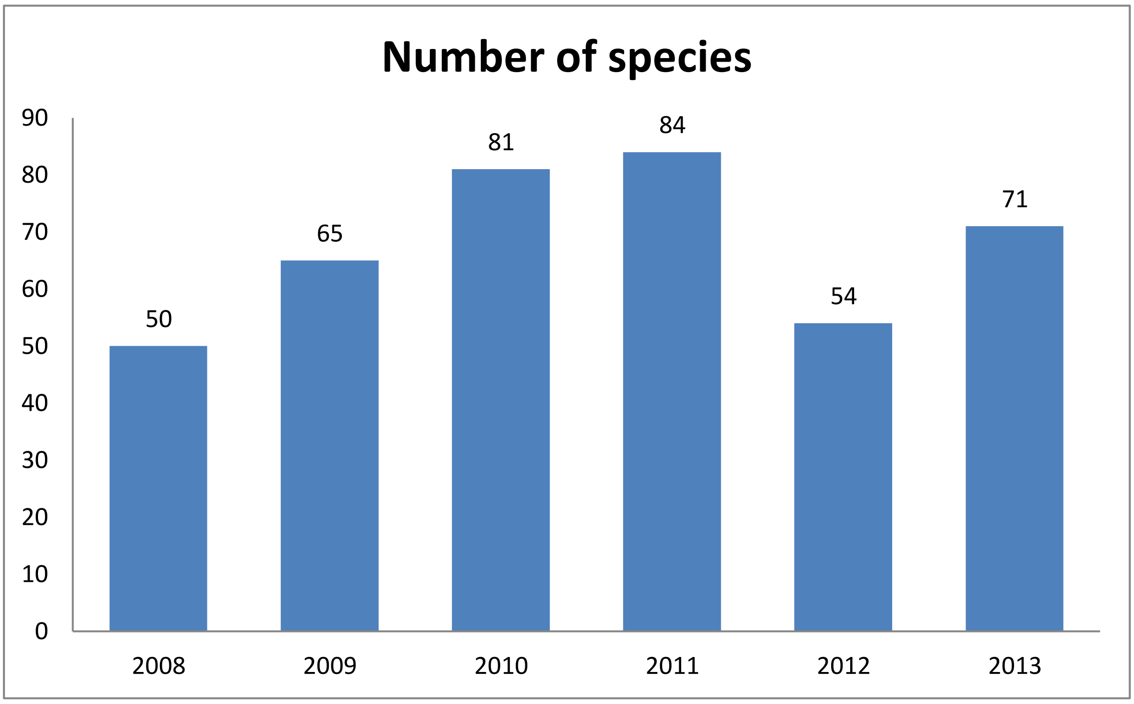

Figure 2 Total Number of Algae Species

3.2. Dominance of algae groups

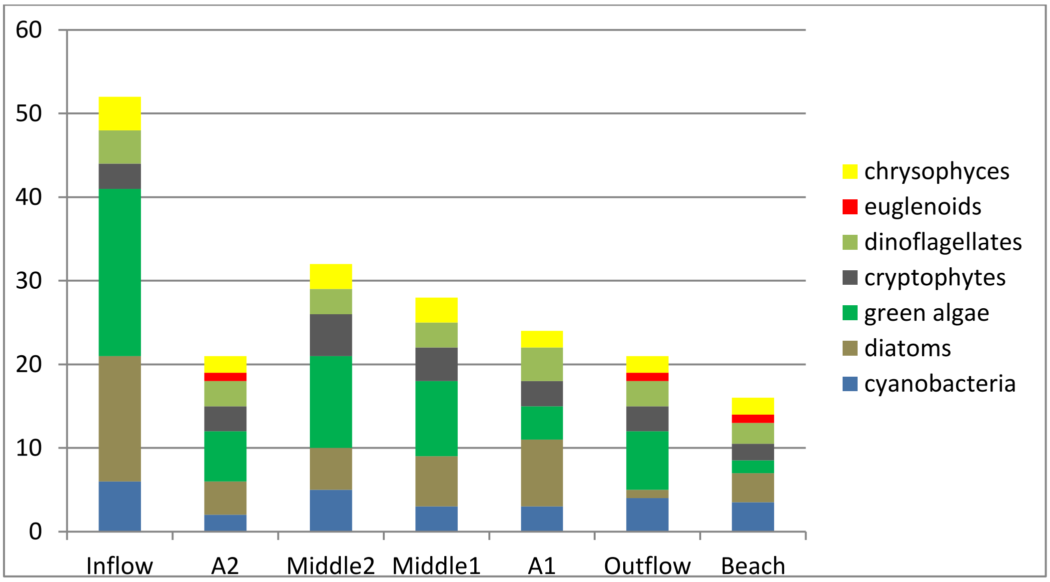

Figure 3 Number of species in every group of algae

In the figure number 3 we can see that the number of species occurring in different stations differ. The biggest amount of species was noted in the inflow which is the cause of river current bringing species from upper lakes and the river itself. Also species composition at that site is different than in the other parts of the lake. In the inflow abundance of cyanobacteria was noted, as well as of diatoms and green algae which are species characteristic for rivers.

In the next four figures the number of algae groups in percentage are shown.

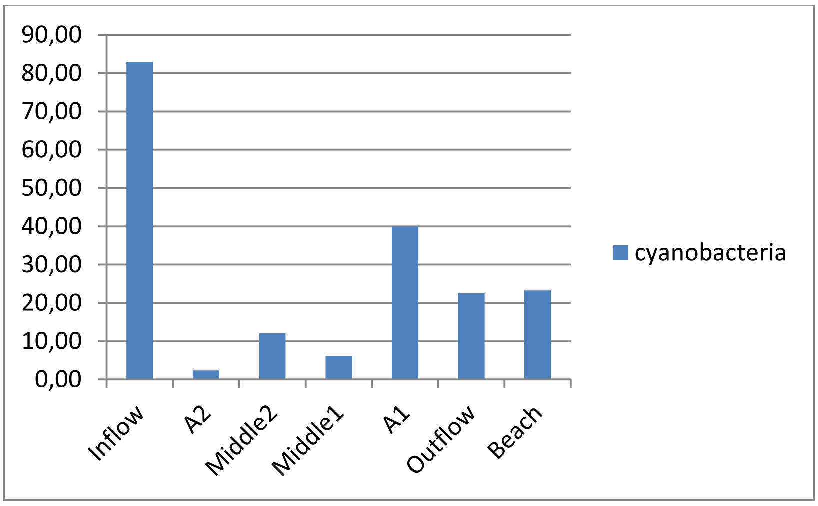

Figure 4 Number of cyanobacteria in %

More than 80% of Cyanobacteria was found in the Inflow because of the amount of sediments brought by river's current and the depth which wasn't bigger than 5 meters , comparing with the values from other sites where the values weren't bigger than 40% in the southern part of the lake and not more than 15% in the northern part of the lake. This indicates a higher water quality in the lake compared to the inflow.

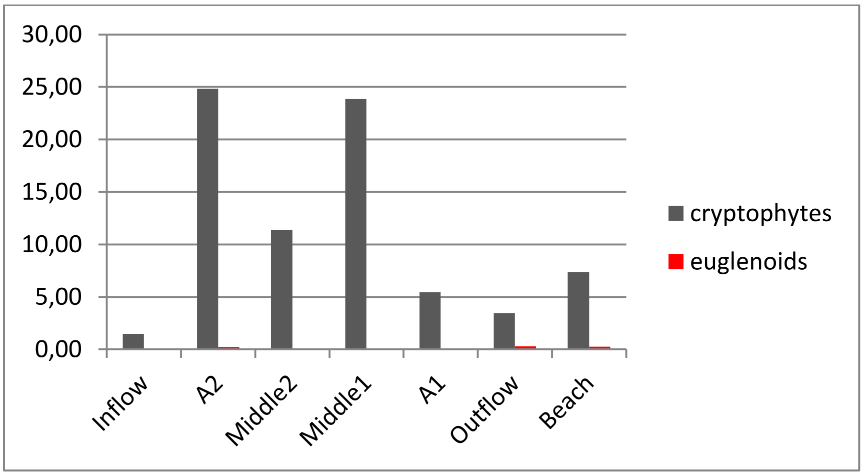

Figure 5 Number of cryptophytes and euglenoids in %

Cryptophytes and euglenoids are mixotrophic organisms feeding with bacteria and other small particles (Jones R.I., Ilmavirta V. 1998). As can be seen, these are dominant in the north part of the lake, because there are suspended organic particles in the water coming from inflow in the deeper waters around Aerator 2, Middle 1 and Middle 2, but in the south is a smaller amount of particles so the number of cryptophytes is also small.

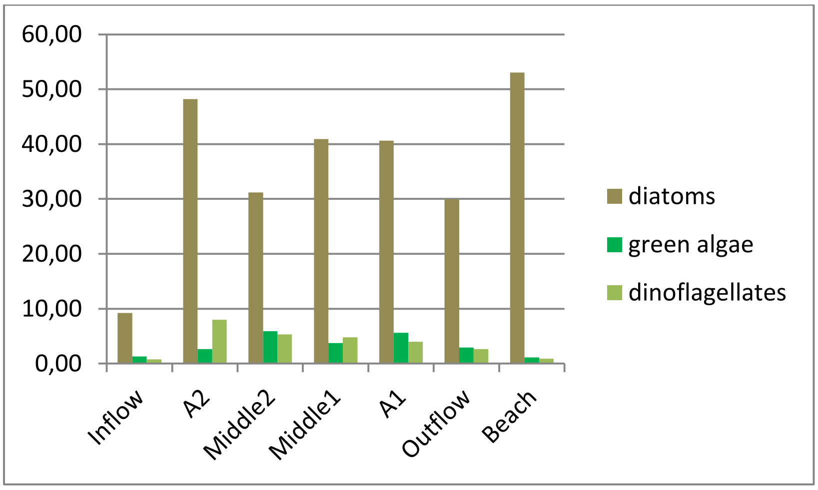

Figure 6 Number of diatoms, green algae and dinoflagellates in %

Diatoms are heavier organisms that can be found in the lower levels of the water, but because of the continuously movement of the water near the beach or the aerators we found a lot of species in the superficial water around this stations, that's why we have such big values in the graph.

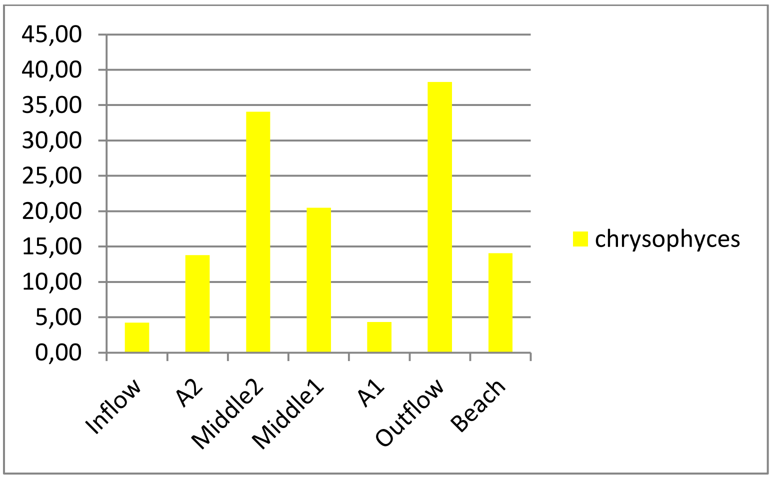

Figure 7 Number of chrysophyces in %

Increased values of the number of chrysophyces can be an effect of the weather conditions from the beginning of the year 2013. Prolonged winter and late spring caused abundance of this algae during investigation as they are specific for spring.

Indicator species prefer alkaline water with oxygen concentration above 75% or higher an eutrophic state of water quality. A good sign is appearance of oligotrophic species.

Table 2 Dominant species of phytoplankton

	Infl	A2	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B**
Erkenia subaequiciliata Skuja	0,00	11,75	19,84	13,71	15,40	42,05	0,00
Fragilaria crotonensis Kitton	7,74	38,65	36,72	47,30	28,29	31,30	55,16
Dinobryon bavaricum Imhoff	0,24	3,23	24,86	11,45	7,54	0,00	12,80
Cryptomonas erosa Ehrenberg	0,00	32,70	9,92	22,70	0,00	0,00	7,77
Limnothrix redekei (Van Goor) Meffert	79,33	3,89	8,67	4,84	25,02	20,06	10,91

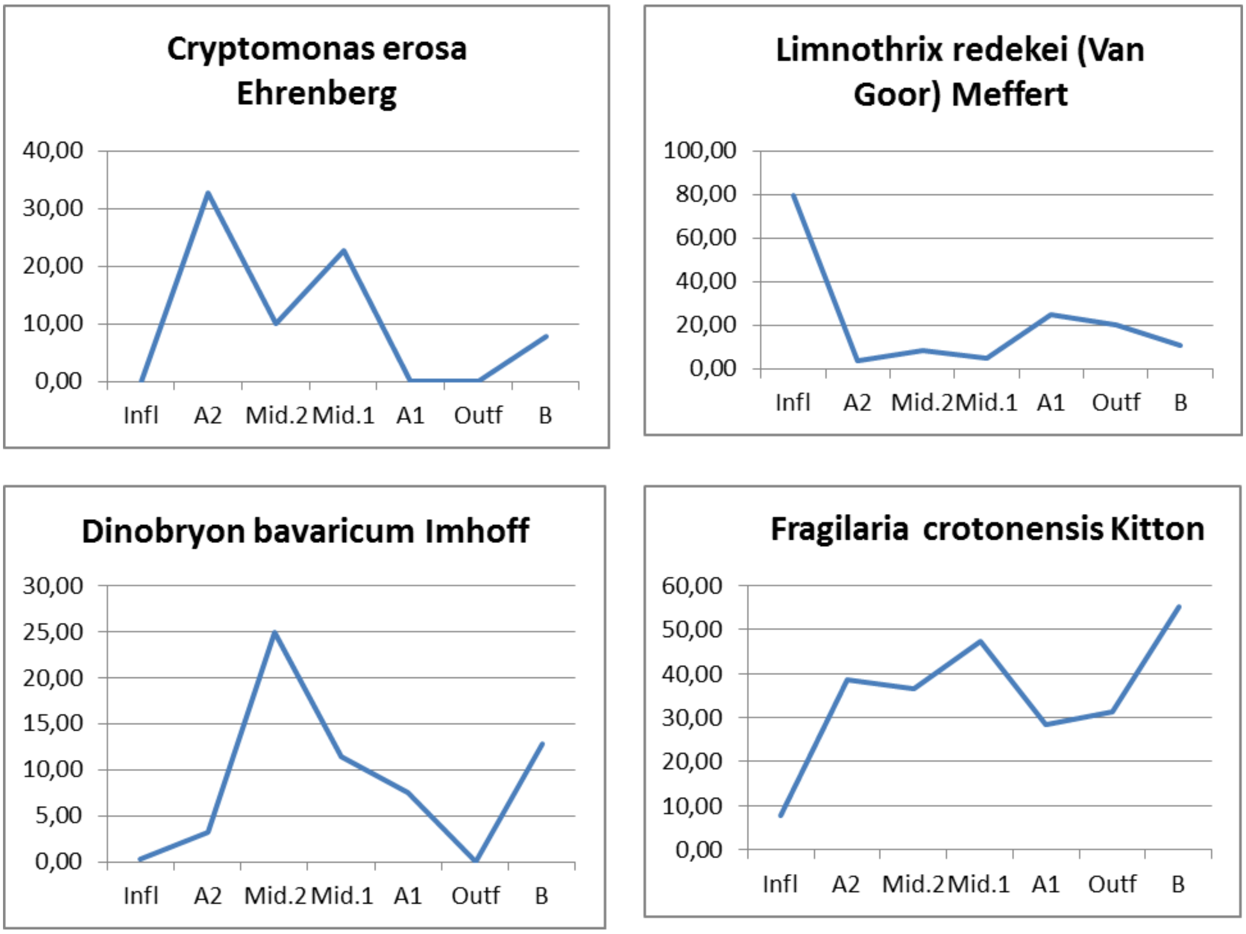

Figure 8 Structure of selected dominant species

3.3. Periphyton

Table 3 Dominants in periphyton community

Taxon	site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8
Achnanthes minutissima var. affinis (Grun.) Lan.-Bert.	50.56	15.38	25.18	31.68	6.73	11.39	14.36	7.25
Cymbella affinis Kützing	6.52	11.9	8.96		5.56		7.06	
Cymbella minuta Hilse ex Rabenhorst	4.49	6.78				16.48		
Fragilaria capucina (Desm.) Rabenhorst	4.72		6.30				9.97	
Amphora pediculus (Kütz.) Grunow		8.42	19.98					5.53
Fragilaria pinnata Ehr.			7.63	8.73		10.18		
Cyclotella radiosa (Grun.) Lemm.					5.56		5.35	5.89
Gomphonema olivaceum (Horn.) Breb.				17.29	21.23			
Fragilaria crotonensis Kitton	4.04						7.79	
Fragilaria ulna (Nitzsch) Lange-Bertalot	4.04							
Cocconeis pediculus Ehr.		10.81						
Gomphonema olivaceoides Hustedt				8.5				
Navicula radiosa Kützing				5.99				
Gomphonema parvulum (Kütz.) Kütz.					6.15			
Achnanthes minutissima var. gracillima (Mei.) L-Ber.						11.15		
Cocconeis placentula var. pseudolineata Geitler						7.39		
Cocconeis placentula Ehr.								17.59
Achnanthes exigua Grun.								7.89
Eunotia praerupta Ehr.								6.79

Below are presented ecological characteristics of selected dominant peryphiton species which indicate ecological conditions present in the lake.

***Achnantes minutissima* var. *affinis* (Grun.) Lan.-Bert.**

Prefers oligotrophic to eutrophic waters. It's poorly alcalic. In Central Europe has a dispersed distribution and it is not a very good indicator because is often confused with Achnantes minutissimum.

***Amphora pediculus* (Kutz.) Grunow**

Considered as one of mostly distributed and abundantly species in Central Europe. Occurs in wide range of trophic conditions preferring oligotrophic waters.

***Cyclotella radiosa (*Grun.) Lemm.**

It's a common species in pelagical areas especially in eutrophic waters. Prefers alcalic waters with oxygen concentration above 75%.

***Cymbella affinis* Kützing**

Species occurring in eutrophic, alcalic waters rich in calcium and with high oxygen concentration. It is an indicator of good ecological state.

***Cymbella minuta* Hilse ex Rabenh**

In Central Europe common species. Occuring also in antropogenicaly disturbed areas. Prefers circumneutral Ph waters.

***Fragilaria capucina* (Desm.) Rabenhorst**

Is a species which prefers mesotrophic waters with neutral Ph.

***Fragilaria pinnata* Ehr.**

Lives in all kind of waters more or less oligo to eutrophic. When settles in one area it occurs there permanently. It is an alkaliphilous species which prefers high concentration of Oxygen.

3.4. Diatom Index

According to Diatom Index the lake was divided into the northern and southern part due to tendencies in change of ecological state. In the stations from northern part the quality of water is on moderate level and a slight improvement was noted in four out of five stations. Worse water quality in this part of lake can be connected with the fishermen activity. In the stations from the southern part the water quality is poor. In all stations the quality of water was decreasing, in one station reaching almost the border of poor and bad state. This tendency is due to the recreational character of this area. One reason is the fishermen who put the bait in the water. Other reason is the activity of motor boats, as well as tourist using the local beaches. Produced waves hit the shore and decrease the visibility of water causing worse conditions for photosynthetic species.

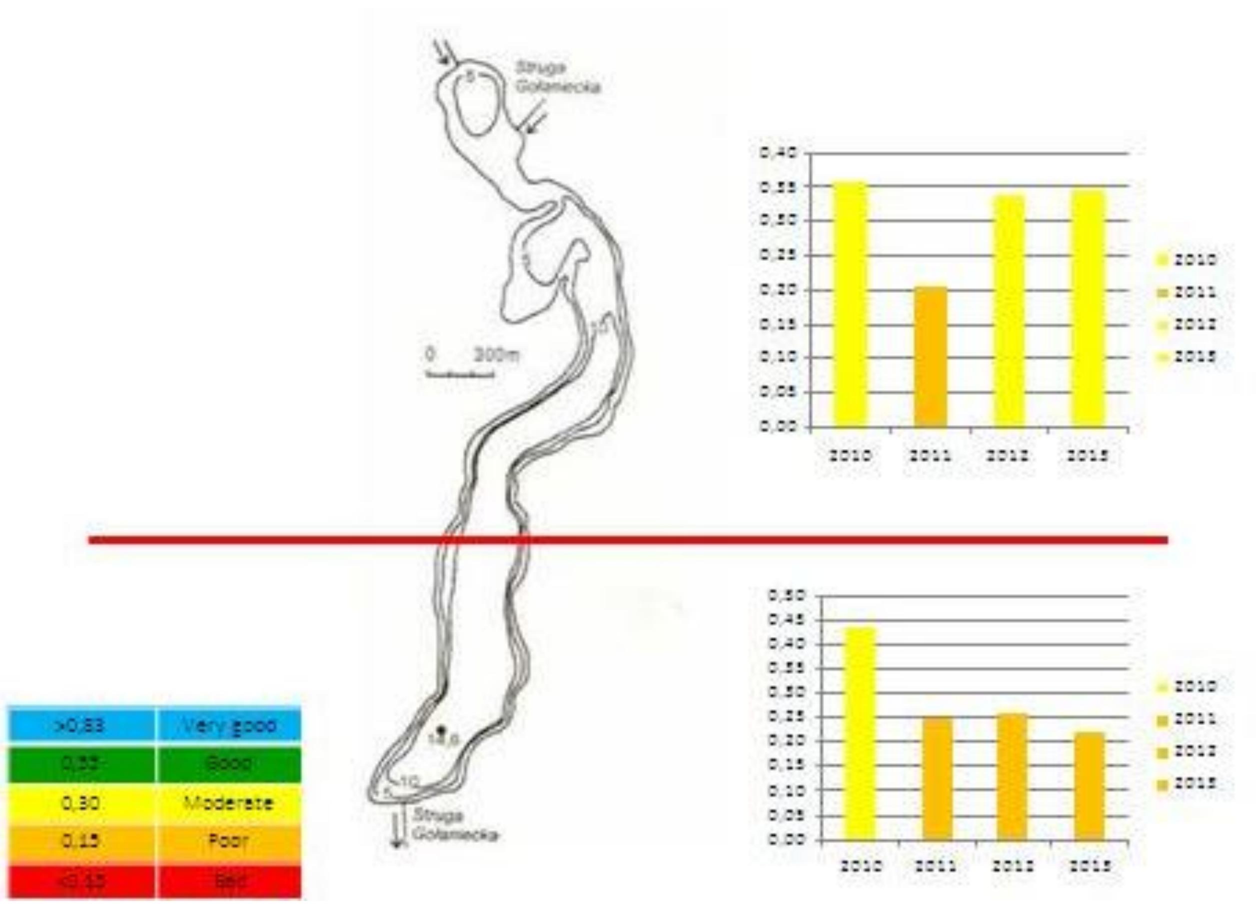

Figure 9 Differentiation between northern and southern part - Diatom Index

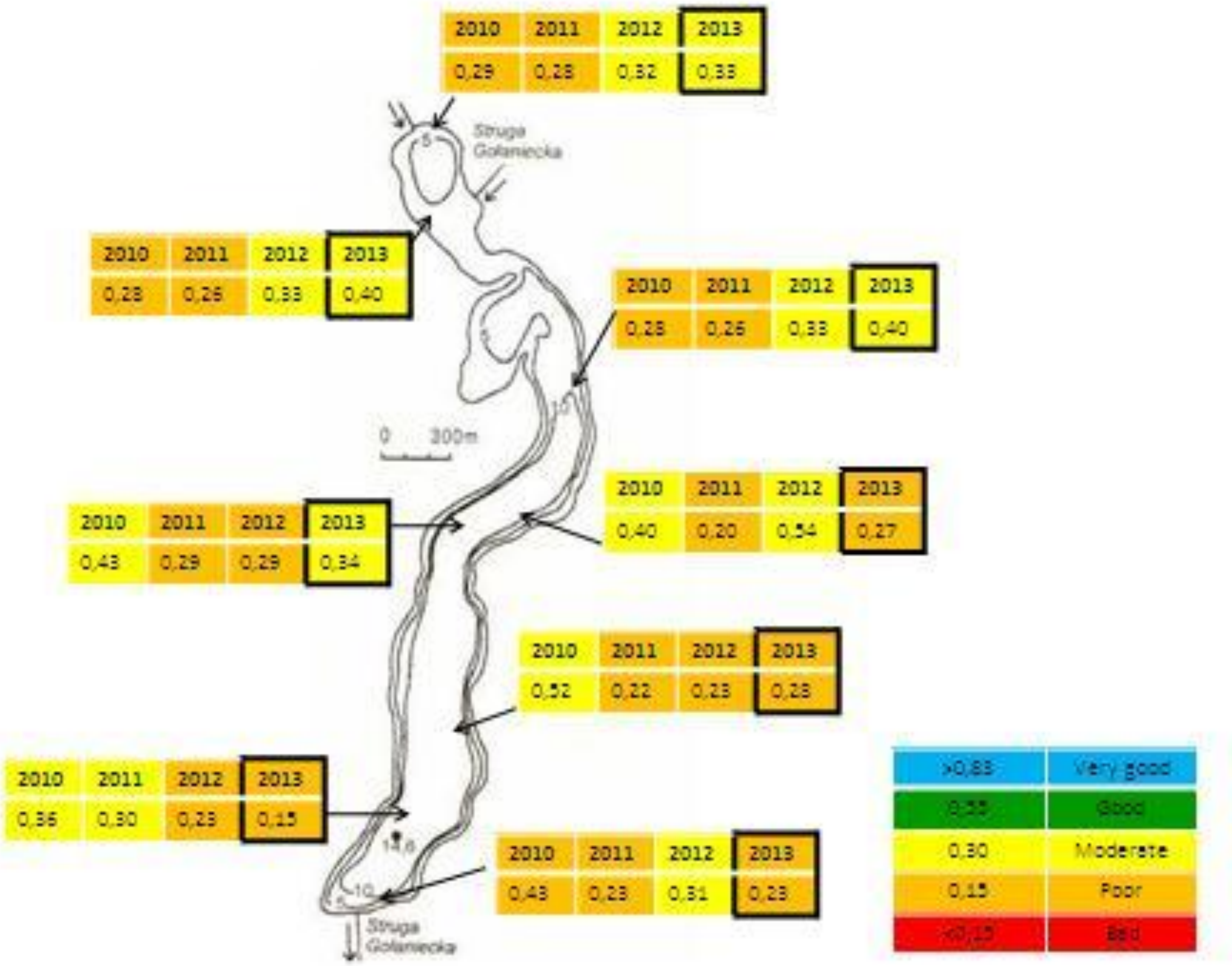

Figure 10 Diatom Inex throughout the years

3.5. Nygaards index

One of the indexes used to evaluate the trophic condition at Durowskie Lake was proposed by Nygaard (1949), and it is based in several algae groups.
Compound Quotient = (Cyanobacteria + Chlorococcales + Centric Diatoms + Euglenoids)/Desmids
The result of the calculation above points to one of the trophic level states seen at the table

Table 4 Nygaards index

Station	2008	2009	2010	2011	2012	2013	Trophyc State
Aerator 1	9,67	16	8,3	9	7	8	Hypertrophy
Aerator 2	-	26	11,5	5	8	14	Hypertrophy
Middle 1	-	9	12,5	13	3	5,5	Hypertrophy
Middle 2	-	-	8,3	18	9	7,5	Hypertrophy
Inflow	-	-	1,8	17	9	19	Hypertrophy
Outflow	-	-	6,5	5	-	12	Hypertrophy
North	-	-	11,5	5,3	-	-	Hypertrophy
Beach 1	-	-	-	3	9	7	Hypertrophy
Beach 2	-	-	-	-	5	6	Hypertrophy

Table 5 Nygaard Index - legend

Legend	Result
Dystrophic	**0 - 0.3**
Oligotrophic	**< 1.0**
Mesotrophic	**1.0 - 2.5**
Eutrophic	**3 - 5**
Hypertrophic	**5 - 43**

In last year in 2012, in the same sampling sites middle 1 and beach 2 showed eutrophic conditions and the others were hypertrophy. However, in this year, all of the sampling sites show hypertrophic state. This shows the condition is worse than last year. This may indicate anthropogenic disturbance in the lake.

3.6. ***Hildenbrandia rivularis***

Figure 11 *Hildenbrandia rivularis* (http://upload.wikimedia.org/wikipedia/commons/9/99/Hildenbrandia_rivularis_02_by-dpc.jpg)

Hildenbrandia rivularis is cosmopolitan red algae which prefers fresh flowing water habitats, but can occur in standing water. It is frequently used as a bioindicator of good water quality. Red crusty thallus overgrow stones. In Durowskie lake it occurs along shoreline in shallow water. This places have constant conditions of good oxygenated water. Also, there is frequent water waving especially during human water activities like riding on motor boats. Another factor of waving is wind which blows especially from west direction and causes washing the eastern shore by waves. The last factor causing appearance of the algae is shadow which is created by trees in park near the lake. Presence of this algae was noted in previous years and was increased. During this year study were found two new localities in south east part of the lake. The map below shows spreading of *Hildenbrandia rivularis* over the years 2011 to 2013.

Figure 12 Stations of *Hildenbrandia rivularis*

3.7. Relation between phytoplankton and zooplankton

On Wednesday, 3rd of July the samples to assess the content of zooplankton in the lake were taken. Samples were collected vertically on each meter of the lake in the deepest place (14m) near Areator 1. After analyzing the material the results showed very high amount of Rotifera – the smallest representative of zooplankton in Durowskie lake. Other groups were Cyclopoida, Cladocera and Calanoida which are Crustaceans. Results are shown on graphs.

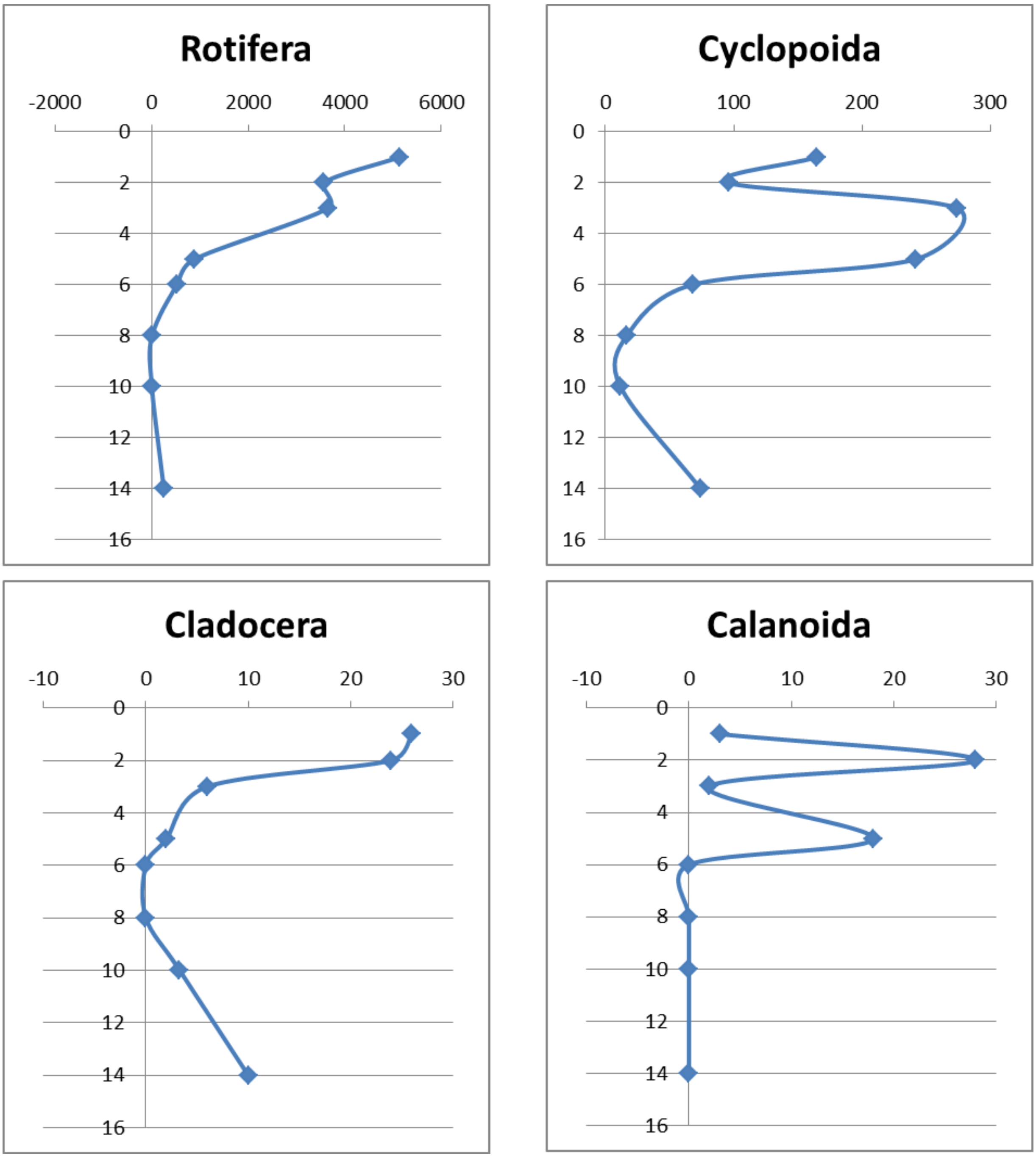

Figure 13 Occurence of zooplankton in Durowskie Lake

Listed animals occur only to a depth of six meters, this is caused by lack of oxygen in deeper parts of water. Some of them are present near the bottom, this may be because oxygenated water is pumped to the bottom from surface by Areator 1. Very important is abundance of each group. Rotifera occur in amount near 6000 specimens per liter, but they are really small and their activity do not influence significantly phytoplankton. The next most abundant group is Cyclopoida but they can sometimes feed on other planktonic animals, the highest degree of prevalence of them is on 3th to 4th meter. The group of Calanoida is very similar to previous one. They occurs to 6th meter but their abundance significantly decrease on the depth where Cyclopoida are dominant. This may be the reason of competition between two groups. The last group of planktonic animals -Cladocera -are present in smaller quantities than 30 individuals per liter. What is more, found specimens are species which never reaches big size. So they have no influence on big filamentous of phytoplankton.

All of this zooplankton groups are phytoplankton grazers. Normally water blooms are limited by planktonic animals.

Table 6 Phytoplankton species which are eaten by zooplankton

Phytoplankton species which are eaten by zooplankton	
eaten in the optimal amount	*Rhodomonas, Cryptomonas, Chrysochromulina parva, Chlamydomonas spp, Monoraphidium contortum;*
eaten in the medium amount	*Staphanodiscus hantzschii, Staphanodiscus binderanus, Aulacoseira granulata, Fragilaria acus, Ultotrix subtilissima, Anabena planctonica, Aphanizomanon flos-aquae;*
eaten in the small amount	*Asterionella formosa, Diatoma elongatum, Chlorella minutissima, Dinobryon spp, Mougeotia thylespora;*
Inedible	*Fragilaria crotonensis, Ceratium hirundinella, Peridinium cinctum, Pandorina morum, Eudorina spp, Closterium aciculare, Staurastrum cingulum, Anabena spiroides, Aphanizomenon flos-aquae, Microcystis aeruginosa, Woronichinia naegeliana*

In Lake Durowskie main factor of zooplankton limitation are predatory fishes which hunt using their eyes. In this way the main preys are big species of Cladocera and Copepoda. In the lake the dominate group is Rotifera, this means that they are too small for fishes to eat them. At the same time Rotifers are too small to feed on big filamentous of phytoplankton, they prefer to eat for example bacteria. The rest of listed groups are relatively small, so they are able to eat only the smaller parts of phytoplankton. In this way big filamentous and these which are inedible are able to develop, for example *Fragilaria crotonensis, Peridinium cinctum, Aphanizomenon flos-aquae* which are common in Durowskie Lake.

4. Conclusions

In our paper we have included the results of our researches based on planktonic organisms, with indicator role, trying to determine the ecological state of the lake Durowskie.

Jaccard Index showed just 40% similarity of this year's phytoplankton communities comparing with the year 2008. It indicates a further change of species composition from the time before the restoration processes begun.

Nygaard Index showed high trophy state in all investigated sites. This means the state of water trophy has worsen comparing to last year.

Diatom Index showed a slight improvement of water quality in the northern part of the lake but a significant decrease in the south. This trend is connected with the recreational character of the southern part of the lake, neighborhood of the city and connected with it anthropopressure.

Indicator species prefer water with pH above 7 and eutrophic state. They also need fairly high and continuously high oxygen concentration which means the oxygen conditions in the lake are not that bad. However we cannot forget that oxygenated part of the lake is only until 4th meter. Another good sign is appearance of oligotrophic species.

Estimating water quality basing on phytoplankton is very complicated because of its complexity. That is why some indices show improvement while the other decline of water quality. It depends on time and place of sampling sites and many other factors. Therefore our results should be treated as a part of a broader research including the investigation of macrophytes, animals and physico-chemical parameters.

Our recommendations for the future according to studies on Durowskie Lake are:

1. Stocking the lake by carnivorous fishes like pike, which can limit the populations of planktivorous fishes. We expect that in future it may result in the increase of big size individuals zooplankton which can control amount of phytoplankton.

2. Constant use of areators which place oxygenated water to the bottom. Durowskie lake has completely lack of oxygen below 4th meter.

3. Good practices of taking care of makrophytes which are able to compete with phytoplankton. For example stonewort (Charophyta) can successfully compete with planktonic algea for place and nutrients as well as they produce compound inhibiting growth of phytoplankton.

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ANNEX 1. Comparison of phytoplankton species composition in different investigated years in July in Lake Durowskie.

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
***Cyanoprokaryota* - cyanobacteria**						
Anabaena flos-aquae Brebisson		+				+
Aphanizomenon aphanizomenoides (Forti) Hort. & Kom.	+				+	
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+		
Aphanizomenon gracile Lemmerman	+					
Aphanizomenon isatschenkoi (Usacc.) Pros. - Lavrenko	+	+	+			
*Aphanocapsa grevillei (*Ber.) Rabenhorst		+				
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	+	+	+			+
Arthrospira massartii Kuff.		+				
Chroococcus limneticus Lemm.	+	+		+		
Chroococcus turgidus (Kűtz.) Naeg.		+		+		
Cyanogranis feruginea (Wawrik) Hind.		+	+			
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.			+	+		
Limnothrix lauterbornii(Schmidle) Anagn.		+				
Limnothrix redekei (Van Goor) Meffert	+		+	+	+	+
Lyngbya hieronymusii Lemm.		+				
Microcystis aeruginosa Kützing	+			+	+	+
Microcystis flos-aquae (Wittrock) Kirchner			+			+
Jaaginema gracile (Bocher) Anagn. et kom.		+				
Phormidium granulatum Gardn. Anagn.	+	+	+		+	
Phormidium tenue (Agards ex Gomont) Anagn. et kom.		+				
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg		+	+	+	+	+
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+	+	+
Pseudanabaena limnetica (Lemm.) Kom.	+	+	+			
Spirulina laxissima (W. West)			+			
Spirulina mior Kütz.					+	

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Oscillatoria grossegranulata Skuja						+
Bacillariophyceae - diatoms						
Achnanthes exigua Grun.			+			
Achnanthes minutissima Kützing	+		+	+		+
Amphora ovalis Kützing	+	+	+	+		
Amphora pediculus (Kütz.) Grun.			+			
Asterionella formosa Hasall		+		+	+	+
Cocconeis euglypta (Ehr.) Clevei	+					
Cocconeis placentula Ehr.	+		+	+	+	+
Cyclotella atomus Hustedt		+				
Cyclotella meneghiniana Kütz.	+	+	+			+
Cyclotella ocellata Pant.	+		+	+	+	+
Cyclotella operculata (Ag.) Kützing	+	+	+			+
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+
Cymbella affinis Kützing				+		
Cymbella microcephala Grun.				+		+
Cymbella minuta Hilse ex Rabenhorst	+		+	+	+	+
Diatoma vulgare Bory				+		
Fragilaria capucina (Desm.) Rabenhorst				+		+
Fragilaria crotonensis Kitton	+	+		+	+	+
Fragilaria pinnata Ehr.	+			+		
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+
Fragilaria ulna var. *angustissima* Sippen	+	+	+	+	+	+
Gomphonema acuminatum Ehr.					+	+
Gomphonema olivaceum (Horn.) Breb.			+	+		
Gomphonema parvulum (Kütz.) Kütz.				+		
Melosira varians Ag.	+					
Hippodonta capitata (Ehr.) L-B, Metz. et Witk.						+

Phytoplankton taxa	2008	2009	2010	2011	2012	2013
Navicula cincta (Ehr.) Ralfs	+	+	+			+
Navicula mensiculus Schumann	+					
Navicula radiosa Kützing			+	+	+	+
Naviula tripunctata (O.F. Muller) Bory de Sain. Van.			+			+
Nitzschia palea (Kütz.) W. Smith				+	+	+
Nitzschia recta Hantzsch ex Rabenh.						+
Nitzschia sigmoidea (Ehr.) W. Smith				+		
Nitzschia sinuata (W. Sm.) Grunow				+		
Pinnularia viridis (Nitzsch) Ehr.				+		
Placoneis gastrum(Ehr.) Meresch.		+				
Rhopalodia gibba (Ehr.) Muller						+
Staurosira construens Ehr.		+				
Chlorophyta- green algae						
Ankistrodesmus falcatus (Corda) Ralfs		+				
Botryococcus braunii Kütz.						+
Characium aqngustatum A. Braun		+		+	+	+
Chlamydomonas globosa Snow	+	+	+	+		+
Chlamydomonas passiva Skuja			+			+
Chlamydomonas reinchardtii Dangeard		+				
Closterium acutum var. *variabile* (Lemm.) Krieg.	+		+	+		
Coelasrum astroideum De Notaris			+	+	+	+
Coelastrum microporum Naegel.			+			
Coelastrum reticulatum (Dang.) Senn	+	+				
Cosmarium abbreviatum Raciborski	+		+	+	+	+
*Cosmarium exiguum*W. Archer		+				
Cosmarium margaritatum (Turp.) Ralfs				+		
Cosmarium phaseolus Brebisson in Ralfs	+		+	+		+
Cosmarium laeve Rabenhorst					+	

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Cosmarium regnellii Wille	+	+	+		+	
Crucigeniella rectnagulrais (Naeg.) Kom.						+
Crucigenia tetrapedia (Kirchner) W. et G.S. West			+			
Desmodesmus communis (Hegew.) Hegew.	+	+	+	+	+	+
Desmodesmus grahneisii (Heynig) Fott				+		
Desmodesmus naegellii (Meyen) Hegew.			+			
Desmodesmus opoliensis (Rchter) Hegew.			+			+
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	+		+			+
Dictyosphaerium pulchellum Wood	+	+	+	+		
Didymocystis planctonica Korsikov				+		
Elkatothrix gelatinosa Wille			+	+		+
Golenkinia radiata Chodat	+		+	+	+	+
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	+					+
Koliella longiseta (Vischer) Hindak	+					
Micractinium crassisetum Hortobagyi				+		
Micractinium pusillum Fresenius				+		
Mougeotia sp.				+	+	
Monoraphidium arcuatum (Kors.) Hindak	+					
Monoraphidium circinale (Nyg.) Nygaard	+					
Monoraphidium contortum (Thur.) Kom.-Legn.	+	+	+	+	+	+
Monoraphidium griffithii (Berk.) Kom.-Legn.	+		+			
Monoraphidium irregulare (G.M. Sm.) Kom.-Legn.	+		+			
Monoraphidium komarkovae Nygaard	+	+	+			
Monoraphidium minutom (Nageli) Kom. - Legn.		+				
Monoraphidium obtusum (Kors.)Kom. - Legn.	+					
Nephrocytium limneticum (G. M. Sm.) G. M. Sm.				+		
Oocystis lacustris Chodat	+	+	+	+	+	
Palmelochette tenerrima Kors.				+		

Phytoplankton taxa	2008	2009	2010	2011	2012	2013
Pandorina morum (O.F. Müller) Bory			+			+
Pediastrum boryanum (Turpin) Meneg.			+	+	+	+
Pediastrum simplex Meyen						+
Pediastrum duplex Meyen						+
Pediastrum tetras (Ehr.) Ralfs			+			
Phacotus lendneri Chodat.				+		
*Phacotus lenticularis (*Ehr.) Stein	+			+	+	+
Provasoliella saccata (Skuja) Ettl					+	
Pteromonas angulosa (Carter) Lemm.		+	+			
Pteromonas cordiformis Lemm.			+			
Scenedesmus acuminatus (Lager.) Chodat			+		+	
Scenedesmus bicaudatus Dedusenko			+	+	+	
Scenedesmus dimorphus (Turp.) Kütz.		+		+		
Scenedesmus ecornis (Ehr.) Chod.			+	+	+	
Scenedesmus obtusus Meyen				+		
Scenedesmus regularis Swirenko		+				
Scenedesmus verucosus Roll				+		
Sphaerocystis planctonica (Korsikov) Bourrelly				+	+	+
Staurastrum gracile Ralfs			+	+	+	+
Tetraedron caudatum (Corda) Hansgirg	+		+			
Tetraedron minimum (A. Br.) Hansgirg	+	+	+	+	+	+
Tetraedron triangulare (Chod.) Kom.	+	+		+		+
Tetrastrum glabrum (Roll) Ahlstr. et Tiff			+	+		
Tetrastrum staurogeanieforme (Schroed.) Lemm.			+	+		+
Treubaria schmidlei (Schroeder) Fott et Kovacik		+	+	+		+
Cryptophyta - cryptophytes						
Chroomonas acuta Uterm.	+					
Cryptomonas erosa Ehrenberg	+	+	+	+	+	+

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Cryptomonas gracilis Skuja		+				
Cryptomonas marssonii Skuja	+	+	+	+	+	+
Cryptomonas ovata Ehrenberg	+	+	+	+	+	+
Cryptomonas rostrata Troitzskaja emend I. Kiselev	+		+	+	+	+
Rhodomonas minuta Skuja	+	+	+	+	+	+
Dinophyta - dinophytes						
Ceratium hirundinella (F. B. Müller) Bergh	+	+		+	+	+
Gymnodinium aeruginosum Stein	+					+
Peridiniopsis cuningtonii Lemm.	+	+	+	+	+	+
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+	+	+
Peridinium gatunense Nygaard						+
Peridinopsis berolinense (Lemm.) Bourrelly	+	+	+	+	+	+
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	+		+	+	+	+
Euglenophyta - euglenoids						
Colacium vesiculosum Ehr.		+		+		+
Euglena caudata Hübner					+	
Euglena pisciformis Klebs		+		+		
Phacus orbicularis Hubner	+	+				
Trachelomonas hispida (Perty) Stein	+		+	+	+	+
Trachelomonas planctonica Swirenko	+		+	+		
Trachelomonas volocina Ehrenberg	+		+	+	+	+
Chrysophyceae - chrysophyces						
Chrysococcus rufescens Klebs				+		
Dinobryon bavaricum Imhoff		+	+	+	+	+
Dinobryon crenulatum W. et G.S. West		+	+	+		
Dinobryon divergens Imhof		+	+		+	+
Dinobryon sociale Ehrenberg	+		+	+		+
Erkenia subaequiciliata Skuja	+	+	+		+	+

ANNEX 2. List of phytoplankton species from different taxonomical algal groups and their frequency in Lake Durowskie from 01st to 06th July 2013 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2).

	n=1	n=6	n=2	n=2	n=6	n=1	n=1	n=1	n=20
Depth	**0m**	**0-2m**	**0m**	**0m**	**0-2m**	**0m**	**0m**	**0m**	**%**
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**	**Frequency**
Cyanoprokaryota - cyanobacteria									
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+	+	+	+	+	75
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	+	+	.	.	.	.	.	.	10
Limnothrix redekei (Van Goor) Meffert	+	+	+	+	+	+	+	+	100
Microcystis aeruginosa Kützing	.	.	.	.	.	.	.	+	5
Microcystis flos-aquae (Wittrock) Kirchner	+	.	.	.	.	.	.	.	5
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cron.	.	.	+	.	.	+	.	.	10
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+	+	+	+	+	90
Pseudanabaena limnetica (Lemm.) Kom.	.	.	+	.	.	.	.	.	5
Oscillatoria grossegranulata Skuja	+	.	.	.	.	.	.	.	5
Bacillariophyceae - diatoms									
Achnanthes minutissima Kützing	.	.	.	.	.	+	.	.	5
Asterionella formosa Hasall	.	+	+	+	.	.	.	.	15
Cocconeis placentula Ehr.	+	.	.	.	.	+	.	.	10
Cyclotella meneghiniana Kütz.	+	.	.	.	.	.	.	.	5
Cyclotella ocellata Pant.	.	.	.	.	+	+	.	.	10
Cyclotella operculata (Ag.) Kützing	+	.	.	.	.	.	.	.	5
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+	+	65
Cymbella microcephala Grun.	.	.	.	.	.	+	.	.	5
Cymbella minuta Hilse ex Rabenhorst	.	+	.	.	+	.	.	.	15
Fragilaria capucina (Desm.) Rabenhorst	.	.	.	.	.	+	.	.	5
Fragilaria crotonensis Kitton	+	+	+	+	+	+	+	+	100

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2	Frequency
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+	+	+	100
Fragilaria ulna var. *angustissima* Sippen	+	.	+	+	.	.	.	.	15
Gomphonema acuminatum Ehr.	+	.	.	.	.	.	.	.	5
Hippodonta capitata (Ehr.) Lange-Bertalot, Metz. et Witk.	+	.	.	.	.	.	.	.	5
Navicula cincta (Ehr.) Ralfs	+	.	.	.	+	.	.	.	10
Navicula radiosa Kützing	+	+	.	.	+	+	.	.	20
Naviula tripunctata (O.F. Muller) Bory de Saint-Vincent	+	.	.	.	.	.	.	.	5
Nitzschia palea (Kütz.) W. Smith	+	.	.	.	+	+	+	.	20
Nitzschia recta Hantzsch ex Rabenhorst	+	.	.	+	+	.	.	.	15
Rhopalodia gibba (Ehr.) Müller	+	.	.	.	.	.	.	.	5
Chlorophyta - green algae									
Botryococcus braunii Kütz.	.	.	+	.	+	.	.	.	10
Characium aqngustatum A. Braun	.	+	.	.	.	.	.	.	5
Chlamydomonas globosa Snow	.	.	.	.	.	+	.	.	5
Chlamydomonas passiva Skuja	+	.	.	.	.	.	.	.	5
Coelastrum astroideum De Notaris	+	+	.	.	+	.	.	.	20
Cosmarium abbreviatum Raciborski	.	.	+	.	.	.	.	.	5
Cosmarium phaseolus Brebisson in Ralfs	.	.	.	+	.	.	.	.	5
Cosmarium regnellii Wille	.	.	+	+	.	.	.	.	10
Crucigeniella rectnagulrais (Naeg.) Kom.	+	.	.	.	.	.	.	.	5
Desmodesmus communis (Hegew.) Hegew.	+	+	.	.	+	.	+	.	30
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	+	.	.	.	.	.	.	.	5
Desmodesmus opoliensis (Rchter) Hegew.	.	.	+	+	.	.	.	.	10
Elkatothrix gelatinosa Wille	.	.	.	.	+	.	.	.	5
Golenkinia radiata Chodat	.	+	+	+	+	+	.	+	75
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	+	.	.	.	.	.	.	.	5
Monoraphidium contortum (Thur.) Kom.-Legn.	.	+	+	+	+	+	.	.	35
Pandorina morum (O.F. Müller) Bory	.	.	.	.	.	+	.	.	5

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2	Frequency
Pediastrum boryanum (Turpin) Meneg.	.	+	.	.	+	.	.	.	15
Pediastrum simplex Meyen	+	.	.	.	.	.	.	.	5
Pediastrum duplex Meyen	+	.	.	.	.	.	.	.	5
*Phacotus lenticularis (*Ehr.) Stein	+	+	+	+	+	+	.	.	60
Sphaerocystis planctonica (Korsikov) Bourrelly	+	+	+	+	+	+	+	.	5
Tetraedron minimum (A. Br.) Hansgirg	+	+	+	+	+	+	.	.	80
Tetraedron triangulare (Chod.) Kom.	.	.	+	+	+	.	.	.	35
Tetrastrum staurogeanieforme (Schroed.) Lemm.	.	.	+	.	.	.	.	.	15
Treubaria schmidlei (Schroeder) Fott et Kovacik	+	.	.	.	.	.	.	.	5
Staurastrum gracile Ralfs	.	.	.	.	+	.	.	.	5
Cryptophyta - cryptophytes									
Cryptomonas erosa Ehrenberg	+	+	+	+	+	+	+	+	95
Cryptomonas marssonii Skuja	.	+	+	+	+	.	+	.	50
Cryptomonas ovata Ehrenberg	+	+	+	+	.	+	.	.	25
Cryptomonas rostrata Troitzskaja emend I. Kiselev	+	+	+	+	+	.	.	+	50
Rhodomonas minuta Skuja	.	+	+	.	+	+	.	.	35
Dinophyta - dinoflagellates									
Ceratium hirundinella (F. B. Müller) Bergh	+	+	.	.	+	.	.	.	25
Gymnodinium aeruginosum Stein	.	.	.	.	.	+	.	.	5
Peridiniopsis cuningtonii Lemm.	+	+	+	+	+	+	+	+	90
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+	+	+	+	+	80
Peridinium willei Huitfeld-Kaas	+	.	.	.	.	.	.	.	5
Peridinium gatunense Nygaard	.	+	.	.	.	.	.	.	5
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	.	+	+	+	+	.	+	.	65
Euglenophyta - euglenoids									
Trachelomonas hispida (Perty) Stein	.	+	.	.	+	.	+	.	15
Trachelomonas volocina Ehrenberg	.	.	.	.	.	+	.	.	5
Colacium vesiculosum Ehr.	.	.	.	.	+	.	.	.	5

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2	Frequency
Chrysophyceae - chrysophyces									
Erkenia subaequiciliata Skuja	+	+	+	+	+	+	+	+	95
Dinobryon sociale Ehrenberg	+	.	.	.	.	.	.	.	5
Dinobryon divergens Imhof	+	.	+	+	.	.	.	.	15
Dinobryon bavaricum Imhoff	+	+	+	+	+	+	+	+	75

ANNEX 3. Average number of phytoplankton species cells (ind./L) from different depth in Lake Durowskie from 01st to 06th July 2013 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2; * - n=2).

Depth	0m	*0m	*1m	*2m	*0m	*0m	*0m	*1m	*2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Cyanoprokaryota - cyanobacteria												
Aphanizomenon flos-aquae (L.) Ralfs	120800	.	800	160	3040	1920	1920	960	640	2400	1600	5600
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	2400	.	.	480	.	.	.	.	.	.	.	.
Limnothrix redekei (Van Goor) Meffert	2622400	10800	2400	6400	12160	12320	24480	9120	8000	100000	33600	27200
Microcystis aeruginosa Kützing	.	.	.	.	.	.	.	.	.	.	.	1600
Microcystis flos-aquae (Wittrock) Kirchner	800	.	.	.	.	.	.	.	.	.	.	.
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cron.	.	.	.	.	320	.	.	.	.	8000	.	.
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	227200	1200	1280	800	5920	5120	13440	6720	4160	19200	43200	31200
Pseudanabaena limnetica (Lemm.) Kom.	.	.	.	.	2080	.	.	.	.	.	.	.
Oscillatoria grossegranulata Skuja	800	.	.	.	.	.	.	.	.	.	.	.
Total	**2974400**	**12000**	**4480**	**7840**	**23520**	**19360**	**39840**	**16800**	**12800**	**129600**	**78400**	**65600**
Bacillariophyceae - diatoms												
Achnanthes minutissima Kützing	.	.	.	.	.	.	.	.	.	800	.	.
Asterionella formosa Hasall	.	3200	.	.	5120	2560	.	.	.	.	.	.

Depth	0m	0m	1m	2m	0m	0m	0m	1m	2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Cocconeis placentula Ehr.	800	.	.	.	.	.	.	.	.	4000	.	.
Cyclotella meneghiniana Kütz.	1600	.	.	.	.	.	.	.	.	.	.	.
Cyclotella ocellata Pant.	.	.	.	.	.	.	800	.	.	1600	.	.
Cyclotella operculata (Ag.) Kützing	3200	.	.	.	.	.	.	.	.	.	.	.
Cyclotella radiosa (Grun.) Lemm.	32800	400	320	480	1280	640	6440	320	800	2400	1600	7200
Cymbella microcephala Grun.	.	.	.	.	.	.	.	.	.	800	.	.
Cymbella minuta Hilse ex Rabenhorst	.	.	160	160	.	.	640	.	.	.	.	.
Fragilaria capucina (Desm.) Rabenhorst	.	.	.	.	.	.	.	.	.	800	.	.
Fragilaria crotonensis Kitton	256000	239200	13440	23840	51520	120320	18240	14240	9920	156000	151200	156800
Fragilaria ulna (Nitzsch) Lange-Bertalot	16000	5600	480	3520	2240	3360	13280	2880	1440	4800	4000	7200
Fragilaria ulna var. *angustissima* Sippen	12000	.	.	.	640	480	.	.	.	.	.	.
Gomphonema acuminatum Ehr.	800	.	.	.	.	.	.	.	.	.	.	.
Hippodonta capitata (Ehr.) Lange-Bert., Metz. et Witk.	800	.	.	.	.	.	.	.	.	.	.	.
Navicula cincta (Ehr.) Ralfs	800	.	.	.	.	.	.	160	.	.	.	.
Navicula radiosa Kützing	800	.	160	.	.	.	320	.	.	800	.	.
Naviula tripunctata (O.F. Muller) Bory de Sain.Vin.	800	.	.	.	.	.	.	.	.	.	.	.
Nitzschia palea (Kütz.) W. Smith	3200	.	.	.	.	.	480	.	.	800	800	.
Nitzschia recta Hantzsch ex Rabenhorst	800	.	.	.	.	1440	320	.	.	.	.	.
Rhopalodia gibba (Ehr.) Müller	1600	.	.	.	.	.	.	.	.	.	.	.
Total	**332000**	**248400**	**14560**	**28000**	**60800**	**128800**	**40520**	**17600**	**12160**	**172800**	**157600**	**171200**
Chlorophyta - green algae												
Botryococcus braunii Kütz.	.	.	.	.	480	.	.	160	.	.	.	.
Characium aqngustatum A. Braun	.	.	.	320	.	.	.	.	.	.	.	.
Chlamydomonas globosa Snow	.	.	.	.	.	.	.	.	.	2400	.	.
Chlamydomonas passiva Skuja	3200	.	.	.	.	.	.	.	.	.	.	.
Coelastrum astroideum De Notaris	5600	.	160	640	.	.	.	.	320	.	.	.
Cosmarium abbreviatum Raciborski	.	.	.	.	160	.	.	.	.	.	.	.
Cosmarium phaseolus Brebisson in Ralfs	.	.	.	.	.	160	.	.	.	.	.	.

Depth	0m	0m	1m	2m	0m	0m	0m	1m	2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Cosmarium regnellii Wille	.	.	.	.	800	320	.	.	.	.	.	.
Crucigeniella rectnagulrais (Naeg.) Kom.	1600	.	.	.	.	.	.	.	.	.	.	.
Desmodesmus communis (Hegew.) Hegew.	1600	800	160	.	.	.	160	.	320	.	1600	.
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	1600	.	.	.	.	.	.	.	.	.	.	.
Desmodesmus opoliensis (Rchter) Hegew.	.	.	.	.	160	160	.	.	.	.	.	.
Elkatothrix gelatinosa Wille	.	.	.	.	.	.	.	.	320	.	.	.
Golenkinia radiata Chodat	.	6400	1120	800	4160	4640	.	1120	2080	2400	.	4800
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	3200	.	.	.	.	.	.	.	.	.	.	.
Monoraphidium contortum (Thur.) Kom.-Legn.	.	400	.	160	960	640	.	.	480	800	.	.
Pandorina morum (O.F. Müller) Bory	.	.	.	.	.	.	.	.	.	800	.	.
Pediastrum boryanum (Turpin) Meneg.	.	1200	320	.	.	.	.	.	160	.	.	.
Pediastrum simplex Meyen	1600	.	.	.	.	.	.	.	.	.	.	.
Pediastrum duplex Meyen	800	.	.	.	.	.	.	.	.	.	.	.
*Phacotus lenticularis (*Ehr.) Stein	16800	1200	.	320	1920	1120	4480	1120	1120	2400	.	.
Sphaerocystis planctonica (Korsikov) Bourrelly	4000	3600	2400	2720	1440	4320	800	3200	2080	5600	800	.
Tetraedron minimum (A. Br.) Hansgirg	4000	.	.	160	1120	320	.	.	160	2400	.	.
Tetraedron triangulare (Chod.) Kom.	.	.	.	.	160	160	.	320	.	.	.	.
Tetrastrum staurogeanieforme (Schroed.) Lemm.	.	.	.	.	160	.	.	.	.	.	.	.
Treubaria schmidlei (Schroeder) Fott et Kovacik	4000	.	.	.	.	.	.	.	.	.	.	.
Staurastrum gracile Ralfs	.	.	.	.	.	.	160	.	160	.	.	.
Total	**48000**	**13600**	**4160**	**5120**	**11520**	**11840**	**5600**	**5920**	**7200**	**16800**	**2400**	**4800**
Cryptophyta - cryptophytes												
Cryptomonas erosa Ehrenberg	27200	125600	27360	15360	13920	57760	3360	2240	2080	9600	27200	16000
Cryptomonas marssonii Skuja	.	1200	160	320	320	320	1920	1280	.	.	800	.
Cryptomonas ovata Ehrenberg	24800	.	7840	.	4960	6880	.	.	.	8800	.	.
Cryptomonas rostrata Troitzskaja emend I. Kiselev	800	1200	2400	160	2240	10080	.	480	.	.	.	1600
Rhodomonas minuta Skuja	.	.	160	320	800	.	160	.	320	1600	.	.
Total	**52800**	**128000**	**37920**	**16160**	**22240**	**75040**	**5440**	**4000**	**2400**	**20000**	**28000**	**17600**

Depth	0m	0m	1m	2m	0m	0m	0m	1m	2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Dinophyta - dinoflagellates												
Ceratium hirundinella (F. B. Müller) Bergh	800	.	160	.	.	.	160	160	160	.	.	.
Gymnodinium aeruginosum Stein	.	.	.	.	.	.	.	.	.	800	.	.
Peridiniopsis cuningtonii Lemm.	26400	30400	2560	1920	4960	8640	1760	1280	1120	13600	800	1600
Peridinium cinctum (O.F. Müller) Ehrenberg	800	9600	640	1120	1920	3200	800	1440	1120	800	800	800
Peridinium willei Huitfeld-Kaas	800	.	.	.	.	.	.	.	.	.	.	.
Peridinium gatunense Nygaard	.	.	.	160	.	.	.	.	.	.	.	.
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	.	1200	960	160	3520	3360	1280	160	480	.	1600	.
Total	**28800**	**41200**	**4320**	**3360**	**10400**	**15200**	**4000**	**3040**	**2880**	**15200**	**3200**	**2400**
Euglenophyta - euglenoids												
Trachelomonas hispida (Perty) Stein	.	1200	.	.	.	.	.	.	160	.	1600	.
Trachelomonas volocina Ehrenberg	.	.	.	.	.	.	.	.	.	1600	.	.
Colacium vesiculosum Ehr.	.	.	.	.	.	.	.	.	480	.	.	.
Total	**0**	**1200**	**0**	**0**	**0**	**0**	**0**	**0**	**640**	**1600**	**1600**	**0**
Chrysophyceae - chrysophyces												
Erkenia subaequiciliata Skuja	60800	26000	12160	5760	27840	34880	3200	3360	16000	209600	5600	9600
Dinobryon sociale Ehrenberg	11200	.	.	.	.	.	.	.	.	.	.	.
Dinobryon divergens Imhof	800	.	.	.	3680	480	.	.	.	.	.	.
Dinobryon bavaricum Imhoff	79200	45200	800	1920	34880	29120	1120	4320	4800	11200	19200	52800
Total	**152000**	**71200**	**12960**	**7680**	**66400**	**64480**	**4320**	**7680**	**20800**	**220800**	**24800**	**62400**

ANNEX 4. Average biomass of phytoplankton species (mg/L) from different depth in Lake Durowskie from 01st to 06th July 2013 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2; * - n=2).

Depth	**0m**	***0m**	***1m**	***2m**	***0m**	***0m**	***0m**	***1m**	***2m**	**0m**	**0m**	**0m**
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Cyanoprokaryota - cyanobacteria												
Aphanizomenon flos-aquae (L.) Ralfs	0.236	.	0.004	0.001	0.0145	0.0095	0.038	0.0045	0.0025	0.005	0.003	0.011
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	0.001	.	.	0.0005	.	.	.	.	.	.	.	.
Limnothrix redekei (Van Goor) Meffert	0.823	0.0035	0.002	0.0055	0.01	0.0095	0.0195	0.007	0.0065	0.031	0.011	0.009
Microcystis aeruginosa Kützing	.	.	.	.	.	.	.	.	.	.	.	0.001
Microcystis flos-aquae (Wittrock) Kirchner	0.001	.	.	.	.	.	.	.	.	.	.	.
Planktolyngbya limnetica (Lem.) Kom. – Leg. et Cr.	.	.	.	.	0.0005	.	.	.	.	0.003	.	.
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	0.285	0.0015	0.004	0.0025	0.0185	0.016	0.291	0.021	0.013	0.024	0.054	0.039
Pseudanabaena limnetica (Lemm.) Kom.	.	.	.	.	0.0015	.	.	.	.	.	.	.
Oscillatoria grossegranulata Skuja	0.002	.	.	.	.	.	.	.	.	.	.	.
Total	**1.348**	**0.005**	**0.01**	**0.0095**	**0.045**	**0.035**	**0.3485**	**0.0325**	**0.022**	**0.063**	**0.068**	**0.06**
Bacillariophyceae - diatoms												
Achnanthes minutissima Kützing	.	.	.	.	.	.	.	.	.	0.001	.	.
Asterionella formosa Hasall	.	0.0005	.	.	0.0025	0.001	.	.	.	.	.	.
Cocconeis placentula Ehr.	0.004	.	.	.	.	.	.	.	.	0.022	.	.
Cyclotella meneghiniana Kütz.	0.002	.	.	.	.	.	.	.	.	.	.	.
Cyclotella ocellata Pant.	.	.	.	.	.	.	0.002	.	.	0.002	.	.
Cyclotella operculata (Ag.) Kützing	0.003	.	.	.	.	.	.	.	.	.	.	.
Cyclotella radiosa (Grun.) Lemm.	0.041	0.0005	0.001	0.0015	0.004	0.002	0.0145	0.001	0.0025	0.003	0.002	0.009
Cymbella microcephala Grun.	.	.	.	.	.	.	.	.	.	0.0003	.	.
Cymbella minuta Hilse ex Rabenhorst	.	.	0.0005	0.001	.	.	0.0295	.	.	.	.	.
Fragilaria capucina (Desm.) Rabenhorst	.	.	.	.	.	.	.	.	.	0.0004	.	.
Fragilaria crotonensis Kitton	0.116	0.1085	0.0155	0.027	0.058	0.1355	0.0205	0.016	0.003	0.071	0.068	0.071
Fragilaria ulna (Nitzsch) Lange-Bertalot	0.022	0.0075	0.0015	0.01185	0.0045	0.011	0.0845	0.0105	0.0045	0.007	0.005	0.010

Depth	0m	*0m	*1m	*2m	*0m	*0m	*0m	*1m	*2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Fragilaria ulna var. *angustissima* Sippen	0.007	.	.	.	0.004	0.003	.	.	.	.	.	.
Gomphonema acuminatum Ehr.	0.001	.	.	.	.	.	.	.	.	.	.	.
Hippodonta capitata (Ehr.) Lange-Ber.. Metz. et Witk.	0.003	.	.	.	.	.	.	.	.	.	.	.
Navicula cincta (Ehr.) Ralfs	0.002	.	.	.	.	.	.	0.0005	.	.	.	.
Navicula radiosa Kützing	0.002	.	0.001	.	.	.	0.02	.	.	0.001	.	.
Naviula tripunctata (O.F. Muller) Bory de Sain.Vin.	0.002	.	.	.	.	.	.	.	.	.	.	.
Nitzschia palea (Kütz.) W. Smith	0.003	.	.	.	.	.	0.001	.	.	0.001	0.001	.
Nitzschia recta Hantzsch ex Rabenhorst	0.008	.	.	.	.	.	0.0085	.	.	.	.	.
Rhopalodia gibba (Ehr.) Müller	0.011	.	.	.	.	.	.	.	.	.	.	.
Total	**0.227**	**0.117**	**0.0195**	**0.04135**	**0.073**	**0.1525**	**0.1805**	**0.028**	**0.01**	**0.1087**	**0.076**	**0.09**
Chlorophyta - green algae												
Botryococcus braunii Kütz.	.	.	.	.	0.001	0.0035	.	0.0005	.	.	.	.
Characium aqngustatum A. Braun	.	.	.	0.001	.	.	.	.	.	.	.	.
Chlamydomonas globosa Snow	.	.	.	.	.	.	.	.	.	0.0003	.	.
Chlamydomonas passiva Skuja	0.003	.	.	.	.	.	.	.	.	.	.	.
Coelastrum astroideum De Notaris	0.018	.	0.0015	0.005	.	.	.	.	0.0025	.	.	.
Cosmarium abbreviatum Raciborski	.	.	.	.	0.0005	.	.	.	.	.	.	.
Cosmarium phaseolus Brebisson in Ralfs	.	.	.	.	.	0.002	.	.	.	.	.	.
Cosmarium regnellii Wille	.	.	.	.	0.001	0.0004	.	.	.	.	.	.
Crucigeniella rectnagulrais (Naeg.) Kom.	0.0002	.	.	.	.	.	.	.	.	.	.	.
Desmodesmus communis (Hegew.) Hegew.	0.001	0.0005	0.0005	.	.	.	0.0005	.	0.0005	.	0.001	.
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	0.001	.	.	.	.	.	.	.	.	.	.	.
Desmodesmus opoliensis (Rchter) Hegew.	.	.	.	.	0.0005	0.0005	.	.	.	.	.	.
Elkatothrix gelatinosa Wille	.	.	.	.	.	.	.	.	0.001	.	.	.
Golenkinia radiata Chodat	.	0.0025	0.0015	0.001	0.0045	0.00515	.	0.001	0.002	0.001	.	0.002
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	0.0005	.	.	.	.	.	.	.	.	.	.	.
Monoraphidium contortum (Thur.) Kom.-Legn.	.	0.00005	.	0.00005	0.0005	0.0005	.	.	0.00155	0.0001	.	.
Pandorina morum (O.F. Müller) Bory	.	.	.	.	.	.	.	.	.	0.004	.	.

Depth	0m	*0m	*1m	*2m	*0m	*0m	*0m	*1m	*2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Pediastrum boryanum (Turpin) Meneg.	.	0.0355	0.0235	.	.	.	.	.	0.001	.	.	.
Pediastrum Simple Meyen	0.024	.	.	.	.	.	.	.	.	.	.	.
Pediastrum duplex Meyen	0.024	.	.	.	.	.	.	.	.	.	.	.
*Phacotus lenticularis (*Ehr.) Stein	0.013	0.001	.	0.0005	0.004	0.002	0.009	0.002	0.002	0.002	.	.
Scenedesmus acuminatus (Lager.) Chodat	.	.	.	.	.	.	.	.	0.0005	.	.	.
Sphaerocystis planctonica (Korsikov) Bourrelly	0.009	0.008	0.014	0.0155	0.0085	0.024	0.0455	0.016	0.001	0.013	0.002	0.011
Tetraedron minimum (A. Br.) Hansgirg	0.0004	.	.	0.00005	0.005	0.0001	.	.	0.0045	0.0003	.	.
Tetraedron triangulare (Chod.) Kom.	.	.	.	.	0.00005	0.00005	.	0.00005	.	.	.	.
Tetrastrum staurogeanieforme (Schroed.) Lemm.	.	.	.	.	0.00005	.	.	.	.	.	.	.
Treubaria schmidlei (Schroeder) Fott et Kovacik	0.002	.	.	.	.	.	.	.	.	.	.	.
Staurastrum gracile Ralfs	.	.	.	.	.	.	0.0105	.	0.001	.	.	.
Total	**0.0961**	**0.0476**	**0.041**	**0.0231**	**0.0256**	**0.0382**	**0.0655**	**0.0196**	**0.0176**	**0.0207**	**0.003**	**0.013**
Cryptophyta - cryptophytes												
Cryptomonas erosa Ehrenberg	0.044	0.2035	0.111	0.062	0.0565	0.234	0.0135	0.01	0.0085	0.016	0.044	0.026
Cryptomonas marssonii Skuja	.	0.0015	0.0005	0.001	0.001	0.001	0.006	0.004	.	.	0.001	.
Cryptomonas ovata Ehrenberg	0.049	.	0.039	.	0.0245	0.0345	.	.	.	0.018	.	.
Cryptomonas rostrata Troitzskaja emend I. Kiselev	1.68	0.0025	0.013	0.001	0.012	0.053	.	0.0025	.	.	.	0.003
Rhodomonas minuta Skuja	.	.	0.0005	0.0005	0.0015	.	0.003	.	0.0005	0.002	.	.
Total	**1.773**	**0.2075**	**0.164**	**0.0645**	**0.0955**	**0.3225**	**0.0225**	**0.0165**	**0.009**	**0.036**	**0.045**	**0.029**
Dinophyta - dinoflagellates												
Ceratium hirundinella (F. B. Müller) Bergh	0.077	.	0.0385	.	.	.	0.0385	0.0385	0.004	.	.	.
Gymnodinium aeruginosum Stein	.	.	.	.	.	.	.	.	.	0.009	.	.
Peridiniopsis cuningtonii Lemm.	0.305	0.3515	0.074	0.139	0.147	0.2495	0.051	0.035	0.016	0.157	0.009	0.019
Peridinium cinctum (O.F. Müller) Ehrenberg	0.021	0.255	0.042	0.0743	0.1275	0.212	0.053	0.0955	0.0455	0.021	0.021	0.021
Peridinium willei Huitfeld-Kaas	0.021	.	.	.	.	.	.	.	.	.	.	.
Peridinium gatunense Nygaard	.	.	.	0.0115	.	.	.	.	.	.	.	.
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	.	0.0095	0.1345	0.003	0.0705	0.0665	0.0255	0.003	0.001	.	0.013	.
Total	**0.424**	**0.616**	**0.289**	**0.2278**	**0.345**	**0.528**	**0.168**	**0.172**	**0.0665**	**0.187**	**0.043**	**0.04**

Depth	0m	*0m	*1m	*2m	*0m	*0m	*0m	*1m	*2m	0m	0m	0m
Site	**Inf**	**A2**	**A2**	**A2**	**Mid.2**	**Mid.1**	**A1**	**A1**	**A1**	**Outf**	**B1**	**B2**
Euglenophyta - euglenoids												
Trachelomonas hispida (Perty) Stein	.	0.0015	.	.	.	.	.	.	0.004	.	0.002	0.0075
Trachelomonas volocina Ehrenberg	.	.	.	.	.	.	.	.	.	0.001	.	0.001
Colacium vesiculosum Ehr.	.	.	.	.	.	.	.	.	0.001	.	.	0.001
Total	**0**	**0.0015**	**0**	**0**	**0**	**0**	**0**	**0**	**0.005**	**0.001**	**0.002**	**0.0095**
Chrysophyceae - chrysophyces												
Erkenia subaequiciliata Skuja	0.003	0.00105	0.0017	0.00105	0.004	0.0049	0.00045	0.00055	0.0025	0.012	0.012	0.001
Dinobryon sociale Ehrenberg	0.005	.	.	.	.	.	.	.	.	.	.	.
Dinobryon divergens Imhof	0.0003	.	.	.	0.004	0.0005	.	.	.	.	.	.
Dinobryon bavaricum Imhoff	0.036	0.0205	0.001	0.002	0.0395	0.033	0.0015	0.0045	0.0005	0.005	0.009	0.024
Total	**0.0443**	**0.0216**	**0.0027**	**0.00305**	**0.0475**	**0.0384**	**0.002**	**0.0051**	**0.003**	**0.017**	**0.021**	**0.025**

ANNEX 5. Comparing diatoms taxa represented by the large cell numbers in periphyton communities on individual research stations in the littoral of Lake Durowskie in July 2013 (1-8 - sites, O - oxygen, T – trophy).

Diatom taxa	1	2	3	4	5	6	7	8	pH*	O*	T*
Achnanthes conspicua Mayer	.	.	.	.	.	.	+	+	0	2	7
Achnanthes exigua Grun.	.	.	+	+	.	+	+	+	4	1	7
Achnanthes hungarica(Grunow) Grun. in Cleve	.	.	.	.	.	.	.	+	4	4	6
Achnanthes lanceolata (Breb.) Grunow	+	+	+	+	.	+	+	+	4	-	-
Achnanthes lanceolata v. elliptica Cleve sensu Straub	.	.	.	.	.	+	.	.	3	1	7
Achnanthes minutissima Kützing	+	+	+	+	+	+	+	+	4	-	-
Achnanthes minutissima var. affinis (Grun.) Lange-Bertalot	+	+	+	+	+	+	+	+	4	-	1
Achnanthes minutissima var. *gracillima* (Meister) Lange-Bertalot	.	.	.	.	.	.	.	+	4	3	5
Amphipleura pellucida (Kützing) Kützing	.	+	.	.	.	.	.	.	4	2	2
Amphora ovalis Kützing	.	+	+	.	+	+	+	+	4	2	5

Diatom taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**pH**	**O**	**T**
Amphora pediculus (Kütz.) Grunow	+	+	+	.	+	+	+	+	4	2	5
Asterionella formosa Hass	.	.	.	.	+	.	.	+	4	2	4
Caloneis bacillum (Grun.) Meresz.	.	+	+	+	.	+	.	.	-	-	-
Caloneis silicula (Ehr.) Cleve	.	.	.	.	.	.	+	.	4	2	4
Cocconeis euglypta (Ehr.) Clevei	.	.	.	.	.	.	.	+	-	-	-
*Cocconeis pediculus*Ehr.	.	+	+	+	+	+	+	.	4	2	5
Cocconeis placentula Ehr.	+	+	+	+	+	+	+	+	4	3	5
Cocconeis placentula var. pseudolineata Geitler	+	+	+	+	.	+	+	+	-	-	-
Cyclotella meneghiniana Kütz.	.	+	+	+	+	+	+	+	4	5	5
Cyclotella ocellata Pant.	+	.	+	.	+	.	.	+	4	1	4
Cyclotella operculata (Ag.) Kützing	.	.	.	.	+	.	.	+	-	-	-
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+	+	4	2	5
Cyclotella steligera Cl. et Grun.	.	.	.	.	.	.	.	+	-	-	-
Cymatopleura solea (Breb.) W. Smith	.	.	.	.	+	.	.	.	4	3	5
Cymbella affinis Kützing	+	+	+	+	+	+	+	+	4	1	5
Cymbella caespitosa (Kützing) Brun.	.	.	.	+	.	.	.	.	-	-	7
Cymbella cistula (Ehr.) Kirchner	+	+	+	.	+	.	.	.	4	2	5
Cymbella lanceolata (Ehr.) Kirchner	.	.	.	.	+	.	.	.	4	1	7
Cymbella microcephala Grun.	+	+	+	.	.	+	+	+	4	1	4
Cymbella minuta Hilse ex Rabenhorst	+	+	+	+	+	+	+	+	3	-	-
Cymbella turgida (Greg.) Cleve	+	.	.	.	+	.	.	.	-	-	-
Diatoma tenuis Agardh	.	.	.	.	+	.	.	.	4	3	5
Diatoma vulgaris Bory	+	+	.	+	+	+	+	+	5	2	4
Diatoma vulgaris Bory Morphotyp *ovalis*	.	+	.	.	+	+	+	+	-	-	-
Diploneis Elliptica	.	.	.	.	+	.	.	.	4	1	3
Encynomena silesiacaum (Bleisch in Rabenh.) D. G. Mann	.	.	.	.	+	.	.	.	-	-	-

Diatom taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**pH**	**O**	**T**
Eunotia exigua (Breb.) Rabenh.	.	.	.	+	+	.	.	.	1	2	7
Eunotia faba (Ehr.) Grun.	.	.	.	.	+	.	.	.	2	1	2
Eunotia intermedia (Krasske) Noerpel & Lange - Bertalot	.	.	.	+	.	.	.	.	2	-	1
Eunotia lunaris	.	.	.	.	.	+	.	.	-	-	-
Eunotia praerupta Ehr.	+	+	+	+	+	+	+	+	2	1	2
Eunotia tenella (Grun.) Hustedt	.	.	.	+	.	.	.	.	2	1	1
Fragilaria capucina (Desm.) Rabenhorst	+	+	+	+	+	+	+	+	4	1	5
Fragilaria constricta Ehr.	.	.	.	.	.	.	+	.	3	-	3
Fragilaria construens (Ehr.) Grun.	.	.	+	.	.	.	+	.	4	1	4
Fragilaria crotonensis Kitton	+	+	+	+	+	+	+	+	2	-	1
Fragilaria dilatata (Breb.) Lange-Bertalot	.	.	+	.	+	.	.	.	4	2	3
Fragilaria exigua Grun.	.	.	.	.	.	.	.	+	3	1	1
Fragilaria martyi (Heribaud) Lange-Bertalot	.	.	.	.	+	.	.	.	-	-	-
Fragilaria pinnata Ehr.	+	+	+	+	+	.	+	+	4	1	7
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+	+	+	4	3	7
Fragilaria ulna var. *angustissima* Sippen	+	+	+	.	.	.	.	+	4	2	7
Gomphonema acuminatum Ehr.	+	.	.	+	+	.	.	+	4	2	5
Gomphonema angustum Agardh	.	.	.	+	.	.	.	.	4	1	4
Gomphonema augur Ehr.	+	.	.	+	.	.	.	.	4	1	1
Gomphonema gracile Ehr.	.	.	.	.	+	.	.	.	3	1	3
*Gomphonema intricatum*Kützing	.	+	.	+	+	.	.	.	-	-	-
Gomphonema italicum Kützing	.	.	.	+	.	.	.	.	-	-	-
Gomphonema micropus Kütz.	+	.	.	.	+	.	.	.	4	2	5
Gomphonema olivaceoides Hustedt	+	+	.	+	+	.	.	.	5	2	5
Gomphonema olivaceum (Horn.) Breb.	+	+	+	+	+	.	+	+	-	-	-
Gomphonema parvulum (Kütz.) Kütz.	+	.	.	+	+	.	+	+	3	4	5

Diatom taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**pH**	**O**	**T**
Gomphonema truncatum Ehr.	.	+	.	.	.	.	.	.	4	2	4
Hantzschia amphioxys (Ehr.) Grunow	.	.	.	.	+	.	+	.	3	2	7
Mastogloia smithii Thwaites	.	+	.	.	.	.	.	.	4	2	7
Meridion circulare Ag.	.	.	+	+	.	+	+	.	4	-	-
Navicula agrestis Hustedt	.	.	.	.	.	.	.	+	3	-	-
Navicula capitata Patrick in Patrick & Reimer	.	+	+	.	+	+	+	+	-	-	-
Navicula cincta (Ehr.) Ralfs	+	.	+	.	+	.	.	+	4	3	5
Navicula cryptocephala Kütz.	+	.	.	.	+	.	.	.	3	3	7
Navicula dicephala (Ehr.) W. Sm.	+	.	.	.	.	.	.	.	-	-	-
Navicula gregaria Donkin	.	.	+	.	.	.	.	+	4	4	5
Navicula radiosa Kützing	+	+	+	+	+	+	+	+	3	2	4
Navicula reinhardtii Grun.	.	.	+	.	.	.	.	.	5	2	5
Navicula sp	+	.	.	.	.	.	.	.	-	-	-
Navicula tenella Hustedt	.	.	.	+	.	.	.	.	4	2	5
Navicula tripunctata (O. F. Müller) Bory	+	+	+	+	+	+	+	+	4	2	5
*Navicula viridula (*Kütz.) Ehr.	.	.	+	.	+	.	.	.	-	-	-
Nitzchia acicularis (Kützing) W. Smith	+	+	+	.	.	.	.	.	4	4	5
Nitzschia amphibia Grunow	+	+	+	+	+	.	.	.	4	3	5
Nitzschia intermedia Hantzsch	.	.	.	.	+	.	.	.	3	-	5
Nitzschia palea (Kütz.) *W. Sm.*	.	.	.	.	.	.	.	+	3	4	6
Nitzschia paleacea Grun.	+	.	+	+	.	+	+	.	4	3	5
Nitzschia recta Hantzsch	+	.	.	.	.	.	+	+	4	2	7
Pinnularia maior (Kütz.) Cleve	.	+	.	.	.	.	.	+	3	2	4
Pinnularia viridis (Nitzsch) Ehr.	.	+	+	+	.	+	+	.	3	3	7
Placoneis eleginensis (Greg.) Cox	.	.	.	.	+	.	.	+	-	-	-
Placoneis placentula (Ehr.) Cox	.	.	.	.	+	.	.	.	-	-	-

Diatom taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**pH**	**O**	**T**
Rhoicosphaenia abbreviata (Ag.) Lange-Bertalot	.	+	+	+	.	.	.	.	4	2	5
Stauroneis phoenicentron Ehr.	+	+	+	.	.	+	.	+	3	3	4
Stephanodiscus astraea (Ehr.) Grun.	+	.	.	+	+	.	+	.	-	-	-
Stephanodiscus hantzschii Grun.	.	.	.	.	.	.	.	+	5	4	6
Stephanodiscus minutulus (Kütz.) Cleve-Mőller	.	.	.	+	.	.	.	.	5	3	6
Surirella ovalis Breb.	.	.	.	.	+	.	.	.	4	4	5
Tabellaria fenestrata (Lyngb.) Kützing	.	.	.	.	.	+	.	+	3	1	2

pH*

1. acidobiontic (optimal occurrence at pH <5,5)
2. acidophilous (mainly occurrence at pH <7)
3. circumboreal (mainly occurring at pH – values about 7)
4. alkaliphilous (mainly occurring at pH >7)
5. alkalibiontic (exclusively occurring at pH >70
6. indifferent (no apparent optimum)

O*

1. continuously high (about 100% saturation)
2. fairly high (above 75% saturation)
3. moderate (above 50% saturation)
4. low (above 30% saturation)
5. very low (about 10% saturation)

T*

1. oligotraphenic
2. oligo-mesotraphenic
3. mesotraphenic

4. meso-eutraphenic
5. eutraphenic
6. hypereutraphenic
7. oligo- to eutraphenic (hypereutraphenic)