ECOLOGICAL STATE OF LAKE DUROWSKIE BASED ON PHYTOPLANKTON AND PERIPHYTON IN JULY 2015

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Introduction

Algae, which is considered as the main primary producers and relevant source of oxygen for many water bodies, plays an important role in lake ecosystem. However, algal blooms, which may be caused by water pollution, have led to severe problems in eutrophic lakes, rivers and other water bodies over the worldwide, which may lead to oxygen depletion, fish gill clogging, production of toxicants and bad odours (Stumpf et al., 2009; Hudnell, 2010; Lewitus et al., 2012). Due to its sensitivity to environmental factors, phytoplankton has been widely used as indicator to evaluate changes in water bodies and has been used as a tool to monitor early warnings of water pollution (Thiébaut et al., 2006, Wu et al., 2012).

Wągrowiec is a town in northwestern Poland. The region around the town is rich in lakes and the town itself sits in the middle of Lake Durowskie. Lake Durowskie is a main attraction for tourists and locals. However it suffered from algal blooming problem since 1999, due to the direct disposal of sewage into it. Agricultural run-off, carrying loads of fertilizers, herbicides and pesticides, also brought additional nutrients such as phosphates and nitrates into the Lake. Due to the algal blooms, the transparency of the lake decreased and it turned out to be tons of dead fishes and other organisms. Consequently, the beaches area of the lake had to be closed and the tourism activities had to be stopped because of the really poor environmental conditions.

The local government of Wągrowiec paid much attention to the lake algal blooming problem. To change the situation, the government decided to start a restoration project for the Lake Durowskie in 2009. The important measures that have been taken so far include installation of aerators for the oxygenation of hypolimnion, addition of Iron sulphate (PIX) to sediment phosphorus and introduction of pike and pike-perch for bio-manipulation. Furthermore, the local government of Wągrowiec cooperated with Adam Mickiewicz University from Poznan to monitor and assess the effectiveness of restoration measures. The monitoring process is taking into consideration many aspects of lake quality assessment including hydrology, physic-chemical parameters, algae, macrophytes and micro-invertebrates communities etc.

From the reports of years before, it seems there is a good trend of the water quality of Lake Durowskie. This report will show and assess the present ecological state based on phytoplankton and periphyton, which was sampled in and around the shoreline of Lake Durowskie. The results will be compared with the data from last six years to assess the restoration project.

Material and Methods

Study area

Studies were conducted in Lake Durowskie, in the city of Wągrowiec between June 29 and July 03, 2015 in order to determine the ecological state of the lake.

Tab 1. Lake Morphometry

surface	143,7 ha
volume	11322900 m^3
max depth	14,6 m
mean depth	7,9 m
main tributary	Struga Gołaniecka
surface of the whole catchment area	236,1 km^2
surface of the direct catchment area	1581,3 ha
share of agricultural area	58,26 %
share of forest	33,52 %
urban area	8,25%

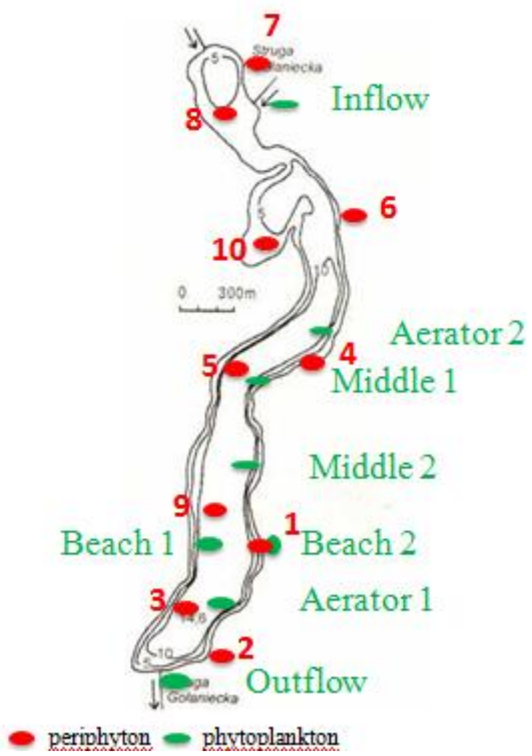

Fig 1. Sampling sites

Investigation were done on phytoplankton and periphyton. Water samples were collected from (8stations) on phytoplankton and (10 stations) on periphyton.

Methods

Phytoplankton

Phytoplankton samples were collected from the surface water at Inflow, Beach 1 and Beach 2, Outflow; and from 0, 1 and 2 meters depth in all Middle and Aerator stations. The samples were concentrated using a plankton net. Taxonomical analysis of sampling tok into consideration:

Number of phytoplankton species cells (ind./L)

We count species in 100 fields of view of the microscope. Then we count factual concentration:

sample concentration 30 ml from 30 l; 30 000 mm^3 : 1.25 mm^3 = 24 000

24 000 – 30 l

x – 1l

x = 800 – factual concentration

Both results multiply and get the individual number of cells per liter.

Biomass of phytoplankton species (mg/L)

To estimate the biovolume of 1 cell of particular algal species we were multiplyed biovolume of 1 cell with the individual number of cells per liter. Next were put the comma on 9 place counting from the right side in direction left. The biomass was always given to 3 decimal places.

Indeces:

- **Mixed index of Nygaard**

Trophic status of the lake was estimated using the mixed index of Nygaard (Nygaard, 1949), following the equation:

$$mixed\ index_{of\ Nygaard} = \frac{Cyanobacteria + Chlorococcales + centric\ diatoms + euglenoids}{desmids}$$

- **Jaccard Index**

The Jaccard Index was used to compare the similarity and diversity of the number of species between the years. We calculated it according to the formula (Jaccard, 1912):

$$J = \left(\frac{c}{a + b - c}\right) \times 100\ \%,$$

Where J is index of Jaccard (percentage of species in common)

a – number of species in one year

b – number of species in another year

c – number of species in common

- **Shannon-Wiener and evenness indices**

In order to measure evenness and diversity of the species between different sites we used Shannon-Wiener and Evenness Indices according to Shaw (2003):

$$H' = -\sum_{i=1}^{s} p_i \log(p_i);$$

$$E = \frac{-\sum p_i \times \log(p)}{\log(S)};$$

Where H’ is the Shannon index, p_i – percentage of individuals of certain species in the community; E – evenness (equitability); S – number of species in the community.

Periphyton

Periphyton species were collected from submerged stones in the 10 stations using a brush. The samples were conserved using Lugol solution and the species were identified in the laboratory.

Van Dam’s ecological indicator values were used to estimate oxygen saturation, trophy and alkalinity in lake Durowskie (van Dam et al., 1994).

Diatom index

Diatom index is calculated only when in the sample you will find at least 10 species being sensitive to the trophy state (TJi).

- Trophy index (TJ)

$$TJ = \sum (TJi \cdot wTJi \cdot Li) / \sum (wTJi \cdot Li)$$

where:

TJi – value of the sensitivity of species for the trophy state;

w TJi - range of the tolerance of the algal species;

Li - number of specimens of the determined species divided by the number of all identified individuals in the sample

- Index of referential species (pGR)

$$pGR = (NB - (NC + ND)) / (NB + NC + ND)$$

where:

NB – number of referential species for all lakes;

NC – number of referential species for deep lakes and of degradation species in shallow lakes;

ND – number of degradation species for both kinds of lakes.

- Transformation of standardized value in the range from 1 (most beneficial) to 0 (least beneficial) according to equations:

$$Z - TJ = 1 – ((TJ -1) \cdot 0.25)$$

$$Z – pGR = (pGR + 1) \cdot 0.5$$

Diatom index

$$DI = (Z\text{-}TJ + Z\text{-}pGR) / 2$$

and clasification of the ecological state for Lake:

Ecological state	**Value range**
very good	>0,83
good	0,55
moderate	0,30
poor	0,15
bad	<0,15

Results and discussion

Phytoplankton

The total number of phytoplankton species collected in all the (8 station) was amount to 75 species and the total of dominated species was recorded in the Middle 2 and Inflow with moving gradually to other parts of the stations, as in Fig 2. This may be related to the high number of the diatom movement and current waves together with human activities which could result in rushing out the sediment phytoplankton around the lake to every stations recorded.

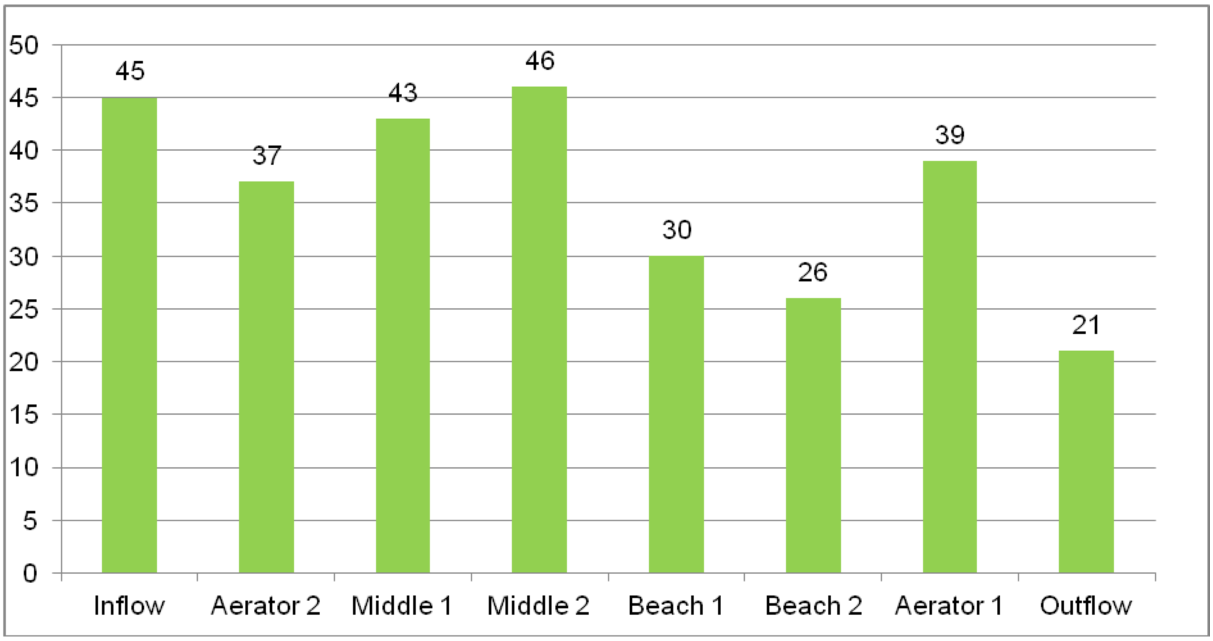

Fig 2. Total number of phytoplankton species from different sampling sites in 2015

Cyanobacteria were dominant and abundant species in the group of algae. Phosphorus and nitrogen flow with the Struga Gołaniecka stream to Lake Durowskie. The reason for the high abundance at the inflow is due to Cyanobacterias preference for nutrient rich waters. Morealso, the Fig 3. indicate hypertrophic state of the rivers water which was observed.

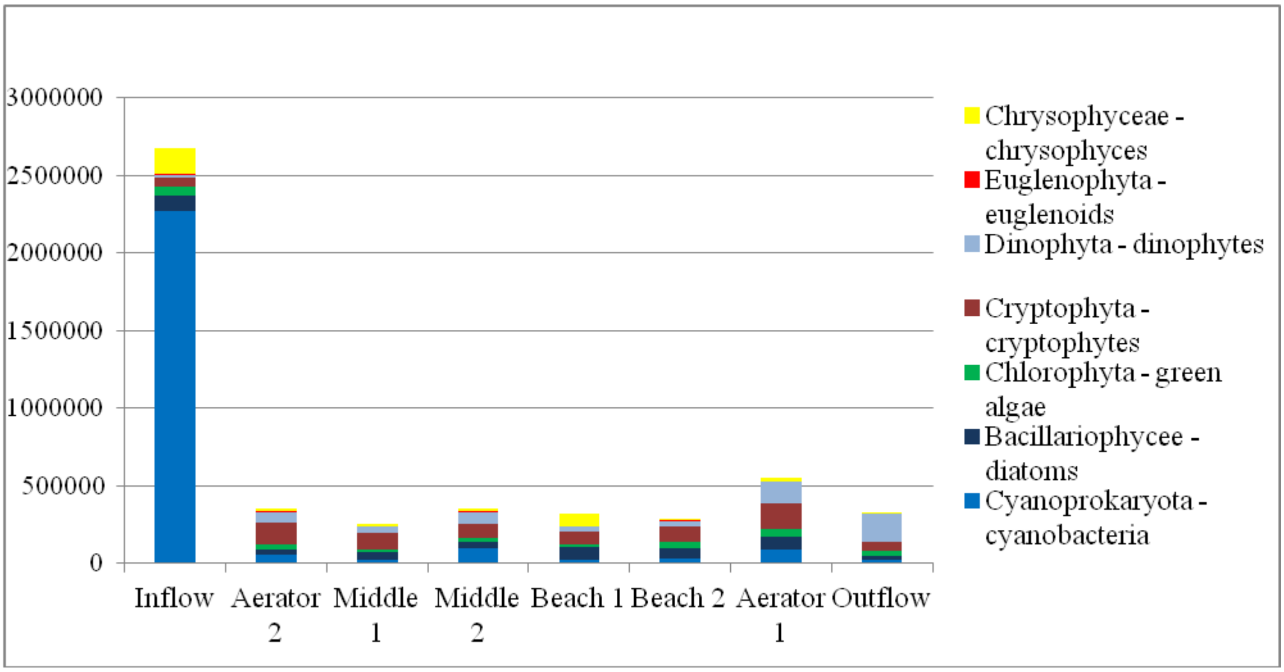

Fig 3. Abundance of each group of algae (number of cells)from different sampling sites in 2015

Figure 4., show how we calculate the biomass of every group of algae samples showing the result as dinophytes, contributed significantly to the total biomass of phytoplankton in different sites. It was related to its large and bigger cells of this group of Algae. Order group of algae shows low contribution and reduction in biomass due to small cells.

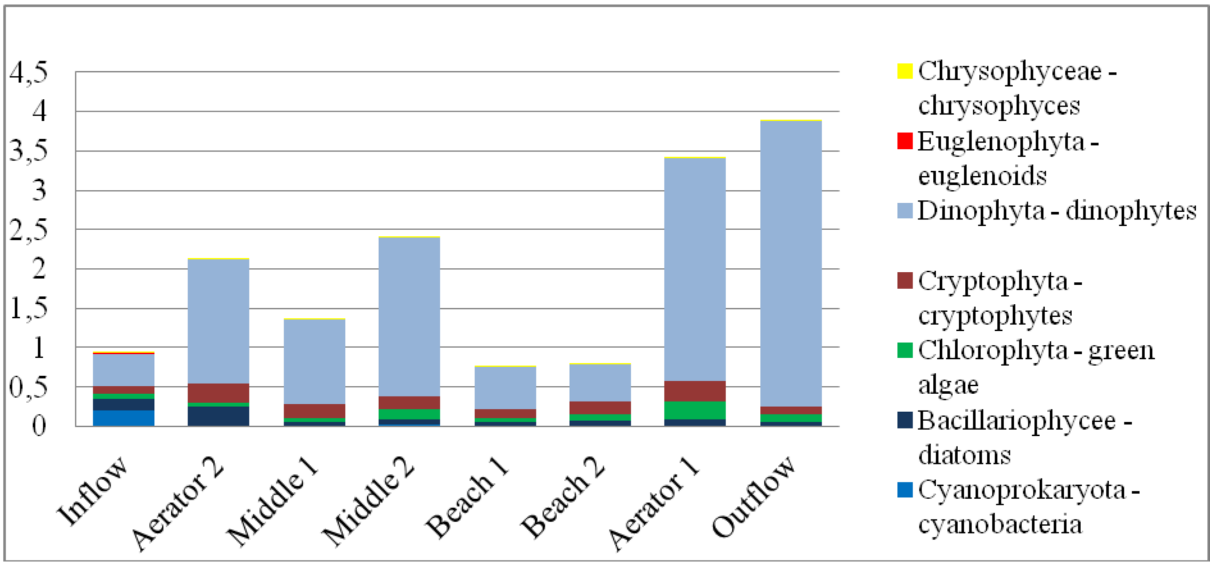

Fig 4. Biomass of each group of algae from different sampling sites in 2015

To the group of phytoplankton dominants of 17 species which were characterized by the greatest number of cells on individual sites were ranked. Species from cryptophytes (*Cryptomonas erosa*), dinoflagelates (*Peridiniopsis cunningtonii*, *Peridinium cinctum*), diatoms (*Fragilaria ulna*) and cyanobacterium (*Limnthrix redekei*) belonged to dominant taxa, which were found in a majority of sites (tab. 4). A large share of blue-green algae in the phytoplankton community connects with an activity of motor boats which create turbulence within a few metres depth taking water out from deeper layers to the surface layer (north sites A2 and M1 – dominance in the range 8-12%; south sites M2 and A1 - dominance in the range 10-27%). In the inflow of the lake only cyanobacteria were dominating (total 81%): *Limnothrix redekei* (64%), *Pseudanabaena limnetica* (10%) and *Aphanizomenon flos-aquae* (7%) .

Table 4. Percentage share of dominating species in the total number of the phytoplankton on individual sites in Lake Durowskie (Infl – Inflow; A – aerator; M – Middle; Outfl – Outflow; B – Beach).

Dominant species	0m	0-2m	0-2 m	0-2 m	0-2 m	0m	0m	0m
	Infl	**A2**	**M1**	**M2**	**A1**	**Outfl**	**B1**	**B2**
Cryptomonas erosa Ehrenberg		8-16	27-59	15-17	15-39	13	21	31
Erkenia subaequiciliata Skuja	6	10-12	12	17			25	
Limnothrix redekei (Van Goor) Meffert	**64**	8-13	11-12	18-27	10-21			10
Peridiniopsis cuningtonii Lemm.		10-12	4-13	10-14	9-18	19		7
Peridinium cinctum (O.F. Müller) Ehrenberg		6-11	6-10	7	8-15	25		
Fragilaria ulna (Nitzsch) Lange-Bertalot		15	10-24	14	7-11		9	15
Cryptomonas rostrata Troitzskaja emend I. Kiselev				6-8				
Rhodomonas minuta Skuja				8				
Aphanizomenon flos-aquae (L.) Ralfs	**7**	6						
Pseudanabaena limnetica (Lemm.) Kom.	**10**							
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	3							
Ceratium hirundinella (F. B. Müller) Bergh		8	3					
Sphaerocystis planctonica (Korsikov) Bourrelly			9		7	9		
Fragilaria crotonensis Kitton					9		6	
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly						11		
Fragilaria ulna var. *angustissima* Sippen							9	
Oocystis lacustris Chodat								6

Mixed index of Nygaard (Nygaard, 1949), was using to determine the trophic state of the lake using the appropriate equation which is contained in the subsection Methods.

After assessing the samples base on the mixed index of Nygaard equation, we have 5 stations in hypertrophic state and 3 stations in eutrophic as show in the Table 2. It is more likely that this due to higher number of Cyanobacteria which are more abundant in the river that are flow into the open zone of lake. This still indicate better quality water, but we are hoping in future that we can have better improvement.

Tab 2. Trophic changes based on the mixed index of Nygaard over the years

Station	2008	2009	2010	2011	2012	2013	2014	2015
Inflow	-	-	1,8	17	9	19	3,8	17
Aerator 2	-	26	11,5	5	8	14	20	4,3
Middle 1	-	9	12,5	13	3	5,5	11	4,8
Middle 2	-	-	8,3	18	9	7,5	20	4
Beach 1	-	-	-	3	9	7	5	5,5
Beach 2	-	-	-	-	5	6	10	12
Aerator 1	9,7	16	8,3	9	7	8	9	6,7
Outflow	-	-	6,5	5	-	12	8	8

Legend	Result
Dystrophy	0 - 0.3
Oligotrophy	< 1.0
Mesotrophy	1.0 - 2.5
Eutrophy	3 - 5
Hypertrophy	5 - 43

We calculated the similarity and richness of the number of species between the years using the Jaccard index. In table 3 analyses indicates how many species in percentage are common in the previous years. According to this we can see that 52% of the species from 2014 while in 2015 we have 82 % which is very close to what we have in 2008. The similarities between 2008 and 2015 is large, however, most species of eutrophic appearing sporadically in the current year.

Tab 3.Jaccard index

YEAR	2009	2010	2011	2012	2013	2014	2015
2008	84	51	43	33	40	52	82
2009	-	48	28	20	29	35	39
2010	-	-	42	42	62	47	37
2011	-	-	-	34	58	47	50
2012	-	-	-	-	77	49	59
2013	-	-	-	-	-	52	78
2014	-	-	-	-	-	-	57

In 2015 there are 5 new species. However, we see in the graph Figu 5., that is two more species, resulting from the fact that the species also disappear.

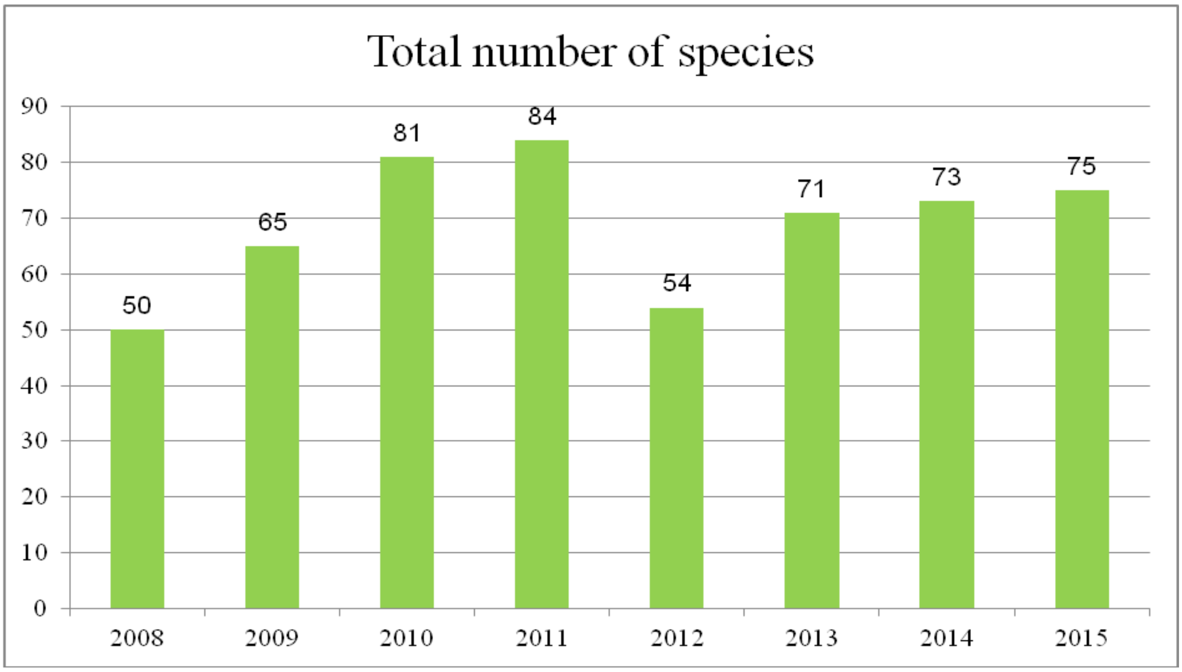

Fig 5. Total number of species over the years

In fig 6. highest diversity was noticed on station Inflow, which may be related to the flow from other parts of the river connected to the lake. The lowest Diversity Index was observed in station of Outflow which was connected to the current waves on the lake. The river (Struga Gołaniecka) provides additional species of benthos and periphyton, which detach from the surface by a current.

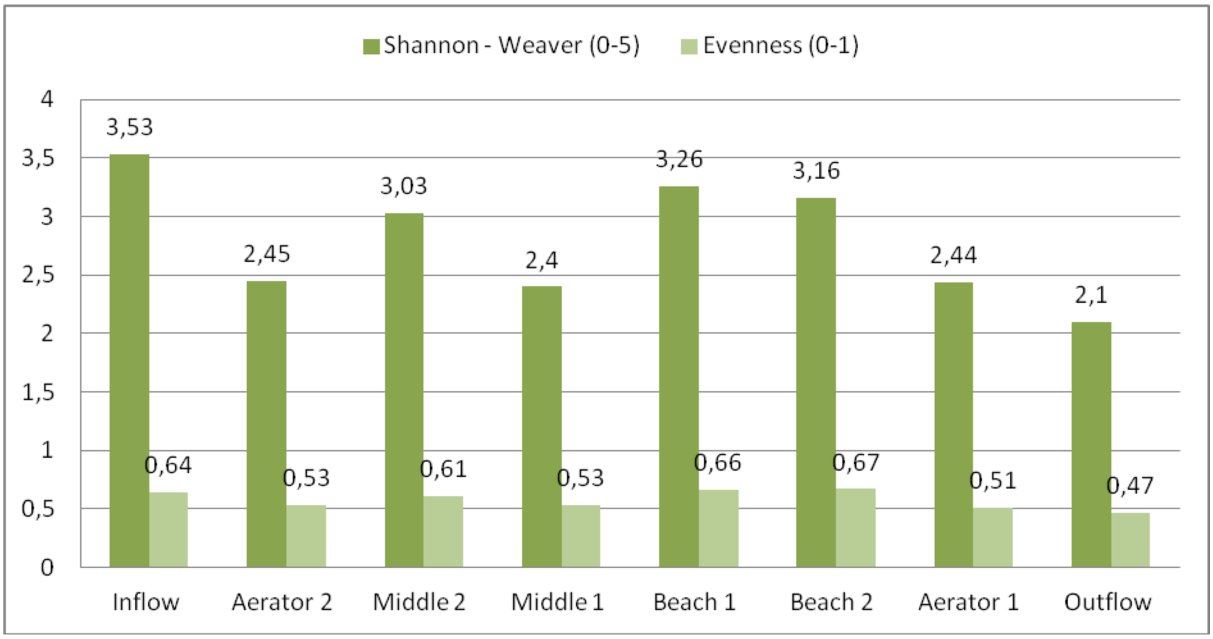

Fig 6. Evenenness and Shannon-Weaver Index from different sampling sites in 2015

Biomanipulation

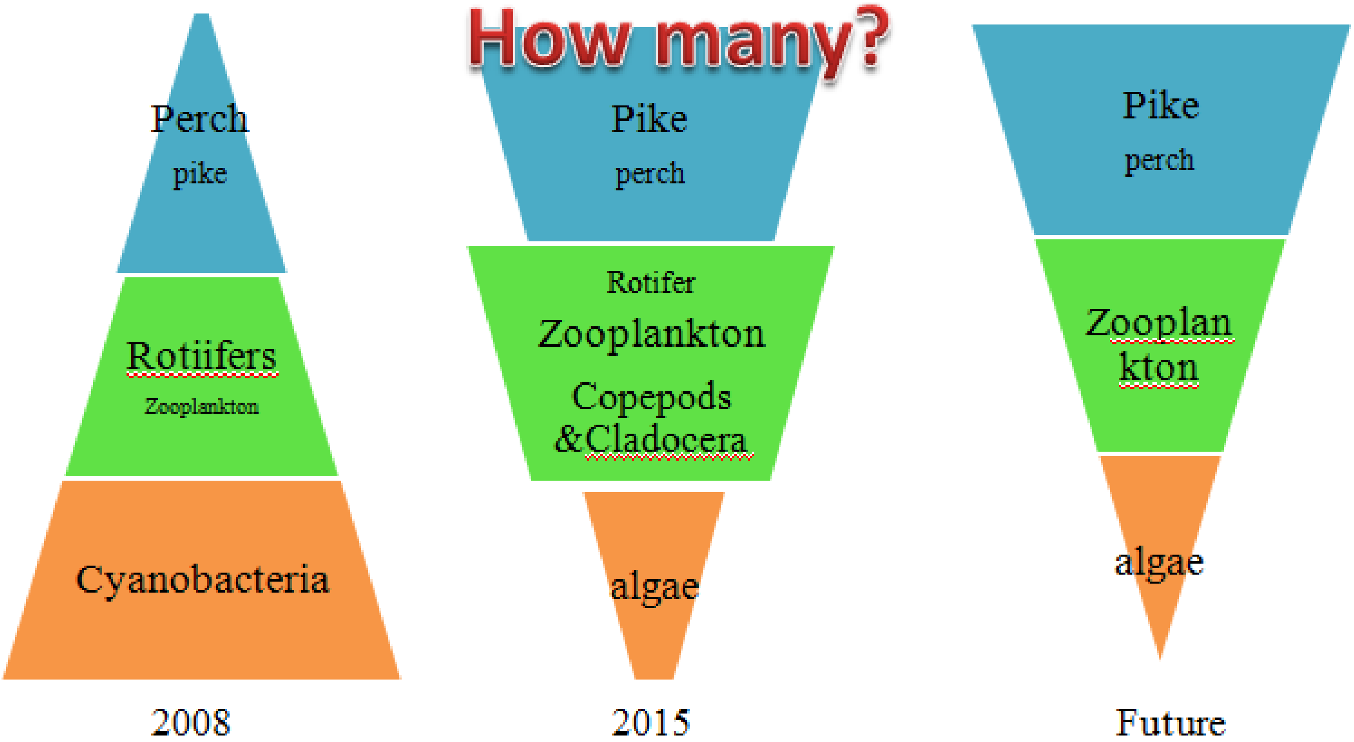

Fig 7. Grazing –trophic Pyramid- biomanipulation

Grazing –trophic Pyramid was use to access the state of the lake due to its restoration, by introducing bio-manipulation to maintain the state of the lake. In comparing 2008 to 2015 the state of restoration through biomanipulation is working but still need close monitoring in-order for the Pike to be able to survive for a long period of time.

Periphyton

From all the ten sampling sites, 103 species of periphyton were found in Lake Durowskie. *Achnanthes minutissima* Kütz is the absolute dominant species as it appears in 9 sites out of 10 (tab. 5 and 6). Furthermore, it even shows as the 71% percentage of site 1. Compared to last year, the dominant species remain almost the same. However, they all appear in more sites than before. Besides *Achnanthes minutissima* Kütz, *Cymbella minuta* Hilse indicates increasing dominant status. This could be a good phenomenon as it prefers eutrophic water while the lake was hypertrophic before.

Table 5. Dominant species in periphyton community from different sampling sites in 2015.

Dominants in periphyton community	**Species percentage from different sites (%)**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Achnanthes minutissima Kütz	71	22	19	20	6	9	11		5	5
Fragilaria crotonensis Kitton	9						7	7	4	
Cymbella affinis Kütz.	8		5				5			11
Cymbella minuta Hilse	7	9			6	15	8		7	5
Cocconeis placentula Ehr.		11	12			7		11		
Fragilaria pinnata			6	6	5	7		5		
Gomphonema olivaceum (Horn.) Breb.				8	21				18	15

Table 6. Dominant species in periphyton community from different sampling sites in 2014.

	Site							
Species	1	2	3	4	5	6	7	8
Achnanthes minutissima Kütz	45.36	14.11	23.96	27.47		11.39	13.23	
Achnanthes minutissima var. affinis (Grun.) Lange-Bertalot						10.89		
Amphora pediculus (Kütz.) Grun.			20.22					
Cymbella affinis Kütz.		11.19						
Cymbella minuta Hilse						15.84		
Cocconeis pediculus Ehr.		10.67						
Cocconeis placentula Ehr.								16.52
Gomphonema olivaceum (Horn.) Breb.				14.66	21.54			

For different species, they could represent for different trophic conditions. Information about some of the dominant species is listed following.

Achnanthes minutissima Kütz is a hypereutraphentic species, therefore it can easily adapt to any trophic conditions. This is probably the reason why it was abundant in the majority of the sites. However, it requires high oxygen saturation (>75%) and circumneutral pH (van Dam et al, 1994).

Gomphonema olivaceum (Horn.) Breb. exclusively occurs at pH >7, and prefers high oxygen saturation. *Gomphonema olivaceum* is a eutraphentic species (van Dam et al, 1994).

Cymbella affinis Kütz. is an alcaphilous and eutraphenic species, with a preference for waters highly saturated in oxygena.

Cymbella minuta Hilse occurs in lakes with neutral pH. It is a common species of Central Europe. *Cymbella minuta* is not a sensitive species to habitat alteration, as it also occurs in antropogenicaly disturbed areas.

Cocconeis placentula Ehr. requires only moderate levels of dissolved oxygen (>50%). It is eutraphentic and alcanophilous. *Cocconeis placentula* is the only dominating species at site 8, which is close to the inflow of the lake.

Preferences of periphyton

For different species, they have different preferences of living conditions, such as pH, dissolved oxygen, trophy state etc. Here in this report, we show the maps (Fig. 8.-10.) of the preferences of priphyton species about pH, oxygen and trophy state. From the maps, we could see more than 60% of the species prefer alkaline water; about half of the species prefer high oxygen concentration, some even prefer up to 100 percentage of dissolved oxygen; more than 50% species share the same trophy state preference as eutrophic (hypertrophic included).

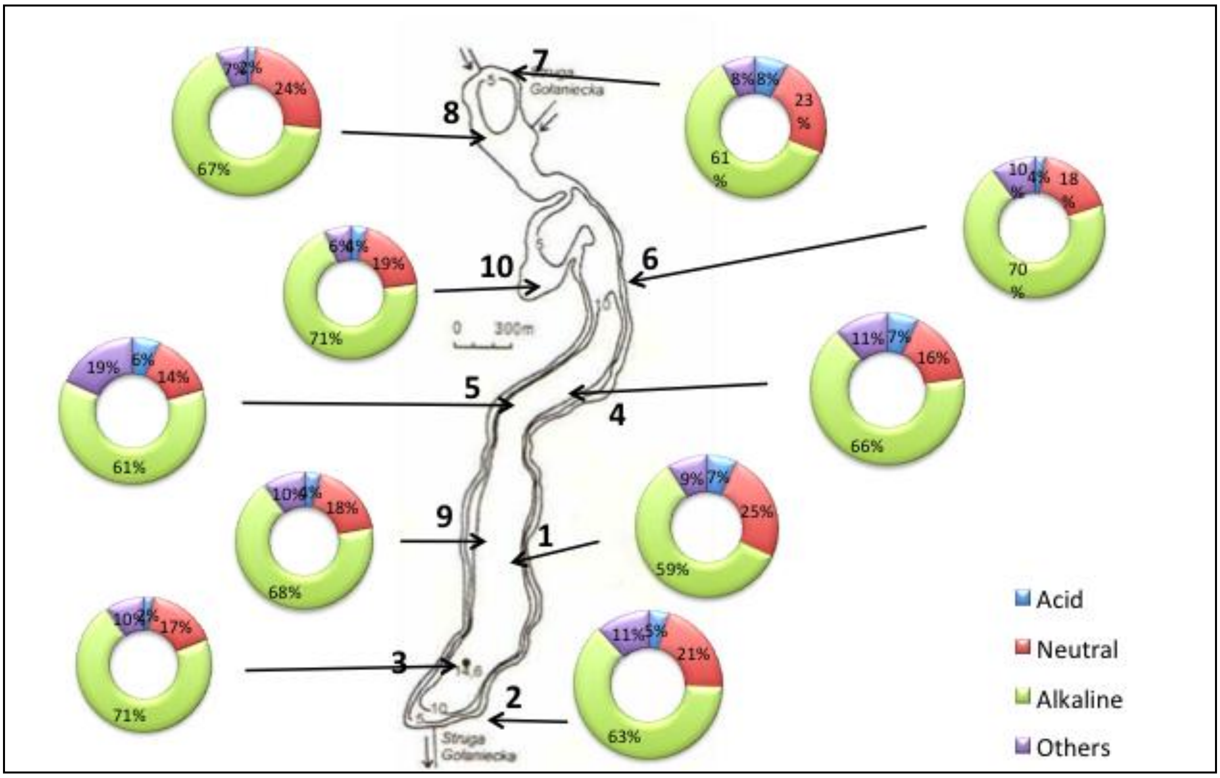

Fig 8. Preferential pH value of periphyton among all the ten sites in 2015.

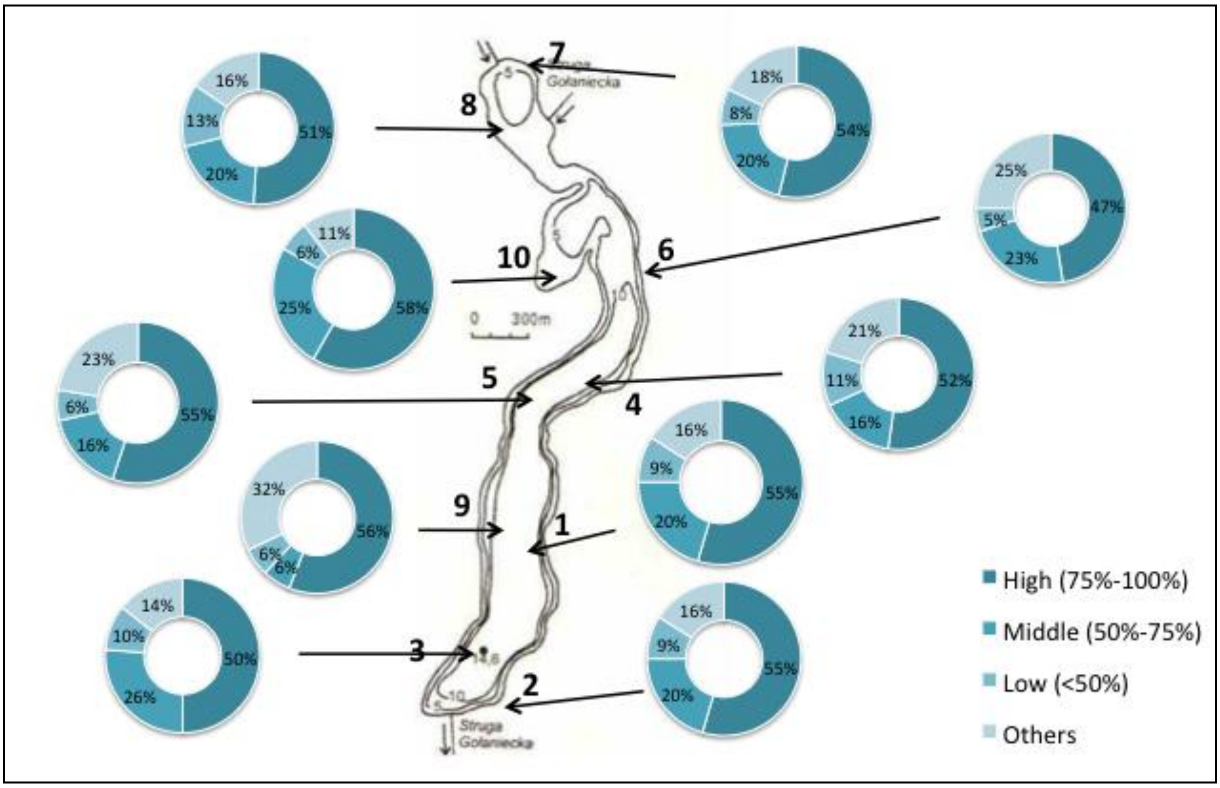

Fig 9. Preferential oxygen value of periphyton among all the ten sites in 2015.

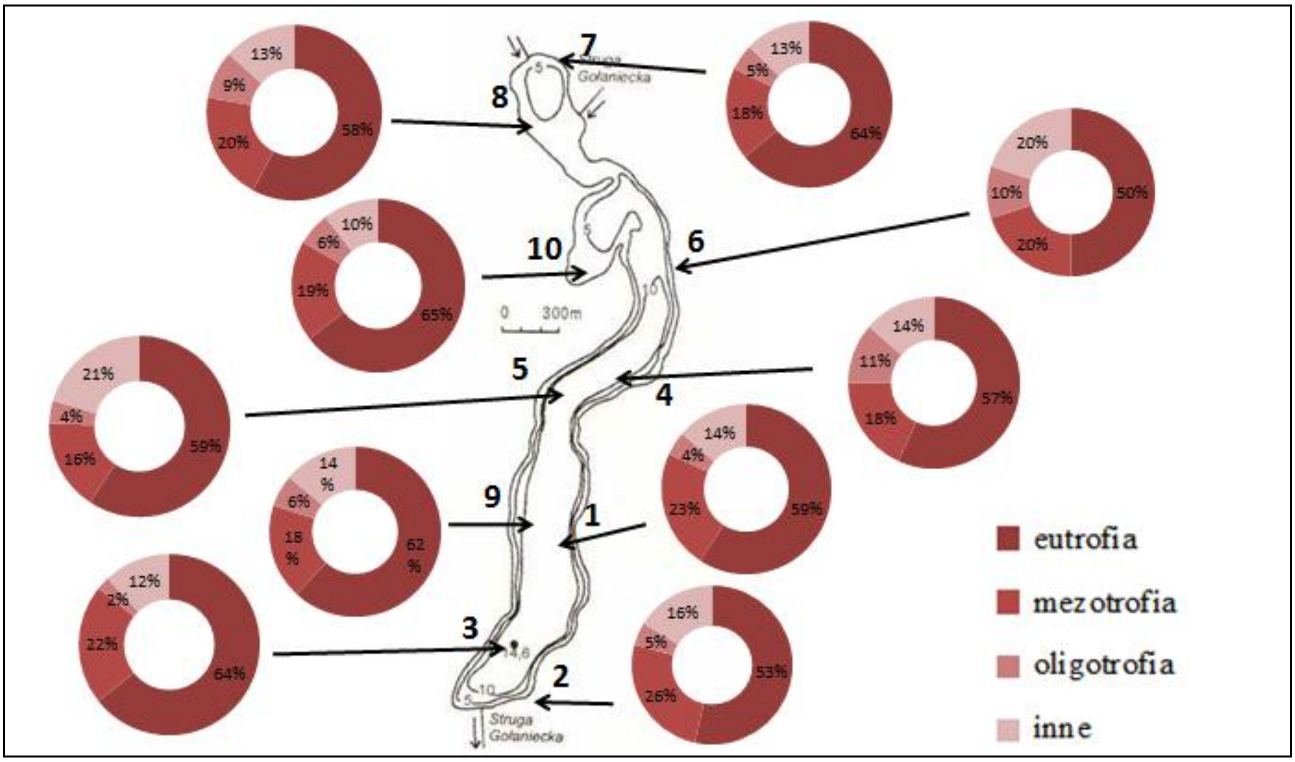

Fig 10. Preferential trophy state of periphyton among all the ten sites in 2015.

Diatom index

Diatoms are unicellular, photosynthetic, eukaryotic algae found throughout the world's oceans and freshwater systems (Armbrust et al., 2004). Many of the diatoms are sensitive to trophic state of water, therefore they can provide valuable information for monitoring rivers, particularly on organic pollution (Wu, 1999). To make the monitoring work more accurate, we sampled 10 sites this year, 2 more than the previous years.

As the same as previous years, the ecological state of Lake Durowskie varied from poor to moderate levels (Fig 11.). Only three sites are in moderate level and almost all the sites present a decreasing trend of the ecological state. The good point is that site 3 has a better situation of poor rather than bad in the year 2014. Broadly speaking, the lake ecological state remains stable.

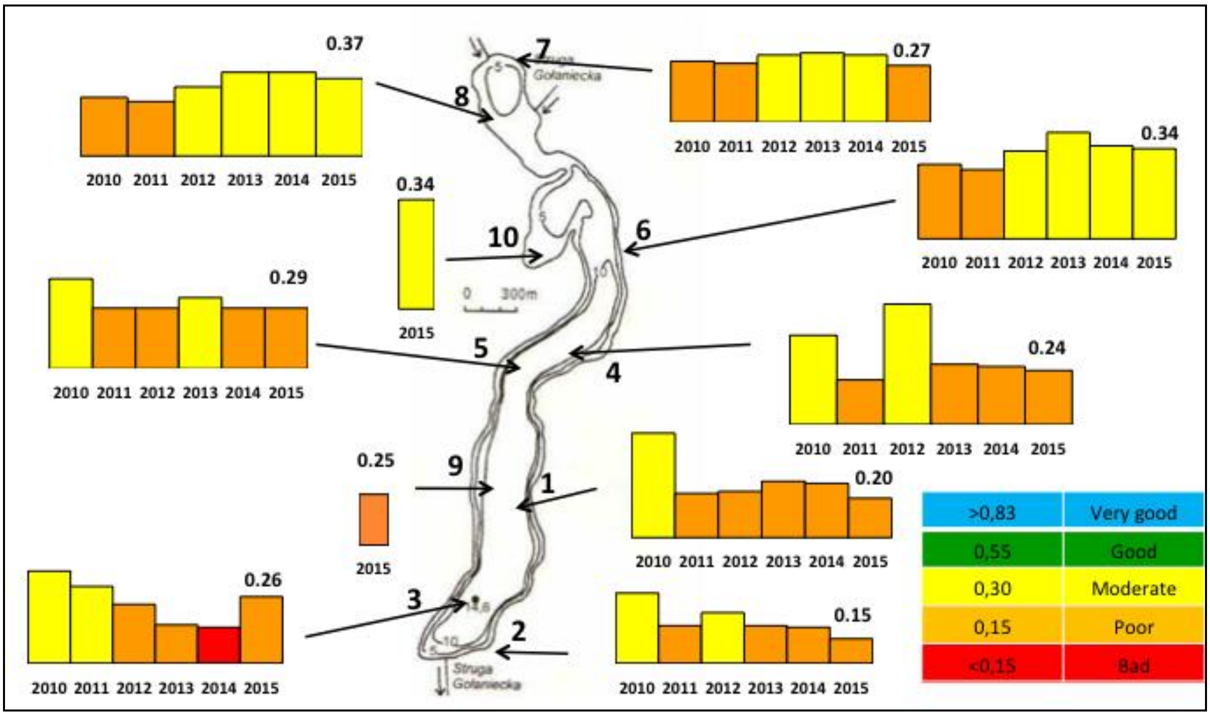

Fig. 11. Ecological state of the lake in different stations based on Diatom Index in 2015

We present here also the ecological state of Lake Durowskie in different geograph. The diatom indices are presented by the mean values for northern (site 4, 5, 6, 7, 8, 10) and southern (site 1, 2, 3, 9) parts. We could see that, the ecological state of the nouthern part is better than the southern part. Furthermore, there is an increasing trend, while the southern part remains the poor situation.

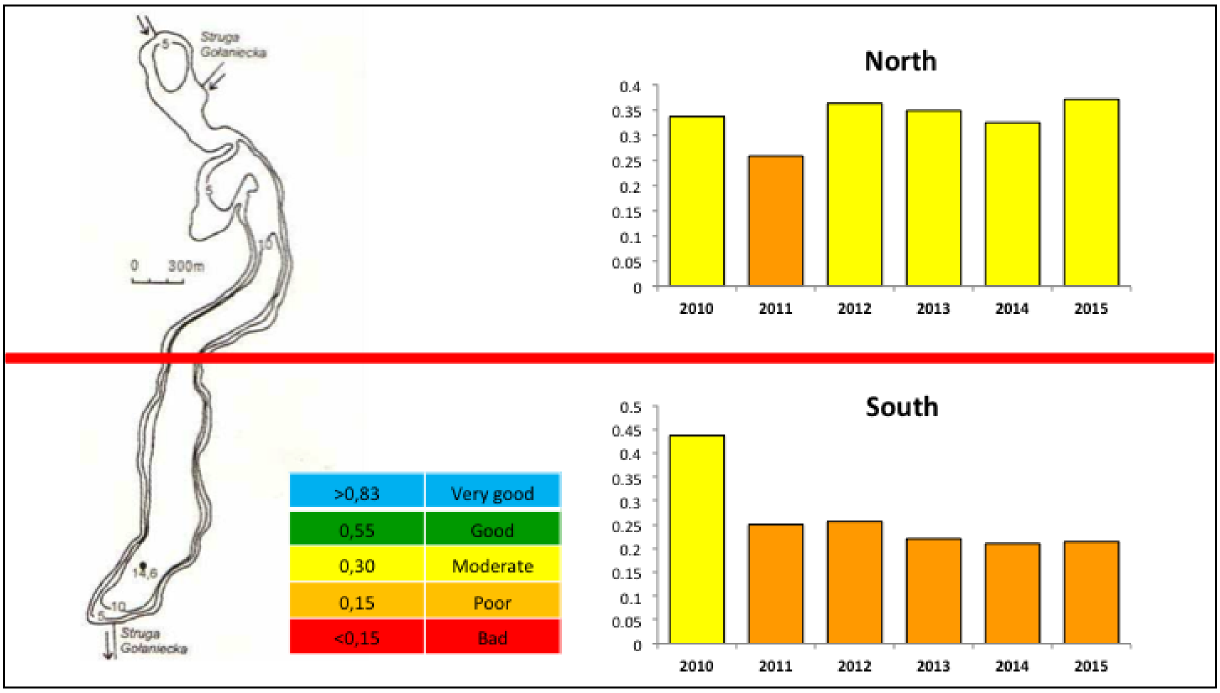

Fig. 12. Ecological state of Southern and Northern part of the lake based on Diatom Index in 2015

Red algae: *Hildenbrandia rivularis*

Hildenbrandia rivularis (fig. 13.) is a cosmopolitan red algae species, which prefers fresh flowing water habitats, but also occurs in standing water. It is considered to be a bioindicator of good water quality. However, it occurs right across the nutrient gradient, and the presence of stable substrata and clear water is probably more important than the nutrient concentration per se (Kelly&King, 2007).

Fig. 13. Photos of red algae appeared on the stones in 2015.

The red algae first appeared in 2010, and an increasing abundance of these algae had been observed (fig 14.). This year the red algae appears at the same allocation as last year, along the south-east region. That could be because that, the dominant wind direction in this area is from the west, and this creates constant wave erosion and oxygenation of the water in the south-east region.

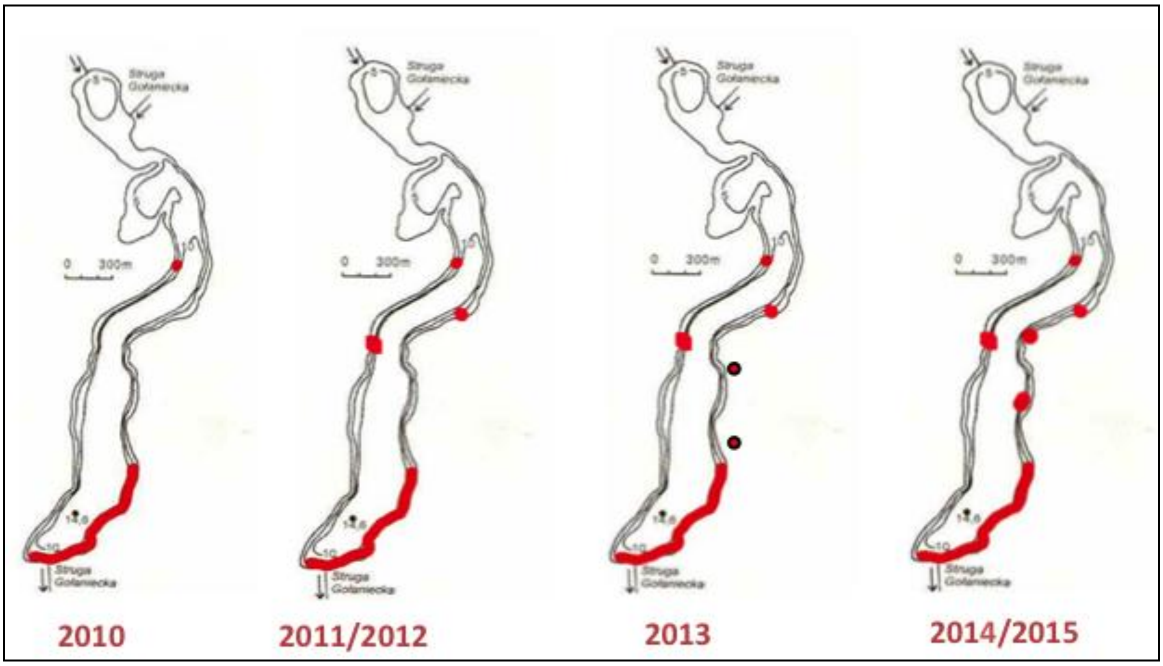

Fig 14. Changes in the abundance of *Hildebrandia rivularis*

Conclusions

From the analyses of our results, the ecological state of Lake Duroskie is still eutrophic, and the hypertrophic situation in the inflow remains the same as before. We can only observe the high inflow of cyanobacteria but not inflow, which indicates that we should pay more attention to the upstream of the river and also the lakes up there.

In the research of this year, 5 new species of phytoplankton were found. This suggests the lake is restructuring into the better direction. In addition, the decrease of the phytoplankton density also turns out to be the consequence of bio-manipulation.

The southern part of the lake remains poor ecological state needs to be paid more attention. This could be due to higher anthropogenic pressure in the littoral zone, also could be due to the less distribution of macrophytes. Macrophytes can absorb nutrients to certain extent. From this point of view, it is necessary to protect the macrophytes along the shoreline of the lake.

To conclude, based on the analysis of phytoplankton and periphyton, the ecological state of Lake Durowskie remains stable, and has the potential to be better. The restoration methods that have been applied are really working, but it is a long procedure to achieve the state we expect.

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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**	**2014**	**2015**
***Cyanoprokaryota* - cyanobacteria**								
Anabaena affinis Lemm.							+	
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.		+	+					
Gloeocapsa minuta Lemm.							+	
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.	+	+	+				+	+

Phytoplankton taxa	2008	2009	2010	2011	2012	2013	2014	2015
Woronichina naegeliana(Unger)Elenkin								+
Spirulina laxissima (W. West)			+					
Spirulina mior Kütz.					+			
Oscillatoria grossegranulata Skuja						+		
Bacillariophyceae - diatoms								
Achnanthes exigua Grun.			+					
Achnanthes minutissima Kützing	+		+	+		+		+
Amphora copulate(Kutz.)Schoeman & Archibald								+
Amphora ovalis Kützing	+	+	+	+				
Amphora pediculus (Kütz.) Grun.			+					
Asterionella formosa Hasall		+		+	+	+	+	+
Caloneis amphisbaena(Bory)Cleve								+
Cocconeis euglypta (Ehr.) Clevei	+							
Cocconeis placentula Ehr.	+		+	+	+	+		+
Cyclotella atomus Hustedt		+						
Cyclotella meneghiniana Kütz.	+	+	+			+		
Cyclotella ocellata Pant.	+		+	+	+	+	+	+
Cyclotella operculata (Ag.) Kützing	+	+	+			+		
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+	+
Cymatopleura solea (Breb.) W. Smith							+	
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	+	+	+	+	+	+	+	+

Phytoplankton taxa	2008	2009	2010	2011	2012	2013	2014	2015
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.						+		+
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.			+					

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Coelastrum reticulatum (Dang.) Senn	+	+					+	
Cosmarium abbreviatum Raciborski	+		+	+	+	+	+	
*Cosmarium exiguum*W. Archer		+						
Cosmarium formosulm Lund								+
Cosmarium trilobulatumr Reinsh								+
Cosmarium margaritatum (Turp.) Ralfs				+				
Cosmarium phaseolus Brebisson in Ralfs	+		+	+		+	+	+
Cosmarium laeve Rabenhorst					+			
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			+	+		+	+	+
Franceia ovais (France) Lemm.							+	
Golenkinia radiata Chodat	+		+	+	+	+	+	+
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	+					+	+	+
Koliella longiseta (Vischer) Hindak	+							
Lagerheimia ciliata(Lag.) Chodat							+	
Micractinium crassisetum Hortobagyi				+				
Micractinium pusillum Fresenius				+				
Mougeotia sp.				+	+			
Monoraphidium arcuatum (Kors.) Hindak	+							

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
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	+	+	+	+	+		+	+
Oedogonium sp.								+
Palmelochette tenerrima Kors.				+				
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					+			
Provasiorella sp.							+	
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		+						

Phytoplankton taxa	2008	2009	2010	2011	2012	2013	2014	2015
Scenedesmus verucosus Roll				+				
Sphaerocystis planctonica (Korsikov) Bourrelly				+	+	+	+	+
Staurastrum gracile Ralfs			+	+	+	+	+	+
Staurastrum paradoxum Meyen							+	
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	+	+	+	+	+	+	+	+
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	+	+		+	+	+	+	+
Ceratium cornutum (Ehr)Clap.&Lachman								+
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								

Phytoplankton taxa	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Colacium vesiculosum Ehr.		+		+		+		+
Euglena caudata Hübner					+			
Euglena pisciformis Klebs		+		+				+
Phacus caudatus Hubner								+
Phacus pusillus Lemm								+
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 29 th June to 3rd July 2015 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2; F – frequency).**

	n=1	n=3	n=3	n=3	n=3	n=1	n=1	n=1	n=16
Depth	**0m**	**0-2m**	**0-2m**	**0-2m**	**0-2m**	**0m**	**0m**	**0m**	**%**
Site	**Inf**	**A2**	**M2**	**M1**	**A1**	**Outf**	**B1**	**B2**	**F**
Cyanoprokaryota - cyanobacteria									
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+	+	+		+	50
Chroococcus turgidus (Kűtz.) Naeg.				+					6
Limnothrix redekei (Van Goor) Meffert	+	+	+	+	+	+	+	+	94
Microcystis aeruginosa Kützing	+								6
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg							+		6
Pseudanabaena limnetica (Lemm.) Kom.	+								6
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+	+	+	+	+	100
Woronichina naegeliana (Unger) Elenkin			+						6
Jaaginema gracilis (Bocher) Anagn. et Kom.					+				6
Bacillariophyceae - diatoms									
Amphora ovalis Kützing	+								6
Amphora copulata (Kutz.) Schoeman & Archibald							+	+	13
Asterionella formosa Hasall		+		+	+				25
Caloneis amphisbaena (Bory) Cleve	+								6
Cocconeis placentula Ehr.	+								6
Cyclotella ocellata Pant.	+	+	+	+	+		+	+	69
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+	+	100
Cymbella minuta Hilse ex Rabenhorst			+	+					13
Fragilaria crotonensis Kitton	+	+	+	+	+	+	+	+	81
Fragilaria pinnata Ehr.				+					6
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+	+	+	94

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Fragilaria ulna var. *angustissima* Sippen	+		+	+			+		25
Hippodonta capitata (Ehr.) L-Bert., Metz. & Witkowski	+								6
Navicula cincta (Ehr.) Ralfs	+								6
Naviula tripunctata (Muller) Bory	+								6
Nitzschia palea (Kütz.) W. Smith	+								6
Nitzschia sigmoidea (Ehr.) W. Smith	+								6
Pinnularia viridis (Nitzsch) Ehr.	+								6
Rhopalodia gibba (Ehr.) Muller	+								6
Chlorophyta - green algae									
Botryococcus braunii Kutzing		+	+	+					31
Characium aqngustatum A. Braun				+					6
Chlamydomonas passiva Skuja	+								6
Chlamydomonas reinhardtii Dangeard			+						13
Closterium acutum var. *variabile* (Lemm.) Krieg.		+			+		+		25
Coelastrum astroideum De Notaris	+	+	+	+	+				50
Cosmarium phaseolus Brebisson in Ralfs		+	+	+					19
Cosmarium regnellii Wille			+	+					25
Cosmarium formosulm Lund			+						13
Cosmarium trilobulatum Reinsch		+	+	+	+		+		31
Desmodesmus communis (Hegew.) Hegew.	+	+	+	+	+	+		+	63
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt				+			+		13
Elkatothrix gelatinosa Wille	+	+	+	+	+		+	+	81
Golenkinia radiata Chodat	+	+		+	+			+	38
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin					+		+		13
Monoraphidium contortum (Thur.) Kom.-Legn.	+	+	+		+			+	31
Monoraphidium griffithii (Berk.) Kom.-Legn.					+				6
Monoraphidium komarkovae Nygaard					+				6
Oocystis lacustris Chodat		+	+	+	+			+	44

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Oedogonium sp.			+				+		13
Pediastrum boryanum (Turpin) Meneg.	+		+	+	+	+			50
Pediastrum duplex Meyen				+	+		+		19
*Phacotus lenticularis (*Ehr.) Stein	+	+	+	+	+	+		+	88
Scenedesmus acuminatus (Lager.) Chodat	+	+					+		19
Sphaerocystis planctonica (Korsikov) Bourrelly		+	+	+	+	+		+	81
Tetraedron caudatum (Corda) Hansgirg			+		+				13
Tetraedron minimum (A. Br.) Hansgirg	+	+	+	+	+				38
Tetrastrum staurogeanieforme (Schroed.) Lemm.			+						13
Staurastrum gracile Ralfs	+	+	+	+	+				50
Cryptophyta - cryptophytes									
Cryptomonas erosa Ehrenberg	+	+	+	+	+	+	+	+	100
Cryptomonas marssonii Skuja	+	+	+		+	+	+	+	44
Cryptomonas ovata Ehrenberg							+		6
Cryptomonas rostrata Troitzskaja emend I. Kiselev	+	+	+	+	+	+	+	+	94
Rhodomonas minuta Skuja	+	+	+	+	+	+	+	+	88
Dinophyta - dinoflagellates									
Peridinopsis berolinense (Lemm.) Bourrelly		+	+		+			+	25
Ceratium hirundinella (F. B. Müller) Bergh	+	+	+	+	+	+	+		94
Ceratium cornutum (Ehr.) Clap. & Lachman		+	+	+	+		+		81
Gymnodinium aeruginosum Stein	+								6
Peridiniopsis cuningtonii Lemm.	+	+	+	+	+	+	+	+	100
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+	+	+	+	+	94
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	+	+	+	+	+	+	+	+	100
Euglenophyta - euglenoids									
Trachelomonas hispida (Perty) Stein	+	+	+			+	+	+	44
Euglena pisciformis Klebs	+	+		+	+				25
Phacus caudatus Hubner			+						6

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Phacus pusillus Lemm.			+				+		13
Colacium vesiculosum Ehr.			+	+				+	19
Chrysophyceae - chrysophyces									
Erkenia subaequiciliata Skuja	+	+	+	+	+	+	+	+	88
Dinobryon divergens Imhof	+	+	+	+	+	+	+		63

ANNEX 3. **Average number of phytoplankton species cells (ind./L) from different depth in Lake Durowskie from 29th June to 03rd July 2015 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2).**

Depth	0-2m	0-2m	0-2m	0-2m	0-2m	0-2m	0-2m	0-2m
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
***Cyanoprokaryota* - cyanobacteria**								
Aphanizomenon flos-aquae (L.) Ralfs	191200	12000	1600	1067	800	800	.	1600
Chroococcus turgidus (Kűtz.) Naeg.	.	.	.	267	.	.	.	.
Limnothrix redekei (Van Goor) Meffert	1714400	37067	82133	20267	82933	17600	20800	29600
Lyngbya hieronymusii Lemm.	.	.	.	.	.	.	.	.
Microcystis aeruginosa Kützing	800	.	.	.	.	.	.	.
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	.	.	.	.	.	.	3200	.
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	92800	4533	12000	3733	5867	2400	3200	3200
Pseudanabaena limnetica (Lemm.) Kom.	276000	.	.	.	.	.	.	.
Woronichina naegeliana (Unger) Elenkin	.	.	267	.	.	.	.	.
Jaaginema gracilis (Bocher) Anagn. et Kom.	.	.	.	.	267	.	.	.
Total	**2275200**	**53600**	**96000**	**25333**	**89867**	**20800**	**27200**	**34400**
***Bacillariophycee* - diatoms**								
Amphora ovalis Kützing	800	.	.	.	.	.	.	.
Amphora copulata (Kutz.) Schoeman & Archibald	.	.	.	.	.	.	1600	800
Asterionella formosa Hasall	.	267	.	800	1333	.	.	.
Caloneis amphisbaena (Bory) Cleve	800	.	.	.	.	.	.	.

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2
Cocconeis placentula Ehr.	800	.	.	.	.	.	.	.
Cyclotella ocellata Pant.	4800	533	1867	1067	533	.	800	800
Cyclotella radiosa (Grun.) Lemm.	20800	4533	7467	3200	7200	11200	1600	5600
Cymbella minuta Hilse ex Rabenhorst	.	.	267	267	.	.	.	.
Fragilaria crotonensis Kitton	48000	4533	6667	8800	31467	14400	20800	12000
Fragilaria pinnata Ehr.	.	.	.	267	.	.	.	.
Fragilaria ulna (Nitzsch) Lange-Bertalot	9600	24000	28000	32000	42133	.	28800	42400
Fragilaria ulna var. angustissima Sippen	800	.	533	267	.	.	28000	.
Hippodonta capitata (Ehr.) L-Bert., Metz. & Witkowski	800	.	.	.	.	.	.	.
Navicula cincta (Ehr.) Ralfs	800	.	.	.	.	.	.	.
Naviula tripunctata (Muller) Bory	800	.	.	.	.	.	.	.
Nitzschia palea (Kütz.) W. Smith	2400	.	.	.	.	.	.	.
Nitzschia sigmoidea (Ehr.) W. Smith	800	.	.	.	.	.	.	.
Pinnularia viridis (Nitzsch) Ehr.	800	.	.	.	.	.	.	.
Rhopalodia gibba (Ehr.) Muller	800	.	.	.	.	.	.	.
Total	**93600**	**33867**	**44800**	**46667**	**82667**	**25600**	**81600**	**61600**
***Chlorophyta* - green algae**								
Botryococcus braunii Kutzing	.	1600	1867	1067	.	.	.	.
Characium aqngustatum A. Braun	.	.	.	267	.	.	.	.
Chlamydomonas passiva Skuja	800	.	.	.	.	.	.	.
Chlamydomonas reinhardtii Dangeard	.	.	4000	.	.	.	.	.
Closterium acutum var. variabile (Lemm.) Krieg.	.	533	.	.	267	.	.	.
Coelastrum astroideum De Notaris	800	533	1067	533	533	.	1600	.
Cosmarium phaseolus Brebisson in Ralfs	.	267	267	267	.	.	.	.
Cosmarium regnellii Wille	.	.	800	533	.	.	.	.
Cosmarium formosulm Lund	.	.	533	.	.	.	.	.
cosmarium trilobulatum Reinsch	.	533	267	267	533	.	.	.
Desmodesmus communis (Hegew.) Hegew.	1600	533	800	267	533	1600	800	800

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	.	.	.	267	.	.	.	.
Elkatothrix gelatinosa Wille	4800	3467	2133	1600	2933	.	4000	800
Golenkinia radiata Chodat	12000	1067	.	1067	800	.	4000	2400
Kirchneriella contorta var. elegans (Schmidle) Bohlin	.	.	.	.	267	.	.	.
Monoraphidium contortum (Thur.) Kom.-Legn.	3200	1067	267	.	267	.	1600	800
Monoraphidium griffithii (Berk.) Kom.-Legn.	.	.	.	.	267	.	.	.
Monoraphidium komarkovae Nygaard	.	.	.	.	533	.	.	.
Oocystis lacustris Chodat	.	267	267	267	3733	.	.	17600
Oedogonium sp.	.	.	800	.	.	.	.	.
Pediastrum boryanum (Turpin) Meneg.	800	.	2667	800	4000	800	800	.
Pediastrum duplex Meyen	.	.	.	267	267	.	.	.
Phacotus lenticularis (Ehr.) Stein	30400	15200	1600	2933	3733	1600	3200	4000
Scenedesmus acuminatus (Lager.) Chodat	800	267	.	.	.	.	.	.
Sphaerocystis planctonica (Korsikov) Bourrelly	.	9067	6400	7200	25067	31200	800	12800
Tetraedron caudatum (Corda) Hansgirg	.	.	267	.	267	.	.	.
Tetraedron minimum (A. Br.) Hansgirg	800	267	267	533	533	.	.	.
Tetrastrum staurogeanieforme (Schroed.) Lemm.	.	.	800	.	.	.	.	.
Staurastrum gracile Ralfs	800	2400	1067	267	8533	.	.	.
Total	**56800**	**37067**	**26133**	**18400**	**53067**	**35200**	**16800**	**39200**
***Cryptophyta* - cryptophytes**								
Cryptomonas erosa Ehrenberg	22400	121467	58133	100800	146933	44000	68000	87200
Cryptomonas marssonii Skuja	25600	533	267	.	800	7200	800	4000
Cryptomonas ovata Ehrenberg	.	.	.	.	.	.	3200	.
Cryptomonas rostrata Troitzskaja emend I. Kiselev	9600	16533	20000	3200	12267	5600	3200	3200
Rhodomonas minuta Skuja	3200	2133	9333	800	1867	800	4000	5600
Total	**60800**	**140667**	**87733**	**104800**	**161867**	**57600**	**79200**	**100000**
***Dinophyta* - dinophytes**								

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2
Peridinopsis berolinense (Lemm.) Bourrelly	.	267	267	.	1333	.	.	2400
Ceratium hirundinella (F. B. Müller) Bergh	1600	4533	8533	4000	4800	4000	4000	.
Ceratium cornutum (Ehr.) Clap. & Lachman	.	800	800	800	800	.	800	.
Gymnodinium aeruginosum Stein	800	.	.	.	.	.	.	.
Peridiniopsis cuningtonii Lemm.	8000	38133	40533	20267	68800	64800	12000	20000
Peridinium cinctum (O.F. Müller) Ehrenberg	4800	20267	23733	14133	52533	80000	6400	4000
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	4800	3200	3467	4267	12000	36000	12800	13600
Total	**20000**	**67200**	**77333**	**43467**	**140267**	**184800**	**36000**	**40000**
***Euglenophyta* - euglenoids**								
Trachelomonas hispida (Perty) Stein	1600	533	1800	.	.	800	800	800
Euglena pisciformis Klebs	800	533	.	267	800	.	.	.
Phacus caudatus Hubner	.	.	2400	.	.	.	.	.
Phacus pusillus Lemm.	.	.	800	.	.	.	800	.
Colacium vesiculosum Ehr.	.	.	1867	267	.	.	.	2400
Total	**2400**	**1067**	**6867**	**533**	**800**	**800**	**1600**	**3200**
***Chrysophyceae* - chrysophyces**								
Erkenia subaequiciliata Skuja	150400	17333	15467	12000	19467	4000	79200	4200
Dinobryon divergens Imhof	15200	1067	267	533	1600	4000	1600	.
Total	**165600**	**18400**	**15733**	**12533**	**21067**	**8000**	**80800**	**4200**

ANNEX 4. **Average biomass of phytoplankton species (mg/L) from different depth in Lake Durowskie from 29th June to 03rd July 2015 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2).**

Depth	**0-2m**	**0-2m**	**0-2m**	**0-2m**	**0-2m**	**0-2m**	**0-2m**	**0-2m**
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
***Cyanoprokaryota* - cyanobacteria**								
Aphanizomenon flos-aquae (L.) Ralfs	0.375	0.024	0.003	0.002	0.002	0.002	.	0.003
Chroococcus turgidus (Kűtz.) Naeg.	.	.	.	0.002	.	.	.	.
Limnothrix redekei (Van Goor) Meffert	.	.	.	0.0003	.	.	.	.
Lyngbya hieronymusii Lemm.	0.538	0.012	0.025	0.006	0.026	0.006	0.007	0.009
Microcystis aeruginosa Kützing	0.001	.	.	.	.	.	.	.
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	.	.	.	.	.	.	0.001	.
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	0.117	0.006	0.017	0.005	0.007	0.003	0.004	0.004
Pseudanabaena limnetica (Lemm.) Kom.	0.087	.	.	.	.	.	.	.
Woronichina naegeliana (Unger) Elenkin	.	.	0.0003	.	.	.	.	.
Jaaginema gracilis (Bocher) Anagn. et Kom.	.	.	.	.	0.001	.	.	.
Total	**0.204**	**0.006**	**0.017**	**0.005**	**0.008**	**0.003**	**0.012**	**0.004**
***Bacillariophycee* - diatoms**								
Amphora ovalis Kützing	0.001	.	.	.	.	.	.	.
Amphora copulata (Kutz.) Schoeman & Archibald	.	.	.	.	.	.	0.0002	0.0008
Asterionella formosa Hasall	.	0.00003	.	0.0001	0.0002	.	.	.
Caloneis amphisbaena (Bory) Cleve	0.009	.	.	.	.	.	.	.
Cocconeis placentula Ehr.	0.001	.	.	.	.	.	.	.
Cyclotella ocellata Pant.	0.005	0.001	0.011	0.001	0.001	.	0.0009	0.0008
Cyclotella radiosa (Grun.) Lemm.	0.026	0.006	0.011	0.004	0.009	0.014	0.002	0.007
Cymbella minuta Hilse ex Rabenhorst	.	.	0.0003	0.0003	.	.	.	.
Fragilaria crotonensis Kitton	0.022	0.002	0.004	0.004	0.014	0.007	0.009	0.005
Fragilaria pinnata Ehr.	.	.	.	0.0003	.	.	.	.
Fragilaria ulna (Nitzsch) Lange-Bertalot	0.013	0.232	0.041	0.044	0.057	0.038	0.039	0.058

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2
Fragilaria ulna var. angustissima Sippen	0.002	.	0.003	0.001	.	.	.	.
Hippodonta capitata (Ehr.) L-Bert., Metz. & Witkowski	0.002	.	.	.	.	.	.	.
Navicula cincta (Ehr.) Ralfs	0.01	.	.	.	.	.	.	.
Naviula tripunctata (Muller) Bory	0.012	.	.	.	.	.	.	.
Nitzschia palea (Kütz.) W. Smith	0.03	.	.	.	.	.	.	.
Nitzschia sigmoidea (Ehr.) W. Smith	0.013	.	.	.	.	.	.	.
Pinnularia viridis (Nitzsch) Ehr.	0.002	.	.	.	.	.	.	.
Rhopalodia gibba (Ehr.) Muller	0.001	.	.	.	.	.	.	.
Total	**0.149**	**0.240**	**0.070**	**0.055**	**0.081**	**0.059**	**0.0511**	**0.0716**
***Chlorophyta* - green algae**								
Botryococcus braunii Kutzing	.	0.007	0.007	0.002	.	.	.	.
Characium aqngustatum A. Braun	.	.	.	0.0002	.	.	.	.
Chlamydomonas passiva Skuja	0.001	.	.	.	.	.	.	.
Chlamydomonas reinhardtii Dangeard	.	.	0.002	.	.	.	.	.
Closterium acutum var. variabile (Lemm.) Krieg.	.	0.001	.	.	.	.	.	.
Coelastrum astroideum De Notaris	0.003	0.002	0.004	0.002	0.002	.	0.005	.
Cosmarium phaseolus Brebisson in Ralfs	.	0.001	0.001	0.001	.	.	.	.
Cosmarium regnellii Wille	.	.	0.001	0.001	.	.	.	.
Cosmarium formosulm Lund	.	.	0.007	.	.	.	.	.
cosmarium trilobulatum Reinsch	.	0.0003	0.001	0.0003	0.003	.	.	.
Desmodesmus communis (Hegew.) Hegew.	0.001	0.001	0.001	0.0003	.	0.001	0.0007	0.001
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	.	.	.	0.0003	.	.	.	.
Elkatothrix gelatinosa Wille	0.005	0.004	0.003	0.002	0.002	.	0.004	0.001
Golenkinia radiata Chodat	0.006	0.001	.	0.001	0.0004	.	0.002	0.001
Kirchneriella contorta var. elegans (Schmidle) Bohlin	.	.	.	.	0.00003	.	.	.
Monoraphidium contortum (Thur.) Kom.-Legn.	0.001	0.0003	.	.	0.00003	.	0.0003	0.0001
Monoraphidium griffithii (Berk.) Kom.-Legn.	.	.	.	.	0.001	.	.	.
Monoraphidium komarkovae Nygaard	.	.	.	.	0.002	.	.	.

Site	Inf	A2	Mid.2	Mid.1	A1	Outf	B1	B2
Oocystis lacustris Chodat	.	0.001	0.001	0.001	0.009	.	.	0.045
Oedogonium sp.	.	.	0.013	.	.	.	.	.
Pediastrum boryanum (Turpin) Meneg.	0.024	.	0.080	0.024	0.118	0.024	0.024	.
Pediastrum duplex Meyen	.	.	.	.	0.008	.	.	.
Phacotus lenticularis (Ehr.) Stein	0.024	0.012	0.001	0.002	0.003	0.001	0.003	0.003
Scenedesmus acuminatus (Lager.) Chodat	0.001	.	.	.	.	.	.	.
Sphaerocystis planctonica (Korsikov) Bourrelly	.	0.021	0.015	0.016	0.057	0.071	0.002	0.029
Tetraedron caudatum (Corda) Hansgirg	.	.	0.00003	.	0.00003	.	.	.
Tetraedron minimum (A. Br.) Hansgirg	0.0001	.	0.00003	0.0002	0.00003	.	.	.
Tetrastrum staurogeanieforme (Schroed.) Lemm.	.	.	0.0001	.	.	.	.	.
Staurastrum gracile Ralfs	0.002	0.006	0.003	0.001	0.021	.	.	.
Total	**0.0681**	**0.056**	**0.140**	**0.053**	**0.226**	**0.097**	**0.041**	**0.0801**
***Cryptophyta* - cryptophytes**								
Cryptomonas erosa Ehrenberg	0.036	0.210	0.097	0.163	0.238	0.071	0.11	0.141
Cryptomonas marssonii Skuja	0.033	0.001	.	.	0.001	0.009	0.001	0.005
Cryptomonas ovata Ehrenberg	.	.	.	.	.	.	0.002	.
Cryptomonas rostrata Troitzskaja emend I. Kiselev	0.02	0.035	0.032	0.007	0.026	0.012	0.007	0.007
Rhodomonas minuta Skuja	0.002	0.001	0.019	0.001	0.001	0.0006	0.003	0.004
Total	**0.091**	**0.247**	**0.148**	**0.171**	**0.266**	**0.0926**	**0.123**	**0.157**
***Dinophyta* - dinophytes**								
Peridinopsis berolinense (Lemm.) Bourrelly	.	0.002	0.003	.	0.001	.	0.037	0.022
Ceratium hirundinella (F. B. Müller) Bergh	.	0.181	0.822	0.310	0.464	0.387	0.077	.
Ceratium cornutum (Ehr.) Clap. & Lachman	0.155	0.306	0.072	0.125	0.072	0.072	.	.
Gymnodinium aeruginosum Stein	0.001	.	.	.	.	.	.	.
Peridiniopsis cuningtonii Lemm.	0.092	0.441	0.467	0.234	0.796	0.75	0.139	0.231
Peridinium cinctum (O.F. Müller) Ehrenberg	0.127	0.538	0.628	0.376	1.394	2.123	0.17	0.106
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	0.038	0.102	0.026	0.034	0.096	0.288	0.102	0.109

Total	**0.413**	**1.570**	**2.019**	**1.080**	**2.823**	**3.62**	**0.525**	**0.468**
***Euglenophyta* - euglenoids**								
Trachelomonas hispida (Perty) Stein	0.001	0.001	0.002	.	.	0.0008	0.0008	0.001
Euglena pisciformis Klebs	0.001	.	.	0.0003	0.0005	.	.	.
Phacus caudatus Hubner	.	.	0.002	.	.	.	0.002	.
Phacus pusillus Lemm.	.	.	0.001	.	.	.	.	.
Colacium vesiculosum Ehr.	.	.	0.003	0.0002	.	.	.	0.002
Total	**0.002**	**0.001**	**0.008**	**0.001**	**0.0005**	**0.0008**	**0.0028**	**0.003**
***Chrysophyceae* - chrysophyces**								
Erkenia subaequiciliata Skuja	0.008	0.001	0.001	0.001	0.001	0.0002	0.004	0.0002
Dinobryon divergens Imhof	0.007	0.0005	0.0001	0.0003	0.001	0.002	0.0007	.
Total	**0.015**	**0.002**	**0.001**	**0.001**	**0.002**	**0.0022**	**0.0047**	**0.0002**

ANNEX 5. Comparison of periphyton species composition in different investigated sites from 29th June to 4th July 2015 in Lake Durowskie.

Diatom taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	pH	O	T
Achnanthes conspicua Mayer	.	.	.	.	.	.	.	.	.	.	3	2	7
Achnanthes exigua Grun.	.	+	+	+	+	+	+	+	+	+	4	1	7
Achnanthes hungarica (Grun.) Grun.	.	.	.	+	.	.	.	+	.	.	4	4	6
Achnanthes lanceolata (Breb.) Grun.	+	+	+	+	.	+	+	+	.	.	4	3	5
Achnanthes lanceolata v. elliptica Cleve sensu Straub	.	+	.	.	.	+	.	.	.	.	4	-	-
Achnanthes minutissima Kütz.	+	+	+	+	+	+	+	+	+	+	3	1	7
Achnanthes minutissima var. affinis (Grun.) Lange-Bertalot	.	.	.	.	.	+	+	+	.	.	4	-	-
Achnanthes minutissima var. gracillina (Meister) Lange-Bertalot	.	.	.	+	.	+	.	+	.	.	4	-	1
Amphipleura pellucida (Kuetzing) Kuetzing	.	.	.	.	.	.	.	.	.	.	4	2	2
Amphora ovalis Kütz.	+	+	+	+	+	+	+	+	+	+	4	2	5
Amphora pediculus (Kütz.) Grun.	+	+	+	+	+	+	+	+	+	+	4	2	5
Amphora pellucida Kütz.	.	+	.	.	.	.	.	.	.	.	-	-	-
Asterionella formosa Hass	+	.	.	.	+	.	.	+	+	+	4	2	5

Diatom taxa	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	pH	O	T
Aulacoseira granulata (Ehr.) Ralfs	.	+	.	.	.	.	.	.	.	.	4	3	5
Aulcoseira granulata var. angustissima f.curvata (O. Mül.) Sim.	.	.	.	.	.	.	.	.	.	.	4	3	5
Caloneis bacillum (Grun.) Meresz.	.	+	+	+	.	+	.	.	.	.	4	2	4
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. linearis Ehr.	.	.	+	.	.	.	.	.	.	.	-	-	-
Cocconeis placentula var. lineata (Ehr.)	.	+	+	.	.	+	.	+	.	.	4	3	5
Cocconeis placentula var. pseudolineata Geitler	+	+	.	.	.	+	+	.	.	.	-	-	-
Cyclotella meneghiniana Kütz.	.	.	+	+	+	+	+	+	+	+	4	5	5
Cyclotella ocellata Pant.	+	+	+	+	+	+	+	+	+	.	4	1	4
Cyclotella operculata (Ag.) Kütz.	.	+	+	+	.	.	+	+	+	+	-	-	-
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+	+	+	+	4	2	5
Cyclotella steligera Cl. et Grun.	.	.	.	.	.	.	.	+	.	.	0	-	-
Cymatopleura solea (Breb.) W. Smith	.	.	.	.	+	.	.	.	+	+	4	3	5
Cymbella affinis Kütz.	+	.	+	+	+	+	+	+	+	+	4	1	5
Cymbella caespitosum (Kütz.)Brun	.	.	.	+	.	.	.	.	.	.	0	-	7
Cymbella cistula (Her.) Kirchner	+	+	+	.	+	.	.	.	+	.	4	2	5
Cymbella lanceolata (Ehr.) Kirchner	+	.	.	.	+	.	.	.	+	+	4	1	7
Cymbella microcephala Grun.	+	+	+	.	.	+	+	+	.	.	4	1	4
Cymbella minuta Hilse	+	+	+	+	+	+	+	+	+	+	3	-	-
Cymbella prostrata (Berkeley) Cleve	.	.	.	.	.	.	.	.	+	.	4	1	5
Cymbella turgida (Greg.) Cleve	+	.	.	.	.	.	.	.	.	.	-	-	-
Diatoma tenuis Agardh	+	.	.	.	+	.	.	.	+	+	4	3	5
Diatoma vulgaris Bory	.	+	.	+	+	+	+	+	+	+	5	2	4
Diatoma vulgaris Bory Morphotyp *ovalis*	.	.	.	.	.	.	.	.	.	.	-	-	-
Diploneis elliptica (Kütz.) Cl.	.	.	.	.	+	.	.	.	+	+	4	1	3
Encynomena silesiacaum (Bleisch in Rabenh.) D. G. Mann	.	.	.	.	.	.	.	.	.	.	-	-	-
Eunotia exigua (Breb.) Rabenh.	+	.	.	.	+	.	.	.	+	+	1	2	7
Eunotia faba (Ehr.) Grun.	.	.	.	.	+	.	.	.	+	.	2	1	2
Eunotia intermedia (Krasske) Norpel I Lange-Bertalot	.	.	.	+	.	.	.	.	.	.	2	-	1
Eunotia lunaris Ehr.	.	.	.	.	.	+	.	.	.	.	-	-	-

Diatom taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**pH**	**O**	**T**
Eunotia praerupta Ehr.	+	+	+	+	+	+	+	+	+	+	2	1	2
Eunotia tenella (Grun.) Hustedt	.	.	.	+	.	.	.	.	.	.	2	1	1
Fragilaria capitata Ehr.	.	.	+	.	.	.	.	.	.	.	-	-	-
Fragilaria capucina (Desm.) Rabenhorst	+	+	+	+	+	+	+	.	.	+	3	-	3
Fragilaria capucina v. amphcephala	.	.	.	.	.	.	.	.	.	+	-	-	-
Fragilaria constricta Ehr.	.	.	.	.	.	.	+	.	.	.	2	-	1
Fragilaria construens (Ehr.) Grun.	.	.	+	.	.	.	.	.	.	.	4	1	4
Fragilaria crotonensis Kitton	+	+	+	+	+	+	+	+	+	+	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
Fragilaria ulna var. biceps (Nitzsch) Lange-Bertalot	+	.	.	.	.	.	.	.	.	.	-	-	-
Fragilaria vaucheriae (Kütz.) Carlson	.	.	.	.	.	.	.	.	.	.	-	-	-
Gomphonema acuminatum Ehr.	+	.	.	+	+	+	.	+	.	+	4	2	5
Gomphonema angustatum (Kütz.) Rabenhorst	.	.	.	+	.	.	.	.	.	.	-	-	-
Gomphonema angustum (Kütz.) Rabenhorst	.	.	.	.	.	.	.	.	.	+	4	1	1
Gomphonema augur Ehr.	+	.	.	+	.	.	.	.	.	.	4	1	4
Gomphonema gracile Ehr.	+	+	.	.	+	.	.	.	.	+	3	1	3
Gomphonema intricatum Kütz.	.	.	.	+	.	.	.	.	.	.	-	-	-
Gomphonema italicum Kütz.	.	.	.	.	.	.	.	.	.	.	-	-	-
Gomphonema micropus Kütz.	.	.	.	.	+	.	.	.	.	+	4	2	5
Gomphonema olivaceoides Hustedt	+	+	.	+	.	+	.	.	+	+	-	-	-
Gomphonema olivaceum (Horn.) Breb.	+	+	+	+	+	.	+	+	+	+	5	2	5
Gomphonema parvulum (Kütz.) Kütz.	+	+	.	+	+	.	+	+	+	+	3	4	5
Gomphonema truncatum Ehr.	.	+	.	.	.	.	.	.	.	.	4	2	4
Hantzschia amphioxys (Ehr.) Grun.	.	.	.	.	.	.	+	.	+	.	3	2	7
Hipodonta capitata (Ehr)Lange-Bertalot	.	.	.	.	.	.	.	.	.	.	-	-	-
Mastogloia smithii Twaites ex W.Smith	.	.	.	.	.	+	.	.	.	.	4	-	-
Meridion circulare Ag.	.	+	+	+	.	+	+	.	.	+	4	2	7
Navicula agrestis Hustedt	.	.	.	.	.	.	.	+	+	.	3	-	-
Navicula anglica Ralfs	.	.	.	.	.	.	.	+	.	.	-	-	-

Diatom taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**pH**	**O**	**T**
Navicula capitata Patrick in Patrick & Reimer	.	+	+	.	.	+	+	+	+	+	4	3	4
Navicula cincta (Ehr.) Ralfs	+	.	+	.	+	.	.	+	+	+	4	3	5
Navicula cryptocephala Kütz.	+	.	.	.	+	.	.	.	+	+	3	3	7
Navicula dicephala (Ehr.) W. Sm.	+	.	.	.	.	.	.	.	.	.	-	-	-
Navicula gastrum	.	.	.	.	.	.	.	.	.	+	4	4	5
Navicula gregaria Donkin	.	.	.	.	.	+	.	+	.	.	4	4	5
Navicula integra (W.Smith) Ralfs	.	.	.	.	.	.	.	.	.	.	3	3	5
Navicula placentula (Placeneis)	.	.	.	.	.	.	.	.	+	+	4	2	5
Navicula pseudoanglica Lange-Bertalot	.	.	.	.	.	.	.	.	.	.	4	1	4
Navicula radiosa Kütz.	+	+	+	+	+	+	+	+	+	+	3	2	4
Navicula reinhardtii Grun.	.	.	+	.	.	.	+	.	.	+	5	2	5
Navicula tenella Brèbisson ex Kützing	.	.	.	.	.	.	.	.	.	.	-	-	-
Navicula tripunctata (O. F. Müller) Bory	+	+	+	+	+	+	+	+	+	+	4	2	5
Navicula viridula (Kütz.) Ehr.	.	.	.	.	+	.	+	.	+	.	4	2	5
Nitzschia acicularis (Kütz.) W.Sm	+	+	+	.	.	.	.	.	.	.	4	4	5
Nitzschia amphibia Grun.	+	+	.	+	+	.	.	.	+	+	4	3	5
Nitzschia incospicua Grun.	.	.	.	.	.	+	+	.	.	+	4	3	5
Nitzschia intermedia Hantzsch	.	.	.	.	.	.	.	.	.	.	3	-	5
Nitzschia micropus Kütz.	+	.	.	.	.	.	.	.	.	.	-	-	-
Nitzschia palea (Kütz.) W. Sm.	+	.	+	+	.	.	+	+	.	.	3	4	6
Nitzschia paleacea Grun.	+	.	+	+	.	+	+	.	.	.	4	3	5
Nitzschia recta Hantzsch	+	.	.	.	+	+	+	+	+	.	4	2	7
Nitzschia sigmoidea (Ehr.) W. Sm.	.	.	+	+	+	.	+	.	+	+	4	3	5
Pinnularia gibba Ehr.	.	+	.	.	.	.	.	.	.	.	3	3	7
Pinnularia maior (Kütz.) Cleve	.	.	.	.	.	.	.	+	.	.	3	2	4
Pinnularia viridis (Nitzsch) Ehr.	.	+	+	+	.	+	+	.	.	.	3	3	7
Placoneis placentula (Ehr.) Cox	.	.	.	.	.	.	.	.	.	.	-	-	-
Rhoicosphaenia abbreviata (Ag.) Lange-Bertalot	.	+	.	+	.	.	.	.	.	.	4	2	5
Rhoicosphaenia curvata (Kütz.) Grun.	.	.	+	.	.	.	.	.	.	.	-	-	-
Rhopalodia gibba (Ehr.) Mueller	.	+	.	.	.	.	.	+	.	+	5	3	5
Stauroneis phoenicentron Ehr.	+	.	+	.	.	+	.	+	.	.	3	3	4
Stephanodiscus astraea (Ehrenberg) Grunow	+	.	.	.	.	.	+	.	+	.	-	-	-

Diatom taxa	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	**Site 7**	**Site 8**	**Site 9**	**Site 10**	**pH**	**O**	**T**
Stephanodiscus hantzschii Grun.	+	.	+	+	.	.	.	+	.	+	5	4	6
Surirella minuta Breb.	.	.	+	.	.	.	.	.	.	.	4	3	5
Surirella ovalis Breb.	.	.	.	.	+	.	.	.	+	.	4	4	5
Syndera capitata Ehrenberg	.	.	.	.	.	.	.	.	.	.	-	-	-
Synedra ulva (Nitzsch)	.	.	.	.	.	.	.	.	.	.	-	-	-
Tabellaria fenestrata (Lyngb.) Kütz.	+	+	.	.	.	+	.	+	.	.	3	1	2
Tabellaria flocculosa (Roth) Kütz.	.	.	.	.	.	.	.	.	.	+	2	1	3