Ecological State of Lake Durowskie

Algae Analysis

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Introduction

Wagrowiec is a city that historically important and also full of natural beauty. Durowskie Lake is the key area which emphasizes treasure of nature belongs to Wagrowiec. Enhancing tourism is one of the main concerns of this municipality. Therefore it is needed to protect Durowskie Lake to attract tourists and for recreation.

This lake was under eutrophic conditions from 1999. It was experienced cyanobacterial blooms also. Durowskie Lake is the final, 5th lake in a chain of upstream lakes. Therefore all the pollutants from upper lakes concentrated in the Durowskie Lake. Agricultural runoff which is rich with fertilizers (N,P,K), pesticides, weedicides and sewage from the upper lakes is the main pollution source of this Lake. Other than fishing, soil erosion and some recreation activities (motor boats) show negative effects on health and integrity of Duroweskie Lake.

In 2009, Local government of Wagroweic started restoration process for Durowskie Lake to improve water quality and ecological state. Restoration process was undergoing through 3 main processes. Aeration of hypolimnion by aerators, Bio manipulation or Top down control of food chain by adding Pikes and Pike perch fishes and phosphorous immobilization by adding Fe^{2+}.

Annual scientific research is going on to monitor the ecological condition and restoration progress of Durowskie Lake. These studies are supporting to identify future trends of lake's ecological state and make decisions on lake management. This annual study basically consists with different approaches as algae, macrophytes, macroinvertebrates, hydrology and lake management to direct final conclusions on ecological state of lake ultimately.

Algal communities are consisting with diverse species which have different ecophysiological and morphological characteristics, growth rates, resource requirements and vertical distribution (Hutchionson,1967). Structure of the algal community, species size and composition is governed by the various environmental interactions (Winder & Hunter, 2008). Therefore algae are very important to define ecological state of lake. They are very sensitive indicators for pollution and eutrophication. Also Lake Ecosystem functionality totally depends on phytoplankton since they are the primary producers of aquatic food chain.

This report is mainly focus on algae (periphyton and phytoplankton) density, composition, diversity, distribution and their relationship with the water quality and trophic level of lake in order to state the ecological state of Durowskie Lake in July 2016. Comparative data analysis from 2009 to 2016 is another objective of this study in order to find progress of restoration and future trends in Lake.

Materials and Methods

2.1 Study area

The study was conducted in Lake Durowskie from 26th of June to 02nd of July 2016. It is located in N 52° 49’ 06” and E 17° 12’ 01” at Wągroweic city, Great Poland region (Wielkopolska). Lake Durowskie is final lake of 5 lake chain, connected by river Struga Gołaniecka receiving water from all upstream lakes (Lake Smolary, Lake Laskownickie, Lake Grylewskie, Lake Bukowieckie Duże, Lake Bukowieckie Małe and Lake Kobyleckie). Lake Durowskie is a postglacial lake.

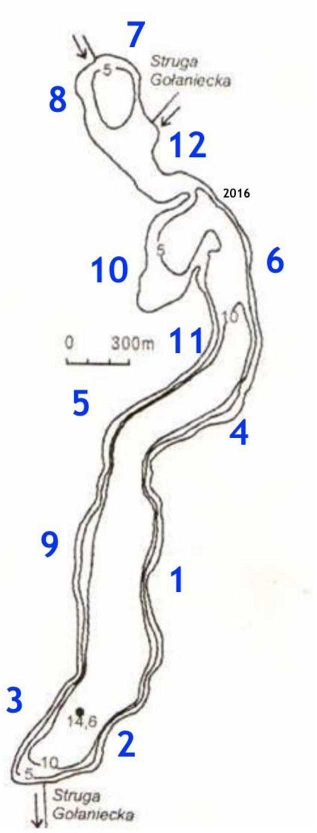
Morphometric Characteristics of Lake Durowskie is given in table 1.

Table 1: Morphometric characteristics of the Lake Duroweskie

Morphometric parameter		
Surface Area (ha)		
Volume (m^3)		
Maximum depth (m)		
Average depth (m)		
Total catchment area (km^2)		
Direct catchment area (ha)		
Land use of surrounding area	Agriculture (%)	58.26
	Forest (%)	33.52
	Urban (%)	8.25

2.2 Sampling

Periphyton sampling was done in 12 sites along the shore (Figure 1) and Phytoplankton was sampled in 8 sites in the lake (Figure 2). Water samples from surface, 1m, 2m and 3m depth levels were taken to analyse vertical distribution of phytoplankton. 30 L of water was sampled from each site using water sampler and filtered through plankton nets. Collected periphyton and phytoplankton samples were fixed with Lugol’s iodine in the field.



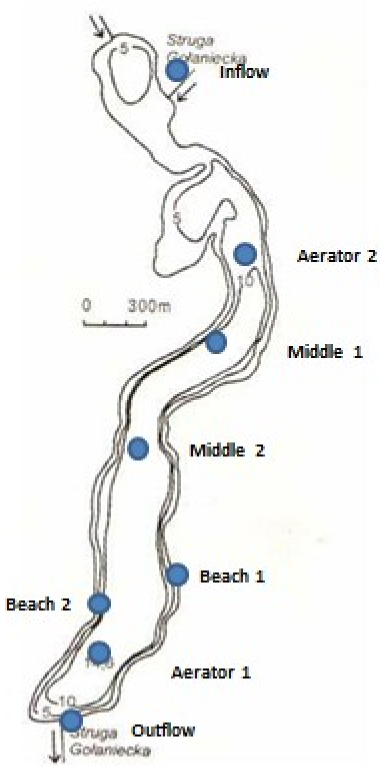


Figure 1: Periphyton sampling sites

Figure 2: Phytoplankton sampling sites

<u>Phsyico-chemical parameters</u>

Additional to peryphyton and phytoplankton sampling, the following physico-chemical parameters were measured in each site (Table 2).

Table 2: Physio-chemical parameters

Parameter	**Unit**	**Method**
Temperature	^{o}C	Water quality meter (YSI 556)
pH		Water quality meter (YSI 556)
Conductivity	μScm^{-1}	Water quality meter (YSI 556)

Dissolved oxygen	mgL^{-1}	Water quality meter (YSI 556)
	% (Saturated)	Water quality meter (YSI 556)
Total Dissolved Solids (TDS)	mgL^{-1}	Water quality meter (YSI 556)
NO_3^-	mgL^{-1}	Hanna Combo meter
NH_4-N	mgL^{-1}	Hanna Combo meter
Transperancy	M	Secchi-disc

Apart from in-situ measurements, water samples were collected to measure chlorophyll and water chemistry (NO_3^- , PO_4^{3-}).

2.3 Laboratory analysis

In laboratory, collected periphytons and phytoplanktons were identified and counted.

- Quantitative analysis (Number of individuals per L)

Numbers of individuals in each species were counted in 100 cells under the microscope. Conversion factor was determined by following equation.

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

Counts of individuals in 100 cells should multiply by 800 to get the individual number of cells per liter.

- Biomass Measurements (mg/L)

To estimate the biovolume of 1 cell of particular algal species,

- Multiplying biovolume of 1 cell with the cell count in 1mL
- Divide by 10^9 to make it under the unit of mgL^{-1}

The biomass was always given to 3 decimal places.

2.4 Data Analysis

Periphyton data was used to map distribution of red algae and to calculate Diatom index. Mixed index, Jaccard index, Diversity index and PMPL index were calculated using phytoplankton data. Each index is described in below.

Periphyton

- Diatom Index

Diatom index was used to determine the state of ecology of lake. To use Diatom index at least 10 species which sensitive to trophic level should presence in particular sample. In order to calculate Diatom index, trophy index (TJ), the index of referential species (pGR) and their standardization are needed. Van Dam's ecological indicator values were used to estimate oxygen saturation, trophy and alkalinity in Lake Durowskie (van Dam et al., 1994).

Trophy index (TJ)

$$TJ = \frac{(TJi \times wTJi \times Li)}{(wTJi \times Li)};$$

Where,

TJi - sensitivity of species for the trophic state;

wTJi - 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)

$$pGR = \frac{NB - (NC + ND)}{NB + NC + ND};$$

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 to 0,

Z - TJ = 1 – ((TJ -1) · 0.25)

Z – pGR = (pGR + 1) ·0.5

Finally Diatom index (D) was calculated by following equation,

DI = (Z-TJ + Z-pGR) / 2

Obtained value for the Diatom index indicates ecological state for lake as bellow.

Diatom index value	Class
> 0,83	Very good
0,55 - 0,82	Good
0,30 - 0,54	Moderate
0,15 - 0,29	Poor
< 0,15	Bad

Phytoplankton

- Mixed Index of Nygaard

This method was developed depend on number of species from all different taxonomical groups.

The value obtained for mixed index implies different classes of trophic level as mentioned in below.

Dystrophy	0.0 - 0.2
Oligotrophy	0.2 - 1.0
Mesotrophy	1.0 - 3.0
Eutrophy	3.0 – 5.0
Hypertrophy	5.0 – 43.0

- Jaccard Index (Jaccard, 1912)

This is the simplest index that can use to compare species in different sites. Absence and presence data of species is used.

$S_J = a/(a + b + c)$

Where,

S_J = Jaccard similarity index;

a = number of species common to (shared by) site;

b = number of species unique to the first site;

c = number of species unique to the second site.

- Diversity Index

- Shannon-Wiener diversity and evenness indices

Diversity and evenness of phytoplankton species in different sites can be measured by using this index.

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Where,

H' - Shannon index;

p_i – relative abundance of each species in the site

E – Evenness (equitability);

S – Total number of species in each site

- Phytoplankton Multimetric for Polish Lakes (PMPL Index)

This is an ecological state assessment that used to implement the European Water Framework Directive (EC, 2000) concerning Lakes in Poland. Chlorophyll a, Total biomass and Cyanobacteria biomass are 3 main parameters involving in this index. All 3 single metrics and PMPL index value ranging from 1 to5.

Where,

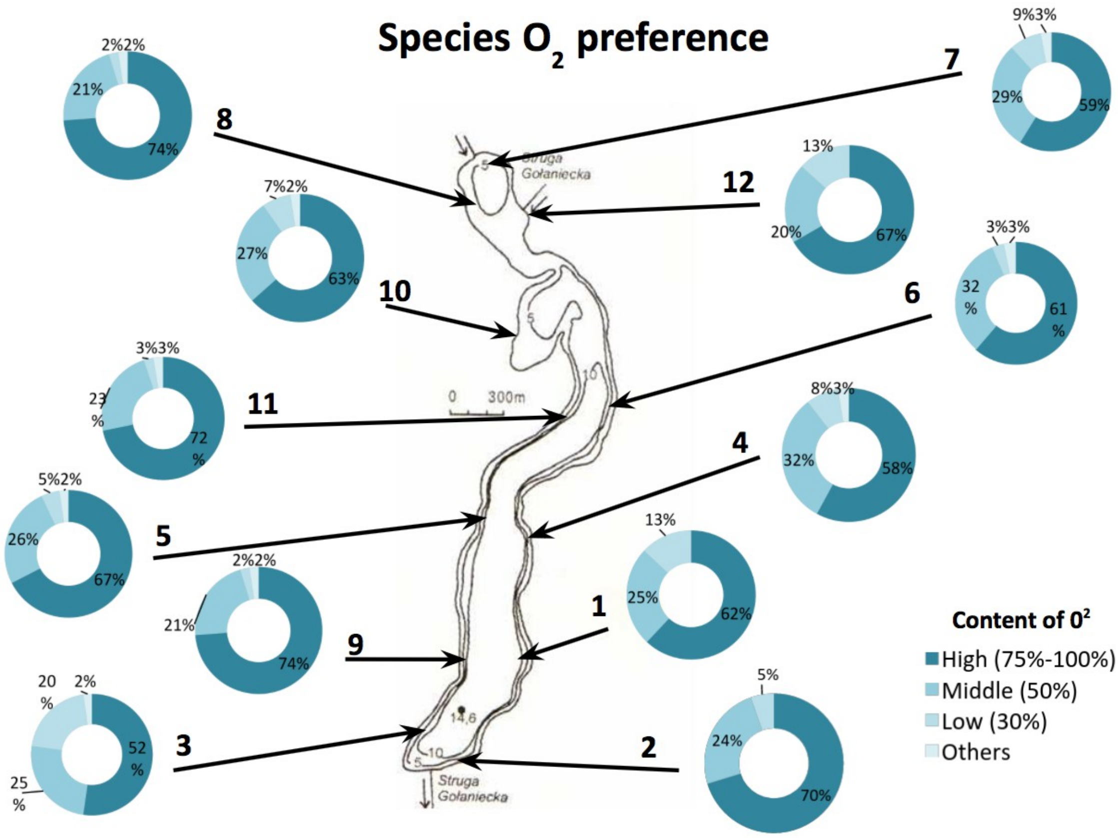
YCh - Chlorophyll-a concentrations

YBm - General biomass of phytoplankton

YCy - Biomass of cyanobacteria

Value obtained for PMPL is indicating different classes of tropic levels as below:

Ecological status	PMPL
very good	0,0 - 1,0
good	1,01 - 2,0
moderate	2,1 - 3,0
poor	3,1 - 4,0
bad	4,01 - 5,0



Results and discussion

Periphyton

Peripython is composed of different organisms (algae, cyanobacteria, microbes, etc) that are attached to the submerged surfaces of fresh water ecosystems. Since the community of periphyton can response to changes in the water quality, they can be considered as indicators of water pollution. Moreover, some periphyton species have specific ecological requirements or preferences for water environments, which can also indicate the water quality of the water where species are present. Ecological characteristics of dominant, rare and new species are described in Annex 6 and 7.

In Lake Durowskie, periphyton species found in sampling points showed overall preference for environments with high oxygen concentration (>75%), alkaline (pH>8) and eutrophic conditions (Figure 3). Ultimately, this preference shows the water quality.

While comparing this results to previous years, the same trend is maintained in every site, however there is a decrease in percentage which indicates an improvement in the water quality. Although most of the periphyton founded shows that goal conditions are not reach yet (oligotrophic and ciarcumneutral environments), there is evidence for small changes in direction to these goal conditions.

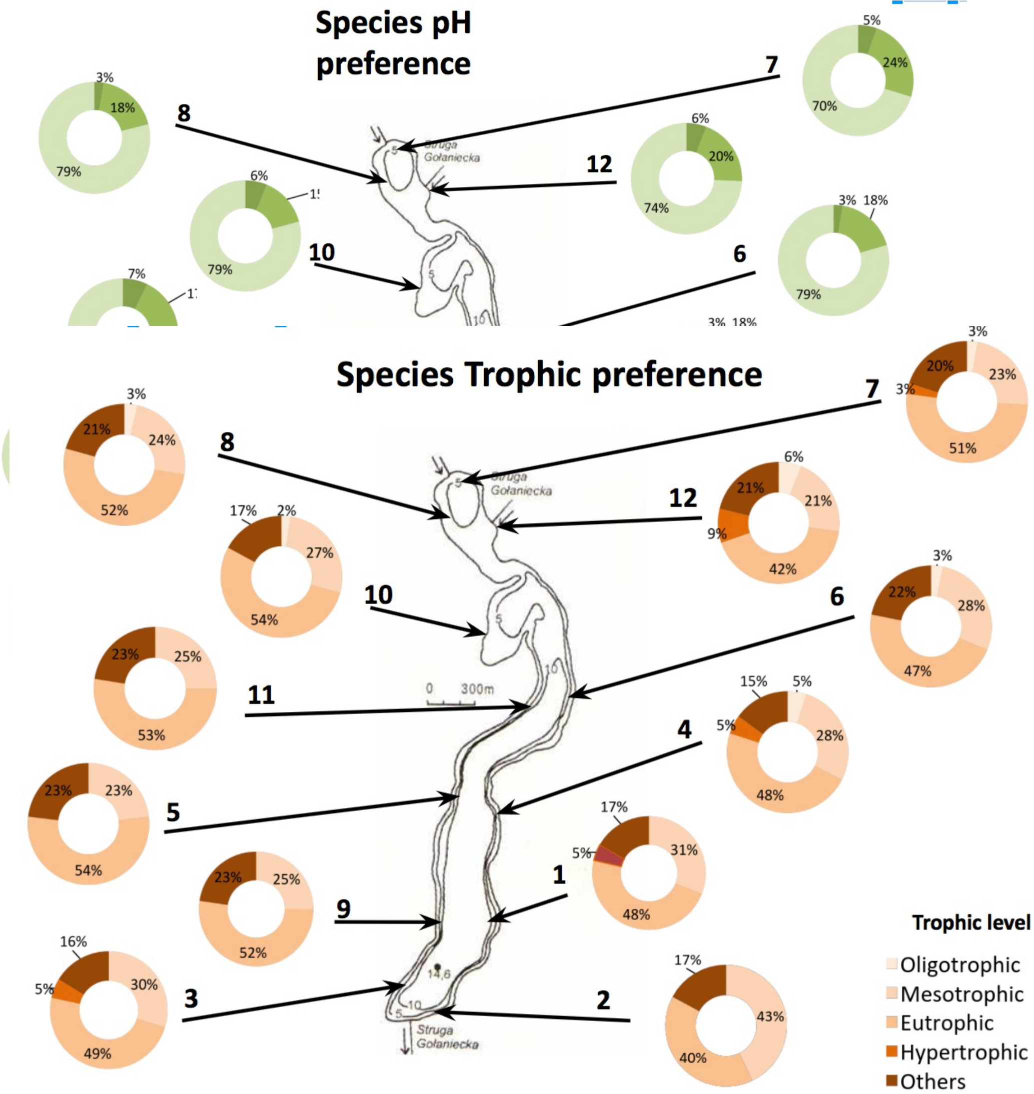
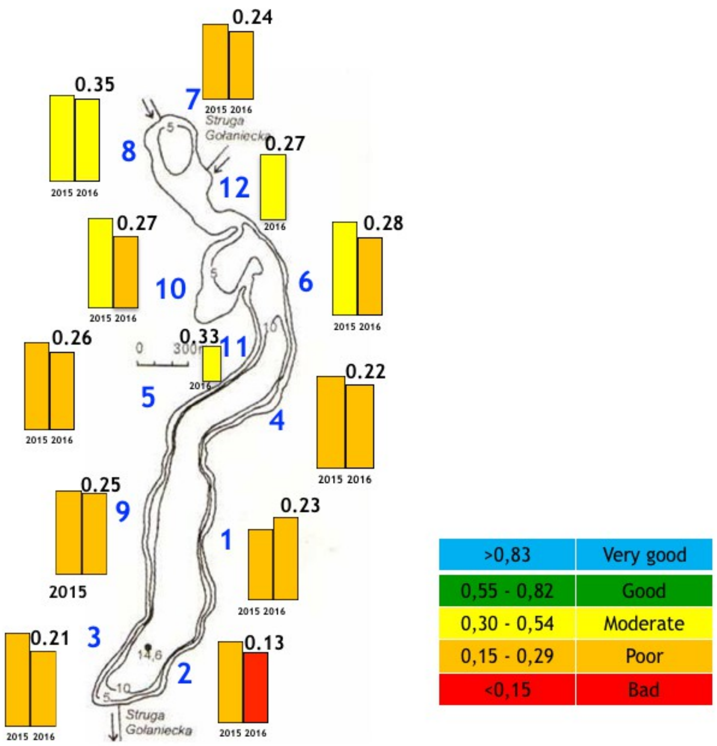


Figure 3: Periphyton species environmental preferences a) periphyton species preference to concentrations of O_2 in the water, b) periphyton species reference to trophic conditions, c) periphyton species preference to pH conditions.

Diatoms are predominant component of the periphyton, hence they have long been used as a tool for monitoring surface water quality (Kelly and Whitton, 1995). Since diatoms are sensitive to the nutrient availability in the water, the Trophic Diatom Index (TDI) can give information about the trophic state of the water where they are found. In Lake Durowskie, the TDI showed overall moderate-poor trophic state in sampling sites (Figure 4), similar to the trend of previous years (Summer School Report 2015). However, site 2 in the south showed a change towards a poorer trophic indicates, which might indicate a degradation in this area. Likewise, site 10 and 6 located in the west and east north part respectively, showed degradation into a poorer state. This degradation can be explained by the anthropogenic factors that are influencing these sites. In addition, diatoms are know to react slowly to changes in the water quality, thus present results perhaps represents previous water conditions. Future monitoring is needed in these sites were degradation is observed, together with sites 11 and 12 that were samples for the first time this year.

Figure 4: Trophic Diatom Index in Lake Durowskie.

Worldwide red alge is considered as an indicator of water quality, as they inhabit unpolluted clean fresh water (Kumano, 2002). In Lake Durowskie, red algae Hidelandia rivularis distribution has been



monitored trough the shoreline, with occurrence trough the middle and south part of Lake Durowskie. Data from the present year (2016) show the increase of H. rivularis distribution mainly trough the east bank (Figure 5) . H. rivularis increased distribution can be explain due to the present abiotic parameters in Lake Durowskie such as the winds coming from the west, high oxygen and Ca+ concentrations in the water or shades areas induced from vegetation. Increased presence of Hidelandia rivularis point out the improvement on water quality in more area compared with results of previous years. However conclusions about water quality must remain precocious as presence of *Hidelandia rivularis* is linked to water velocity. Nevertheless, results show an improvement in the water quality related to the presence of *Hidelandia rivularis.*

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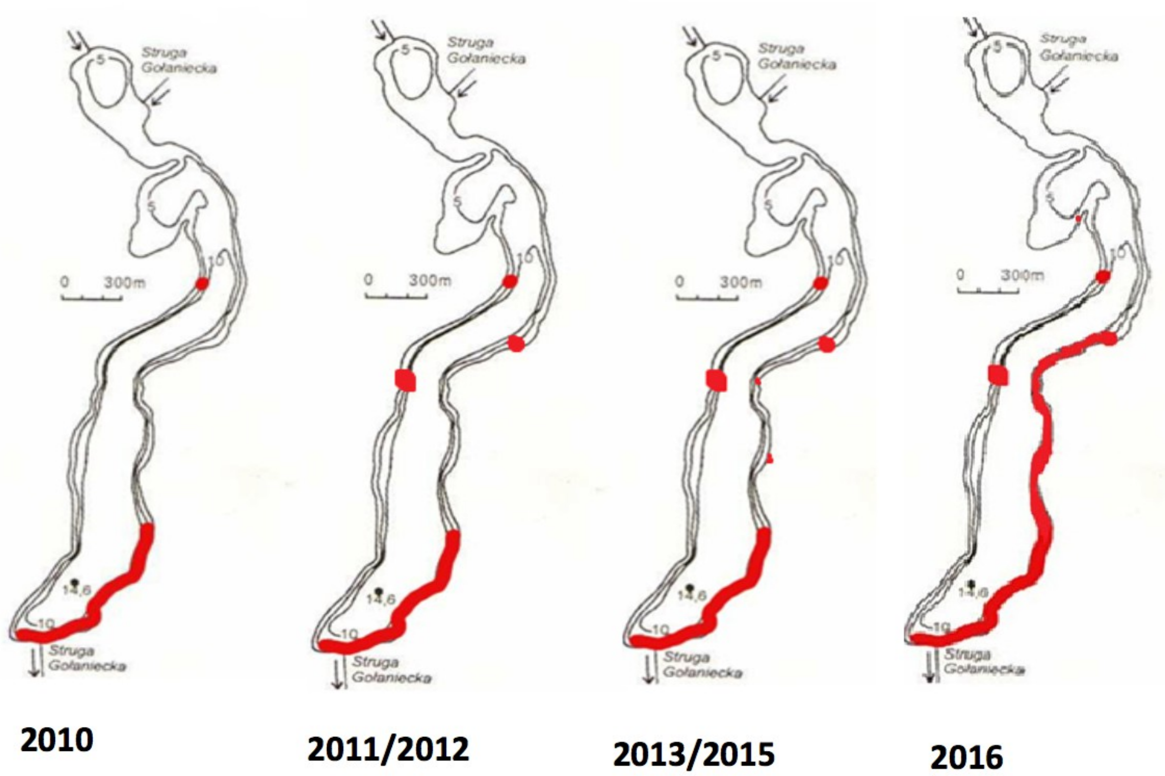
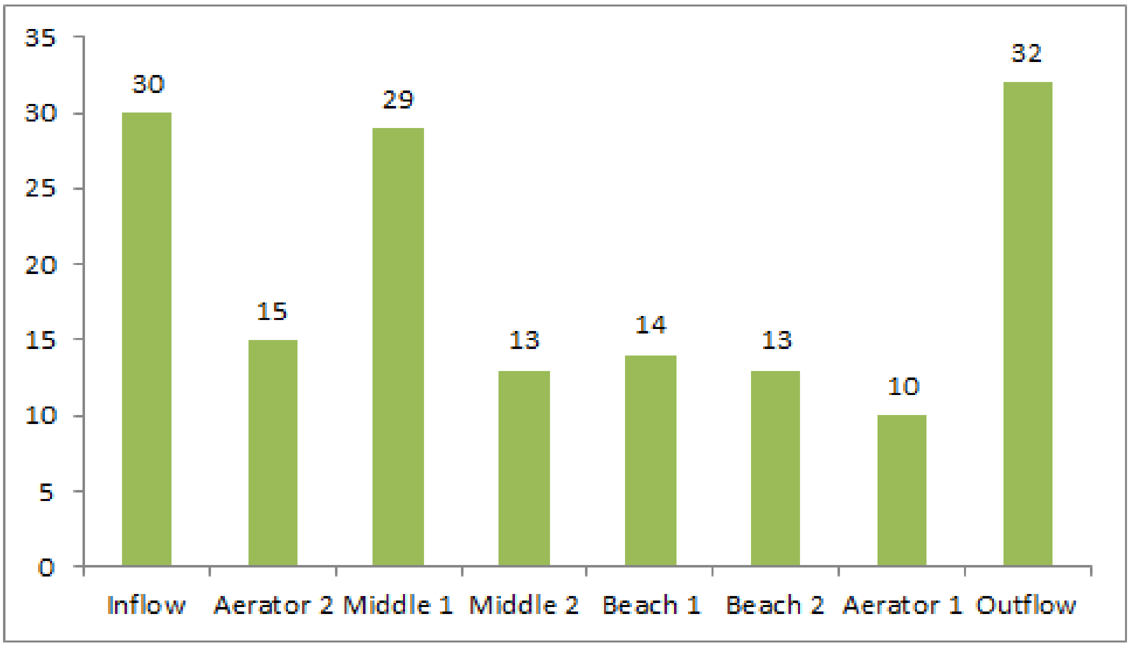


Figure 5: Time line distribution of red algae *Hidelandia rivularis* in Lake Durowskie

Phytoplankton

In Lake Durowskie, number of phytoplankton species ranged from 10 in the site Aerator 1 to 32 in site



Outflow, where the sites with highest species richness are the inflow and outflow (Figure 6). This sites receive a water input from rivers upstream and Lake Durowskie itself, thus the conditions change relatively faster than in other sites offering different environments and niches for different species to occupy them. Furthermore, similarity index calculated by Jaccard formula showed that for the present year (2016) 53% of the phytoplankton species are new records for Lake Durowskie compared to year 2008 (Table 3). This outstanding figure reflect the restoration progress of Lake Durowskie, as in 2008 most of the phhytoplankton species were Cyanobacteria and during the following years more species and more groups contribute to the richness.

The abundance of each phytoplankton species (number of individual for each species) was correlated with the richness to have an insight about the species diversity. This was calculated by the Shannon-Wiener Index. Overall sampling sites in Lake Durowskie, species diversity ranged from 1 to 3, where the Inflow and site Beach 1 showed the lowest diversity (Figure 7). This result can be expected as in this sites the sampling effort is reduced due to the depth of the places (sampling reach 1 meter in the vertical column). Furthermore, evenness on the abundance of species for each sampling site was evaluated, resulting in similar abundance for most of the sampling sites except for the site Inflow, which indicates the dominance of a species in this place (Figure 7).

Figure 6: Phytoplankton species richness at the surface of sampling sites in Lake Durowskie.

Table 3: Phytoplankton similarity index (Jaccard) over the monitoring years in Lake Durowskie.

YEAR	2009	2010	2011	2012	2013	2014	2015	2016
2008	84	51	43	33	40	52	82	35
2009	-	48	28	20	29	35	39	13
2010	-	-	42	42	62	47	37	35
2011	-	-	-	34	58	47	50	40
2012	-	-	-	-	77	49	59	47
2013	-	-	-	-	-	52	78	45
2014	-	-	-	-	-	-	57	40
2015								43

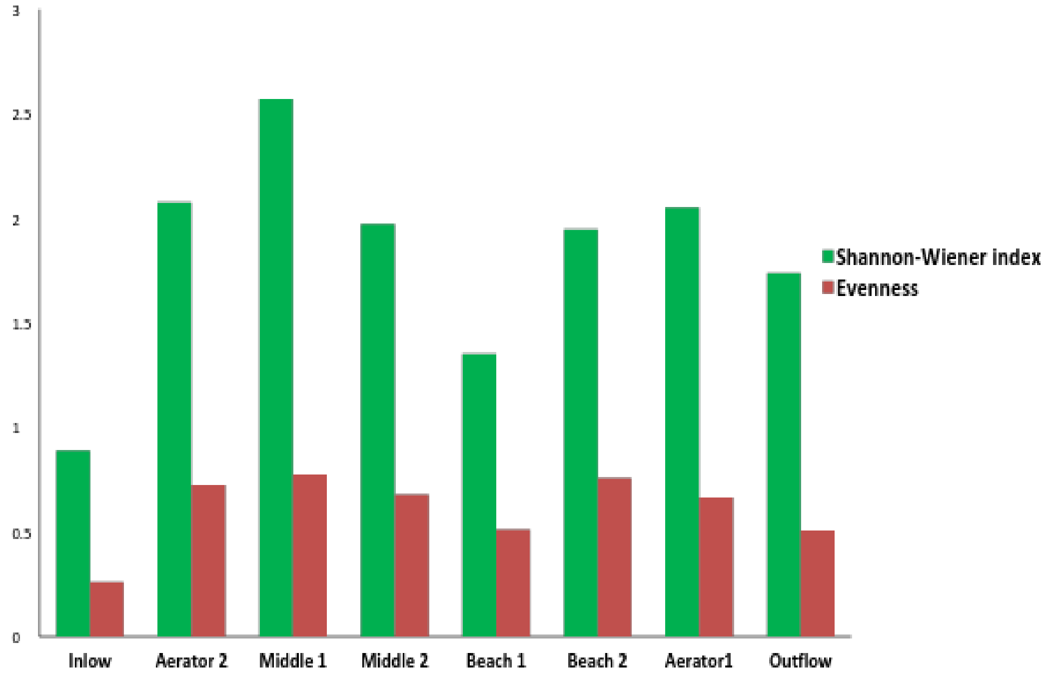
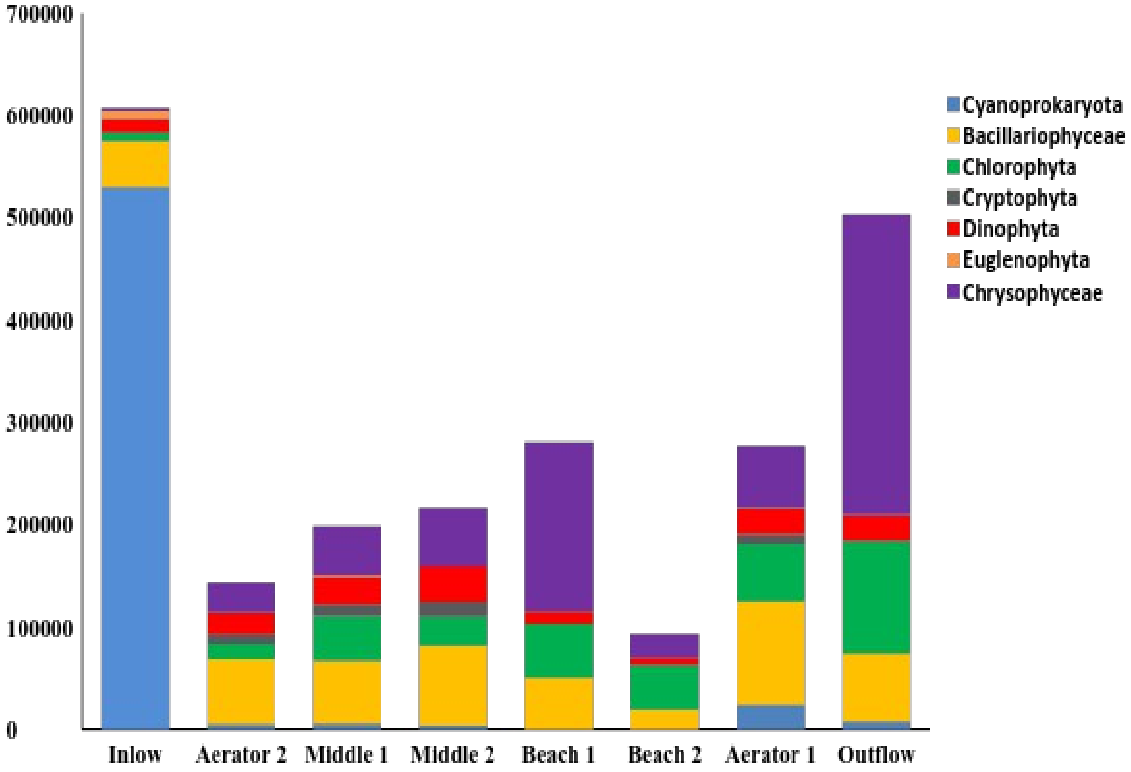


Figure 7: Phytoplankton species diversity and evenness (abundance) over sampling sites in Lake Durowskie.

In order to investigate the dominance in abundance of some phytoplankton species, group abundance (Cyanoprokaryota, Bacillariophyacea, Chlorophyta, Cryptophyta, Dinophyta, Euglenophyta and Chrysophyceae) was evaluated. In concordance with results from evenness, group abundance showed that in site Inflow the most abundant group is Cyanobacteria (Figure 8). This result represents an important warning signal, since increased abundance of Cyanobacteria can derive into bloom. Cyanobacteria blooms are extremely detrimental for all the ecosystem services that Lake Durowskie offers, as cyanobacteria expel several toxins that are harmful for humans, change the transparency of the



water and increase doors. Most likely presence of Cyanobacteria at site Inflow is due to the transport of organisms from the upper lakes, because this site receive oxygen from the aerator that its near (Fidure 2) there is no suggestion to assume that Cyanobacteria is growing at this site. It is highly recommendable to keep monitoring in this site for Cyanobacteria along seasons and specially increase management actions in the upper lakes to avoid cyanobacteria blooms.

Regarding the rest of the sampling sites, abundance of groups was distributed with dominant abundance of Chlorophyta and Chrysophyceae (Figure 8).

Figure 8: Phytoplankton groups abundance over sampling sites in Lake Durowskie.

Trophic state can be indicated by phytoplancton, as the composition of different groups can inform about the environmental requirements that these need to survive. Trophic state has been monitored trough the Mixed Index of Nyagaard, since the restoration of Lake Durowskie started. Niagara Index showed for previous years the similar group composition, resulting in an indication for hypertrophy. In 2015, this state upgraded into the category eutrophic (Summer School Report 2015). For this year, group composition indicates once more a Hypertrophic state for 5 sites (Table 4). Although this particularly results show a decrease in quality for the trophic state in the sampling sites, this results should not discourage the restoration actions as the respond of the phytoplankton can be delayed due their ecology.

Table 4: Trophic state of Lake Durowskie calculated by Mixed Index of Nyagaard over monitored years.

Station	2008	2009	2010	2011	2012	2013	2014	2015	2016
Inflow	-	-	1.8	17	9	19	3.8	17	7
Aerator 2	-	26	11.5	5	8	14	20	4.3	12
Middle 1	-	9	12.5	13	3	5.5	11	4.8	7.7
Middle 2	-	-	8.3	18	9	7.5	20	4	8.5
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	14

Dystrophy	0.0 - 0.2
Oligotrophy	0.2 - 1.0
Mesotrophy	1.0 - 3.0
Eutrophy	3.0 - 5.0
Hypertrophy	5.0 - 43.0

Phytoplankton composition can variate not only trough the surface of the lake, but also can variate trough the vertical column (depth) in each site. Phytoplankton species and groups can be limited by oxygen concentration, thus to indicate trophic state in the vertical column it requires take into account variables in depth rather that species composition. For such analysis in Lake Durowskie, PMPL Index was calculated, which takes into account the chlorophyll *a* concentrations, phytoplankton and cyanobacteria biomass in the water column; and was designed for trophic state indication in Lakes of Poland. Results from PMPL index indicate a moderate trophic state for all sites, except for site Inflow where Cyanobacteria was most abundant (Figure 9).

Ecological status	PMPL
very good	0,0 - 1,0
good	1,01 - 2,0
moderate	2,1 - 3,0
poor	3,1 - 4,0
bad	4,01 - 5,0

Figure 9: Trophic state of Lake Durowskie in the vertical profile indicated by PMPL index.

PMPL index is also used in environmental studies conducted in Poland in the framework of the national monitoring. Phytoplankton index PMPL is based on an assessment of 3 biological indicators: general biomass of phytoplankton, biomass of cyanobacteria and chlorophyll-a concentrations.

The value for the calculation of metrics of these biological parameters are means of the summer period in the vertical profile from the surface to a depth of 5 meters in the water column.

For stratified lakes pattern looks like this:

PMPL = [YCh + YBm + YCy] / 3,

where:

YCh - Chlorophyll-a concentrations

YBm - General biomass of phytoplankton

YCy - Biomass of cyanobacteria.

Vertical distribution of Phytoplankton

Different phytoplankton groups spread over different depth levels according to their ecological preferences. Vertical distribution of different phytoplankton groups in first 3m of Lake Duroweskie is illustrated in Figure 10.

Figure 10 : Vertical distribution of phytoplankton groups in the site Middle 1

Different groups have different preference in the water column from surface to 3m level. Group Chrysophycae has a highest abundance at the surface of the lake and second little peak shows at the 2m. They are being as individual cells without making colonies and it's less sensitiveness to sunlight ensured the higher abundance of Chrysophycae on water surface.

Both Bacillariophyceae and Dinophyta are following same trend (surface highest, but 2^{nd} peak also very significant). Bacillariophyceae or diatoms are heavy and also zooplanktons do not like to have as their food. Therefore they are aggregate below the surface around 2m level. Dinoflagelates or Dinophyta group is also abundant at 2m level due to their ability of making mass colony structures binding with each other.

Chlorophyta show its maximum at 1m depth. This is favorite food of zooplankton due to its small edible size. Therefore in the levels of high zooplankton abundant, Chlorophyta is lower since they are subjecting to zooplankton grazing.

Crytophyta and Cyanoprokaryota groups are representing in lower amount in the vertical profile when compare with the other phytoplankton groups. Crytophyta is a mesotrophic algae. They are mostly abundant at 2m level in Lake Durowskie where the conditions are optimum to them. In the case of Cyanoprokaryota, they have air voids in their body and therefore have ability to migrate over the vertical profile in order to find their optimum conditions to grow. In Lake Duroweskie, it shows two abundant layers at 2m level and surface but still amount of cells are very low. But their presence in water column, give alert about a risk of developing Cyanoprokaryota as a mass bloom when the conditions are favorable for them, especially when there is high temperature and high nutrient conditions.

Dominant phytoplankton species in each group throughout vertical profile

In each group of phytoplankton, 1 or 2 species were found as dominant species in their vertical profile of distribution. Below mentioned figure 11, 12 , 13 and 14 illustrate dominant species in each plankton group. Dominancy of particular phytoplankton species in specific locality implies availability of optimum conditions for their growth and reproduction.

Figure 11: Dominant species of Chrysophyceae in Middle 1 site

Figure 12: Dominant species of Bacillariophyceae and Dinophyta groups in Middle 1 site

Figure 13: Dominant species of Chlorophyta group

Figure 14: Dominant species of Cyanoprokaryota and Cryptophyta

Effectiveness of bio manipulation

Bio manipulation is one of the main lake restoration methods taken by the local government in order to restore the Lake Duroweskie. Effectiveness of this method can be evaluated by the algal vertical distribution. In 2008, ecology of Lake Duroweskie was governed by Cyanobacteria. Bottom-up control was observed with massive algal blooms (Figure 15).

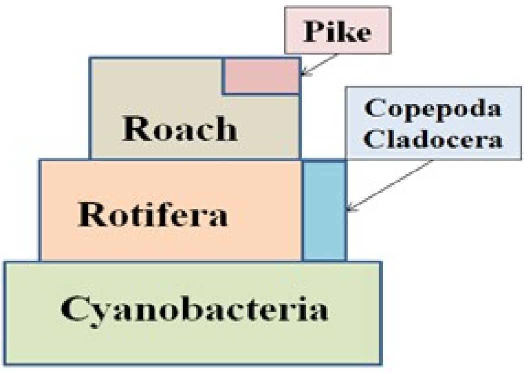


Figure 15: Top down control by Bio manipulation of Lake Duroweskie in 2008.

Adding Pikes as Picivourus fish to control Roach population was the measure taken under the bio manipulation concept. Reduction of Roach population as planktivourous fish will help to increment of zooplanktons and ultimately increased zooplanktons control the cyanobacteria level in Lake was expected.

By analyzing vertical distribution for the zooplankton, we can confirm whether our expected grazing activity taken place as illustrated in Figure 16.

Total zooplankton density is increased with the depth and at 2m level it became in to its maximum. Same distribution was followed by the copepods. Zooplankton abundance at upper water layer is limited by the planktivouros fish which are the predators of the zooplankton. Other than that sudden decrease in zooplanktons after 2m level was occurred due to lack of oxygen in deeper water layer. Therefore finally zooplanktons were concentrated at 2m level. Other important thing is Copepods which are larger zooplankton group is a lower fraction of the total zooplankton. Rotifers are the major contributor to total zooplankton density.

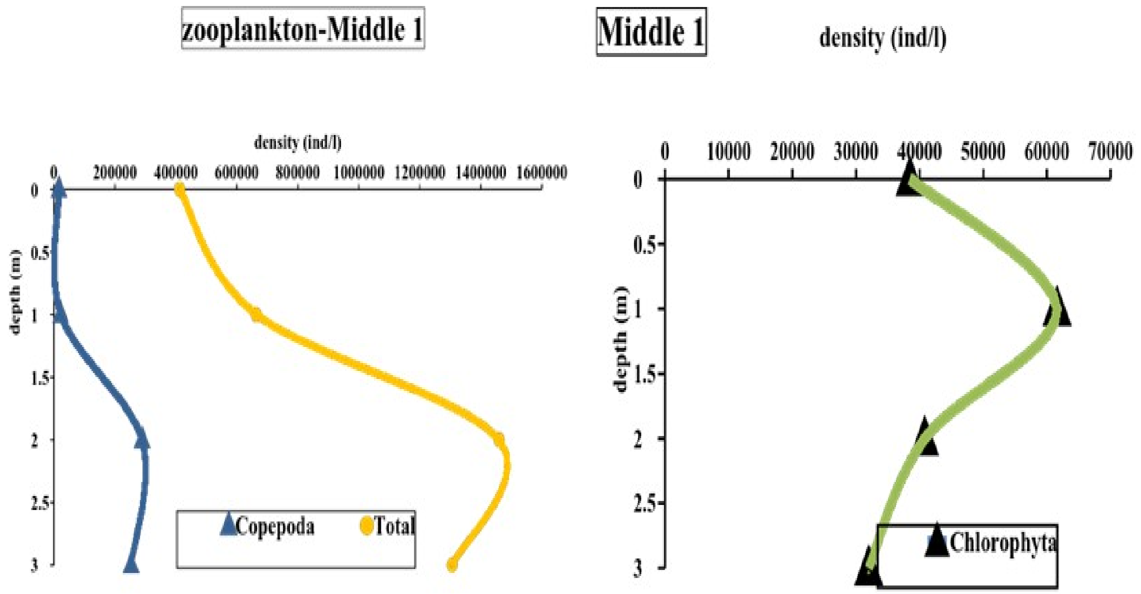


Figure 16: Vertical distribution of Zooplankton and Chlorophyta in Middle 1 site.

Effective grazing of zooplankton on phytoplankton can be confirmed by analyzing chlorophyte vertical distribution parallel to zooplankton distribution. As shown in figure 17.
Chlorophyta is lower in density at 2m level where zooplanktons are highly abundant since it subject to zooplankton grazing. Therefore expected control of phytoplankton density through zooplankton is happening up to certain extent.

In overall, effectiveness of bio manipulation in Lake Duroweskie can be discussed with the aid of figure 8 while comparing conditions of 2008 and 2016.

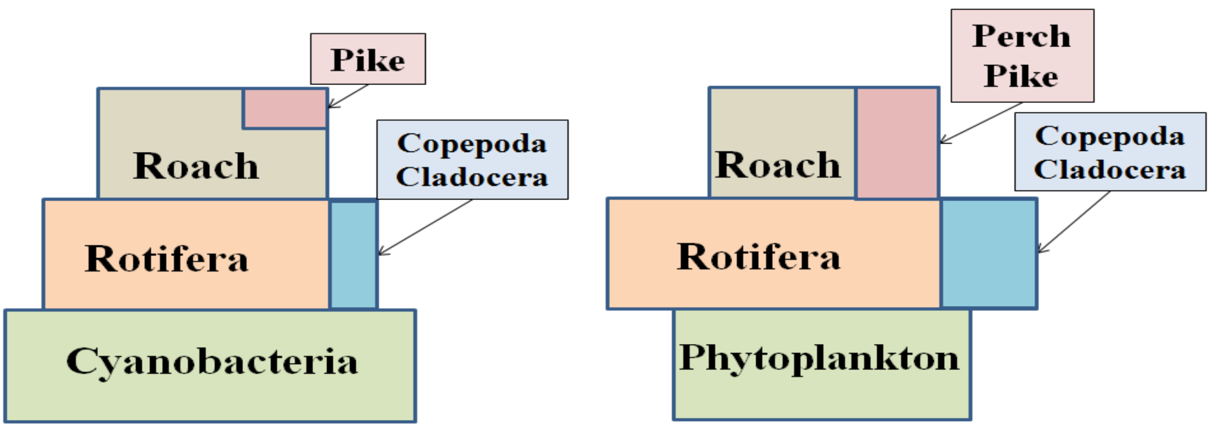


Figure 17: Top down control change over restauration time.

There are improvements of lake conditions due to bio manipulation. No more cyanobacterial blooms can be observed and it replaced by harmless phytoplankton groups. Copepods and cladocerans (zooplankton) are increasing which large in size and important as grazers. But still the higher fraction of zooplankton is rotifers which depend on organic matter and not involving with phytoplankton control. Therefore species composition of zooplankton should still develop towards copepods and cladocerans in order to have stable top down control in the Lake Duroweskie.

Conclusions

- Red algae *Hidelandia rivularis* increased the distribution in Lake Durowskie, specially in the east bank.
- Environmental preferences of Periphyton present the same trend as previous years, however there is evidence for an improvement towards preference for good water quality.
- Diatoms index for this year indicate that eutrophic conditions are maintained for most of the sampling sites, with hypertrophy in the south part.
- Phytoplankton diversity is relatively similar in all sampling sites compared with previous years.
- Inflow of the river Struga Golaniecka to Lake Durowskie present high abundance of Cyanobacteria.
- Phytoplankton index PMPL indicate mostly a moderate trophic state for Lake Durowskie. Group analysis of phytoplankton indicate an eutrophic state for Lake Durowskie.
- Phytoplankton analysis in the water column evidence that grazing on phytoplankton is happening by zooplankton.
- The larger fraction of the total zooplankton is Rotifers, which do not involve in the Phytoplankton control. Thus to have a continues control on Phytoplankton, conditions for increasing larger zooplankton should be provided.
- Overall, algae analysis in this study show that the eutrophic conditions in Lake Durowskie are still similar to years before, however trophic level are changing towards a moderate trophic level. Nevertheless, there is a risk that jeopardise the stability of the Lake Durowskie.

Recommendations

- Continue the monitoring of algae in Lake Durowskie, specially in the inflow and outflow where there are signals of eutrophic conditions.
- Monitor during the seasons the cyanobacteria abundance in the Inflow of Lake Durowskie.
- Add larger predator fishes (pikes). This will reduce the zooplankton predator which ultimately will induce the phytoplankton reduction and the risk of algae bloom with be reduced.

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Annexes

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

Phytoplankton taxa	2009	2010	2012	2013	2015	2016
***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 gracils (Bocher) Anagn. et kom.	+				+	
Phormidium granulatum Gardn. Anagn.	+	+	+			
Phormidium tenue (Agards ex Gomont) Anagn. et kom.	+					

Phytoplankton taxa	2009	2010	2012	2013	2015	2016
Phormidium autumnale Gomont						+
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	+	+	+	+	+	+
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+	+	+
Pseudanabaena limnetica (Lemm.) Kom.	+	+			+	
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					+	

Phytoplankton taxa	**2009**	**2010**	**2012**	**2013**	**2015**	**2016**
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.				+	+	+
Navicula cincta (Ehr.) Ralfs	+	+		+	+	
Navicula mensiculus Schumann						
Navicula radiosa Kützing		+	+	+		+
Navicula lanceolata Ehr.						+
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 maior (Kütz.) Rabenhorst						+
Pinnularia viridis (Nitzsch) Ehr.					+	
Placoneis gastrum(Ehr.) Meresch.	+					
Rhopalodia gibba (Ehr.) Muller				+	+	
Staurosira construens Ehr.	+					+
Chlorophyta- green algae						
Actinastrum hantzschii Lagerh.						+
Ankistrodesmus falcatus (Corda) Ralfs	+					
Botryococcus braunii Kütz.				+	+	+

Phytoplankton taxa	2009	2010	2012	2013	2015	2016
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	+					+
Coenocystis planctonica Korshikov						+
Cosmarium abbreviatum Raciborski		+	+	+		
Cosmarium exiguum W. Archer	+					
Cosmarium formulosum Lund					+	
Cosmarium trilobulatum 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		+		+	+	
Dicellula geminata (Printz) Kors.						+
Dictyosphaerium pulchellum Wood	+	+				
Didymocystis planctonica Korsikov				+		
Elkatothrix gelatinosa Wille		+		+	+	+

Phytoplankton taxa	**2009**	**2010**	**2012**	**2013**	**2015**	**2016**
Franceia ovais (France) Lemm.		+				
Golenkinia radiata Chodat		+	+	+	+	+
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin				+	+	
Kirchneriella incurvata Belcher et Swale						+
Kirchneriella obesa (West) West & West						+
Koliella longiseta (Vischer) Hindak						
Lagerheimia ciliata (Lag.) Chodat						
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.						
Nephrocystium agardhianum						+
Nephrocytium limneticum (G. M. Sm.) G. M. Sm.						
Oocystis lacustris Chodat	+	+	+		+	+
Oedogonium sp.					+	
Palmelochette tenerrima Kors.						
Pandorina morum (O.F. Müller) Bory		+		+		
Pediastrum biradiatum						+
Pediastrum boryanum (Turpin) Meneg.		+	+	+	+	+
Pediastrum simplex Meyen				+		+
Pediastrum duplex Meyen				+	+	+

Phytoplankton taxa	**2009**	**2010**	**2012**	**2013**	**2015**	**2016**
Pediastrum duplex var.gracillium West						+
Pediastrum tetras (Ehr.) Ralfs		+				
Phacotus lendneri Chodat.			+			
*Phacotus lenticularis (*Ehr.) Stein			+	+	+	+
Plankosphaceeria gelatinosa						+
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	+					
Scenedesmus verucosus Roll						
Sphaerocystis planctonica (Korsikov) Bourrelly			+	+	+	+
Staurastrum gracile Ralfs		+	+	+	+	+
Staurastrum paradoxum Meyen						
*Staurastrum tetracerum*Ralfs ex 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.			+			

Phytoplankton taxa	**2009**	**2010**	**2012**	**2013**	**2015**	**2016**
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		+	+	+	+	+
Peridinopsis kevei Grig. & Vasas						+
Euglenophyta - euglenoids						
Colacium vesiculosum Ehr.	+			+	+	
Euglena caudata Hübner			+			+
Euglena pisciformis Klebs	+				+	+
Phacus caudatus Hubner					+	
Phacus pusillus Lemm.					+	+
Phacus orbicularis Hubner	+					
Trachelomonas hispida (Perty) Stein		+	+	+	+	+
Trachelomonas intermedia Dangeard						+
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 27 th June to 1st July 2016 (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=4	n=4	n=4	n=5	n=1	n=1	n=1	n=16
Depth	**0m**	**0-3m**	**0-3m**	**0-3m**	**0-4m**	**0m**	**0m**	**0m**	**%**
Site	**Inf**	**A2**	**M2**	**M1**	**A1**	**Outf**	**B1**	**B2**	**F**
Cyanoprokaryota - cyanobacteria									
Aphanocapsa incerta (Lemm.) Cronberg et Komarek				+					19
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+		+			67
Chroococcus turgidus (Kűtz.) Naeg.	+								19
Limnothrix redekei (Van Goor) Meffert	+		+	+		+			67
Lyngbya hieronymusii Lemm.	+								19
Microcystis aeruginosa Kützing	+	+		+		+			62
Phormidium autumnale Gomont	+	+		+					43
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	+			+					29
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+					76
Pseudanabaena limnetica (Lemm.) Kom.	+								19
Woronichina naegeliana (Unger) Elenkin	+	+							38

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Jaaginema gracilis (Bocher) Anagn. et Kom.	+								19
Bacillariophyceae - diatoms									
Amphora ovalis Kützing	+								19
Amphora copulata (Kutz.) Schoeman & Archibald	+								19
Asterionella formosa Hasall	+			+		+			38
Caloneis amphisbaena (Bory) Cleve	+								19
Cocconeis placentula Ehr.	+					+			24
Cyclotella ocellata Pant.	+	+	+	+		+		+	86
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+		+	+	+	90
Cymbella minuta Hilse ex Rabenhorst	+	+		+					48
Fragilaria crotonensis Kitton	+	+	+	+		+	+	+	85
Fragilaria pinnata Ehr.	+								19
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+		+	+	+	85
Fragilaria ulna var. angustissima Sippen	+								19
Gomphonema parvulum	+					+			24
Hippodonta capitata (Ehr.) L-Bert., Metz. & Witkowski	+								19
Navicula radiosa Kutz	+		+	+					33
Navicula cincta (Ehr.) Ralfs	+								19
Navicula lanceolata Ehr.	+								19
Naviula tripunctata (Muller) Bory	+								19
Nitzschia palea (Kütz.) W. Smith	+								19
Nitzschia sigmoidea (Ehr.) W. Smith	+								19
Pinnularia maior (Kütz.) Rabenhorst	+								19
Pinnularia viridis (Nitzsch) Ehr.	+								19
Rhopalodia gibba (Ehr.) Muller	+								19
Staurosira construens Ehr.	+								24
Chlorophyta - green algae									
Actinastrum hantzschii Lagerh.	+			+					24

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Botryococcus braunii Kutzing	+	+							38
Characium aqngustatum A. Braun	+			+					24
Chlamydomonas passiva Skuja	+								19
Chlamydomonas reinhardtii Dangeard	+								19
Closterium acutum var. variabile (Lemm.) Krieg.	+			+					38
Coelastrum astroideum De Notaris	+	+		+		+			62
Coelastrum reticulatum (Dangaerd) Senn	+								24
Coenocystis planctonica Kors.	+	+		+				+	52
Cosmarium phaseolus Brebisson in Ralfs	+			+					24
Cosmarium regnellii Wille	+		+	+					43
Cosmarium formosulm Lund	+								19
cosmarium trilobulatum Reinsch	+								19
Crosmarium margaritatum (Lundell) Roy & Bisset	+	+							38
Desmodesmus communis (Hegew.) Hegew.	+	+		+		+			57
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	+								19
Dicellula geminata (Printz) Kors.	+		+						24
Elkatothrix gelatinosa Wille	+	+		+		+	+		62
Golenkinia radiata Chodat	+	+	+	+					71
Kirchneriella contorta var. elegans (Schmidle) Bohlin	+								19
Kirchneriella incurvata Belcher et Swale	+		+						24
Kirchneriella obesa (West) West & West	+								19
Micractinium pusillum Fresenius	+			+					24
Monoraphidium contortum (Thur.) Kom.-Legn.	+	+		+					48
Monoraphidium griffithii (Berk.) Kom.-Legn.	+								19
Monoraphidium komarkovae Nygaard	+								19
Nephrocytium agardhianum Nagel.	+	+							38
Oocystis lacustris Chodat	+	+		+					62
Oedogonium sp.	+								19

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Pediastrum boryanum (Turpin) Meneg.	+	+	+	+					81
Pediastrum duplex Meyen	+		+	+		+	+		57
Pediastrum duplex var. gracillium West	+					+			24
Pediastrum biradiatum Meyen	+		+						29
Pediastrum simplex Meyen	+		+						24
Phacotus lenticularis (Ehr.) Stein	+	+	+	+		+	+		90
Planktosphaeria gelatinosa Smith	+	+	+			+		+	71
Pteromonas angulosa (Carter) Lemm.	+								19
Pteromonas cordiformis Lemm.	+			+					24
Scenedesmus acuminatus (Lager.) Chodat	+								24
Scenedesmus bicaudatus Dedusenko	+		+						24
Scenedesmus ecornis (Ehr.) Chodat	+	+							38
Sphaerocystis planctonica (Korsikov) Bourrelly	+	+	+	+		+	+	+	85
Tetraedron caudatum (Corda) Hansgirg	+								19
Tetraedron minimum (A. Br.) Hansgirg	+		+	+		+			57
Tetrastrum staurogeanieforme (Schroed.) Lemm.	+	+					+		48
Tetraedron triangulare Kors.	+		+						24
Staurastrum gracile Ralfs	+	+				+			43
Staurastrum tetracerum Ralfs & Ralfs	+		+						33
Dinophyta - dinoflagellates									
Peridinopsis berolinense (Lemm.) Bourrelly	+			+			+		43
Ceratium hirundinella (F. B. Müller) Bergh	+	+	+	+		+		+	85
Ceratium cornutum (Ehr.) Clap. & Lachman	+								19
Gymnodinium aeruginosum Stein	+								19
Peridiniopsis cuningtonii Lemm.	+	+	+	+		+	+	+	85
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+		+			85
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	+	+	+	+		+	+	+	85
Peridinopsis kevei Grig. & Vasas	+	+							38

Site	Inf	A2	M2	M1	A1	Outf	B1	B2	F
Euglenophyta - euglenoids									
Trachelomonas hispida (Perty) Stein	+			+					38
Trachelomonas intermedia Dangeard	+	+							38
Trachelomonas volvocina Ehr.	+					+			24
Euglena caudata (Swirenko) Popova	+	+							38
Euglena pisciformis Klebs	+								24
Phacus caudatus Hubner	+								19
Phacus pusillus Lemm.	+	+							38
Colacium vesiculosum Ehr.	+								19
Chrysophyceae - chrysophyces									
Erkenia subaequiciliata Skuja	+	+	+	+		+	+		95
Dinobryon bavaricum Imhoff	+		+	+					33
Dinobryon sociale Ehr.	+			+					24
Dinobryon divergens Imhof	+	+	+	+		+	+	+	100

ANNEX 3. Average number of phytoplankton species cells (ind./L) from different depth in Lake Durowskie from 27th June to 01st July 2015 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2).

Depth	0-3m	0-3m	0-4m	0m	0m
Site	**A2**	**Mid.2**	**A1**	**B1**	**B2**
Cyanoprokaryota - cyanobacteria					
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	-	-	800	-	-
Aphanizomenon flos-aquae (L.) Ralfs	2400	1600	10400	-	-

Chroococcus turgidus (Kűtz.) Naeg.	-	-	-	-	-
Limnothrix redekei (Van Goor) Meffert	-	7733	20600	-	-
Lyngbya hieronymusii Lemm.	-	-	-	-	-
Site	**A2**	**Mid.2**	**A1**	**B1**	**B2**
Microcystis aeruginosa Kützing	4000	-	4400	-	-
Phormidium autumnale Gomont	-	-	-	-	-
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	-	-	800	-	-
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	1600	1600	24533	-	-
Pseudanabaena limnetica (Lemm.) Kom.	-	-	-	-	-
Woronichina naegeliana (Unger) Elenkin	800	-	-	-	-
Jaaginema gracilis (Bocher) Anagn. et Kom.	-	-	-	-	-
Total	**8800**	**10933**	**61533**	**0**	**0**
***Bacillariophy cee* - diatoms**					
Amphora ovalis Kützing	-	-	-	-	-
Amphora copulata (Kutz.) Schoeman & Archibald	-	-	-	-	-
Asterionella formosa Hasall	-	-	-	-	-
Caloneis amphisbaena (Bory) Cleve	-	-	-	-	-
Cocconeis placentula Ehr.	-	-	-	-	-
Cyclotella ocellata Pant.	1200	9200	22400	-	6400
Cyclotella radiosa (Grun.) Lemm.	7200	2667	9200	1600	800
Cymbella minuta Hilse ex Rabenhorst	-	-	800	-	-
Fragilaria crotonensis Kitton	83200	223200	279680	48000	5400
Fragilaria pinnata Ehr.	-	-	-	-	-
Fragilaria ulna (Nitzsch) Lange-Bertalot	36000	15800	56800	800	6400
Fragilaria ulna var. angustissima Sippen	-	-	-	-	-
Gomphonema parvulum Ehr.	-	-	-	-	-
Hippodonta capitata (Ehr.) L-Bert., Metz. & Witkowski	-	-	-	-	-
Navicula radiosa (Grun.) Lemm.	-	800	-	-	-

Navicula cincta (Ehr.) Ralfs	-	-	-	-	-
Navicula lanceolata Ehr.	-	-	-	-	-
Naviula tripunctata (Muller) Bory	-	-	-	-	-
Nitzschia palea (Kütz.) W. Smith	-	-	-	-	-
Site	**A2**	**Mid.2**	**A1**	**B1**	**B2**
Nitzschia sigmoidea (Ehr.) W. Smith	-	-	-	-	-
Pinularia maior (Kutz.) Rabenhorst	-	-	-	-	-
Pinnularia viridis (Nitzsch) Ehr.	-	-	-	-	-
Rhopalodia gibba (Ehr.) Muller	-	-	-	-	-
Staurosira construens Ehr.	-	-	2400	-	-
Total	**127600**	**251667**	**371280**	**50400**	**19000**
Chlorophyta - green algae					
Actinastrum hantzschii Lagerh.	-	-	-	-	-
Botryococcus braunii Kutzing	1600	-	-	-	-
Characium aqngustatum A. Braun	-	-	-	-	-
Chlamydomonas passiva Skuja	-	-	-	-	-
Chlamydomonas reinhardtii Dangeard	-	-	-	-	-
Closterium acutum var. variabile (Lemm.) Krieg.	-	-	2400	-	-
Coelastrum astroideum De Notaris	2400	-	-	-	-
Coelastrum reticulatum (Dangeard) Senn	-	-	800	-	-
Coenocystis planctonica Kors.	3200	-	-	-	1600
Cosmarium phaseolus Brebisson in Ralfs	-	-	-	-	-
Cosmarium regnellii Wille	-	800	-	-	-
Cosmarium formosulm Lund	-	-	-	-	-
Cosmarium trilobulatum Reinsch	-	-	-	-	-
Cosmarium margaritatum (Lundell) Roy & Bisset	800	-	-	-	-
Desmodesmus communis (Hegew.) Hegew.	800	-	1200	-	-
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	-	-	-	-	-

Dicellula geminata (Printz) Kors.	-	1600	-	-	-
Elkatothrix gelatinosa Wille	-	-	2800	2400	-
Golenkinia radiata Chodat	2000	800	1867	-	-
Kirchneriella contorta var. elegans (Schmidle) Bohlin	-	-	-	-	-
Kirchneriella incurvata Belcher et Swale	-	800	-	-	-
Site	**A2**	**Mid.2**	**A1**	**B1**	**B2**
Kirchneriella obesa (West) West & West	-	-	-	-	-
Micractinium pusillum Fresenius	-	-	-	-	-
Monoraphidium contortum (Thur.) Kom.-Legn.	800	-	-	-	-
Monoraphidium griffithii (Berk.) Kom.-Legn.	-	-	-	-	-
Monoraphidium komarkovae Nygaard	-	-	-	-	-
Nephrocytium agardhianum Nagel.	2400	-	-	-	-
Oocystis lacustris Chodat	-	-	4267	-	-
Oedogonium sp.	-	-	-	-	-
Pediastrum boryanum (Turpin) Meneg.	1600	2667	2000	-	-
Pediastrum duplex Meyen	-	2400	1600	800	-
Pediastrum duplex var. gracillium West	-	-	-	-	-
Pediastrum biradiatum Meyen	-	1600	1600	-	-
Pediastrum simpelex Meyen	-	800	-	-	-
Phacotus lenticularis (Ehr.) Stein	1600	800	25000	1600	3200
Plankosphaeria gelatinosa Smith	800	50000	34400	-	-
Pteromonas angulosa (Carter) Lemm.	-	-	800	-	-
Pteromonas cordiformis Lemm.	-	800	-	-	-
Scenedesmus acuminatus (Lager.) Chodat	6400	-	-	-	-
Sphaerocystis planctonica (Korsikov) Bourrelly	10000	31200	162560	45600	39200
Tetraedron caudatum (Corda) Hansgirg	-	-	-	-	-
Tetraedron minimum (A. Br.) Hansgirg	-	800	2133	-	-
Tetrastrum staurogeanieforme (Schroed.) Lemm.	800	-	800	2400	-
Tetrastrum triangulae Kors.	-	800	-	-	-

Staurastrum gracile Ralfs	800	-	-	-	-
Staurastrum tetracerum Ralfs ex Ralfs	-	4000	1200	-	-
Total	**36000**	**99867**	**247026**	**52800**	**44000**
***Cryptophyta* - cryptophytes**					
Cryptomonas erosa Ehrenberg	13600	35000	25600	-	1600
Site	**A2**	**Mid.2**	**A1**	**B1**	**B2**
Cryptomonas marssonii Skuja	800	-	1200	-	-
Cryptomonas ovata Ehrenberg	-	-	1600	-	14400
Cryptomonas rostrata Troitzskaja emend I. Kiselev	4000	5333	10800	-	-
Rhodomonas minuta Skuja	-	4000	18560	5600	-
Total	**18400**	**44333**	**57760**	**5600**	**8800**
***Dinophyta* - dinophytes**					
Peridinopsis berolinense (Lemm.) Bourrelly	-	-	1200	2400	-
Ceratium hirundinella (F. B. Müller) Bergh	1600	11400	19800	-	800
Ceratium cornutum (Ehr.) Clap. & Lachman	-	-	-	-	-
Gymnodinium aeruginosum Stein	-	-	-	-	-
Peridiniopsis cuningtonii Lemm.	33600	56000	43680	8800	2400
Peridinium cinctum (O.F. Müller) Ehrenberg	10000	23400	24480	-	-
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	11200	23600	13400	800	4000
Total	**56400**	**114400**	**102560**	**12000**	**7200**
***Euglenophyta* - euglenoids**					
Trachelomonas hispida (Perty) Stein	-	-	800	-	-
Trachelomonas volvocina Ehr.	-	-	-	-	-
Euglena caudata (Swirenko) Popova	1600	-	-	-	-
Euglena pisciformis Klebs	-	-	1600	-	-
Phacus caudatus Hubner	-	-	-	-	-

Phacus pusillus Lemm.	800	-	-	-	-
Colacium vesiculosum Ehr.	-	-	-	-	-
Total	**2400**	**0**	**2400**	**0**	**0**
***Chrysophyceae* - chrysophyces**					
Erkenia subaequiciliata Skuja	15200	8400	24800	1600	-
Dinobryon bavaricum Imhoff	-	800	3200	-	-
Dinobryon sociale Ehr.	-	-	-	-	-
Dinobryon divergens Imhoff	55200	214900	255680	164000	23200
Total	**70400**	**224100**	**288480**	**165600**	**23200**

ANNEX 4. Average biomass of phytoplankton species (mg/L) from different depth in Lake Durowskie from 27th June to 01st July 2016 (Inf – inflow; A2 – Aerator 2; Mid. 2 – Middle 2; Mid.1 – Middle 1; Outf – outflow; B1 – Beach 1; B2 – Beach 2).

Depth	**0m**	**0-3m**	**0-3m**	**0-3m**	**0-4m**	**0m**	**0m**	**0m**
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
***Cyanoprokaryota* - cyanobacteria**								
Aphanocapsa incerta Naegel.					0.0003			
Aphanizomenon flos-aquae (L.) Ralfs	0.009	0.003	0.0025	0.0025	0.02	0.003		
Chroococcus turgidus (Kűtz.) Naeg.								
Limnothrix redekei (Van Goor) Meffert	0.16		0.001	0.001	0.00275	0.0003		
Lyngbya hieronymusii Lemm.								
Microcystis aeruginosa Kützing		0.001333		0.00055	0.0022	0.002		
Phormidium autumnale Gomont				0.0002				
Planktolyngbya limnetica (L.)Kom.–Legn.Et Cr.	0.005			0.0002	0.0002			
Planktothrix agardhii (Gom.) An. et Kom.	0.015	0.003	0.0015	0.003333	0.027333			

Pseudanabaena limnetica (Lemm.) Kom.								
Woronichina naegeliana (Unger) Elenkin		0.006						
Jaaginema gracilis (Bocher) Anagn. et Kom.								
Total	**0.189**	**0.013333**	**0.005**	**0.007783**	**0.052783**	**0.0053**		
Bacillariophyceae - diatoms								
Asterionella formosa Hasall				0.000467		0.0001		
Caloneis amphisbaena (Bory) Cleve								
Cocconeis placentula Ehr.	0.005					0.01		
Cyclotella ocellata Pant.		0.001	0.0049	0.002	0.0036	0.002		0.007
Cyclotella radiosa (Grun.) Lemm.	0.003		0.001333	0.002	0.009333	0.014	0.002	0.001
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
Cymbella minuta Hilse ex Rabenhorst				0.001	0.001			
Fragilaria crotonensis Kitton	0.002		0.03175	0.039	0.03674	0.02	0.022	0.023
Fragilaria pinnata Ehr.								
Fragilaria ulna (Nitzsch) Lange-Bertalot	0.043		0.00575	0.0415	0.018	0.009	0.001	0.009
Fragilaria ulna var. angustissima Sippen								
Gomphonema parvulum (Kutz.) Kutz.						0.0007		
Hippodonta capitata (Ehr.) L-Bert.. Metz. & Witkowski	0.002							
Navicula cincta (Ehr.) Ralfs								
Navicula lanceolata (Ag.) Ehr.	0.003							
Navicula radiosa (Grun.) Lemm.	0.006		0.002	0.0025				
Naviula tripunctata (Muller) Bory								
Nitzschia palea (Kütz.) W. Smith								
Nitzschia sigmoidea (Ehr.) W. Smith								
Pinnularia maior Krammer	0.008							
Pinnularia viridis (Nitzsch) Ehr.								

Rhopalodia gibba (Ehr.) Muller								
Staurosira construens Ehr.					0.0006			
Total	**0.072**	**0.001**	**0.045733**	**0.088467**	**0.069273**	**0.0558**	**0.025**	**0.04**
***Chlorophyta* - green algae**								
Actinastrum hantzschii Lagerh.				0.001				
Characium aqngustatum A. Braun				0.001				
Closterium acutum var. variabile (Lemm.) Krieg.		0.010		0.008	0.010			
Coelastrum astroideum De Notaris				0.016		0.008		
Coelastrum reticulatum (Dangeard) Senn		0.003			0.003			
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
Coenocystis planctonica Kors.				0.006				
Cosmarium phaseolus Brebisson in Ralfs				0.005				
Cosmarium regnellii Wille			0.0004	0.002				
Desmodesmus communis (Hegew.) Hegew.	0.001	0.001		0.001	0.001	0.001		
Dicellula geminata (Printz) Kors.			0.001					
Elkatothrix gelatinosa Wille		0.005		0.003	0.005	0.002		
Golenkinia radiata Chodat	0.001	0.0007	0.0004	0.001	0.0007		0.003	
Kirchneriella incurvata Belcher et Swale			0.004					
Kirchneriella obesa (West) West & West	0.001							
Micractinium pusillum Fresenius				0.010				
Monoraphidium contortum (Thur.) Kom.-Legn.		0.0004			0.0004			
Monoraphidium komarkovae Nygaard				0.0003				
Oocystis lacustris Chodat		0.004		0.003	0.004			
Pediastrum boryanum (Turpin) Meneg.	0.023	0.035	0.031	0.073	0.035			
Pediastrum duplex Meyen		0.040	0.047	0.015	0.040	0.024	0.024	
Pediastrum duplex var. gracillium West						0.070		

Pediastrum biradiatum Meyen			0.047					
Pediastrum simpelex Meyen			0.015					
Phacotus lenticularis (Ehr.) Stein	0.001	0.006	0.001	0.003	0.006	0.003	0.001	
Plankosphaeria gelatinosa Smith		0.015	0.005		0.015	0.009		0.001
Pteromonas angulosa (Carter) Lemm.	0.001							
Pteromonas cordiformis Lemm.				0.001				
Scenedesmus acuminatus (Lager.) Chodat		0.001			0.001			
Sphaerocystis planctonica (Korsikov) Bourrelly	0.006	0.082	0.049	0.041	0.082	0.177	0.104	0.089
Tetraedron minimum (A. Br.) Hansgirg		0.0002	0.0003	0.0003	0.0002	0.0004		
Tetrastrum staurogeanieforme (Sch.) Lemm.		0.0004			0.0004		0.054	
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
Tetrastrum triangulae Kors.			0.0004					
Staurastrum gracile Ralfs						0.002		
Staurastrum tetracerum Ralfs ex Ralfs		0.005	0.025		0.005			
Total	**0.034**	**0.207**	**0.222**	**0.189**	**0.207**	**0.296**	**0.189**	**0.091**
***Cryptophyta* - cryptophytes**								
Cryptomonas erosa Ehrenberg	0.004	0.0125	0.015	0.012	0.0125	0.013		0.003
Cryptomonas marssonii Skuja	0.001	0.001		0.001	0.001			
Cryptomonas ovata Ehrenberg		0.003			0.003	0.0008		0.029
Cryptomonas rostrata Troitzskaja emend I. Kiselev	0.003	0.006	0.005	0.004	0.006	0.007		
Rhodomonas minuta Skuja	0.001	0.0023	0.0015	0.003	0.0023	0.003	0.004	
Total	**0.009**	**0.0248**	**0.022**	**0.019**	**0.0248**	**0.0238**	**0.004**	**0.032**
***Dinophyta* - dinophytes**								
Peridinopsis berolinense (Lemm.) Bourrelly	0.014	0.007		0.0105	0.007		0.022	
Ceratium hirundinella (F. B. Müller) Bergh	0.154	0.6955	0.523	0.167	0.6955	0.232		0.077
Peridiniopsis cuningtonii Lemm.	0.055	0.120	0.183	0.155	0.120	0.194	0.102	0.028

Peridinium cinctum (O.F. Müller) Ehrenberg	0.063	0.139	0.175	0.2255	0.139	0.127		
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	0.025	0.035	0.054	0.026	0.035	0.006	0.0006	0.032
Total	**0.311**	**0.997**	**0.934**	**0.584**	**0.997**	**0.559**	**0.125**	**0.137**
***Euglenophyta* - euglenoids**								
Trachelomonas hispida (Perty) Stein	0.008			0.0015	0.0008			
Trachelomonas volvocina Ehr.						0.0003		
Euglena pisciformis Klebs					0.0009			
Total	**0.008**	**0**	**0**	**0.0015**	**0.0017**	**0.0003**	**0**	**0**
***Chrysophyceae* - chrysophyces**								
Erkenia subaequiciliata Skuja	0.0002	0.0005	0.0003	0.0002	0.0005	0.0003	0.0001	
Site	**Inf**	**A2**	**Mid.2**	**Mid.1**	**A1**	**Outf**	**B1**	**B2**
Dinobryon bavaricum Imhoff		0.002	0.0005	0.001	0.002			
Dinobryon sociale Ehr.				0.074				
Dinobryon divergens Imhoff		0.023	0.0267	0.008	0.023	0.131	0.075	0.011
Total	**0.0002**	**0.0255**	**0.028**	**0.0832**	**0.0255**	**0,13**	**0.0751**	**0.011**

ANNEX 5. Comparison of periphyton species composition in different investigated sites from 27th June to 1st July 2015 in Lake Durowskie.

Diatom taxa	**Site**									**O**	**pH**	
	1	**3**	**4**	**5**	**7**	**8**	**9**	**11**	**12**			
Achnanthes conspicua Mayer												
Achnanthes exigua Grun.		+	+	+	+	+	+	+	+	4	1	7
Achnanthes hungarica(Grunow) Grun. in Cleve									+	4	4	6
Achnanthes lanceolata (Breb.) Grunow	+	+	+		+	+			+	4	3	5
Achnanthes lanceolata v. elliptica Cleve sensu Straub						+				4	-	-
Achnanthes minutissima Kützing	+	+	+	+		+	+	+	+	3	1	7
Achnanthes minutissima var. affinis (Grun.) Lange-Bertalot						+			+	4	-	-
Achnanthes minutissima var. *gracillima* (Meister) Lange-Bertalot						+				4	-	1
Amphipleura pellucida (Kützing) Kützing										4	2	2
Amphora ovalis Kützing	+	+	+	+	+	+	+	+	+	4	2	5
Amphora pediculus (Kütz.) Grunow	+	+	+	+	+	+	+	+	+	4	2	5
Asterionella formosa Hass	+			+			+	+		4	2	5
Aulacoseira granulata										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	+				+	+				-	-	-
Craticula cuspidata (Kützing) Mann W Round	+									4	3	5
Cyclotella meneghiniana Kütz.		+	+	+	+	+	+	+		4	5	5
Cyclotella ocellata Pant.	+	+	+	+	+	+	+	+	+	4	1	4
Cyclotella operculata (Ag.) Kützing		+	+	+	+		+	+	+	-	-	-
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+		+	+	+	+	4	2	5
Cymatopleura solea (Breb.) W. Smith				+	+		+	+		4	3	5
Cymbella affinis Kützing	+	+	+	+	+	+	+	+	+	4	1	5
Cymbella caespitosa (Kützing) Brun.									+	0	-	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 prostrata (Berkeley) Cleve				+	+		+	+		4	1	5
Cymbella tumida (Bréb.) Van Heurck	+	+					+			4	1	4
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
Eunotia bilunaris Ehr.						+				-	-	-
Eunotia exigua (Breb.) Rabenh.	+			+			+	+		1	2	7
Eunotia faba (Ehr.) Grun.				+			+	+		2	1	2
Eunotia intermedia (Krasske) Noerpel & Lange - Bertalot									+	2	-	1
Eunotia praerupta Ehr.	+	+	+	+	+	+	+	+	+	2	1	2

Eunotia tenella (Grun.) Hustedt									+	2	1	1
Fragilaria capitata Ehr.		+	+							-	-	-
Fragilaria capucina (Desm.) Rabenhorst	+	+	+	+	+	+	+	+	+	3	-	3
Fragilaria constricta Ehr.					+					2	-	1
Fragilaria construens (Ehr.) Grun.		+	+					+		4	1	4
Fragilaria crotonensis Kitton	+	+	+	+		+	+		+	4	2	3
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 vaucheriae *(Kütz.) Carlson*								+		-	-	-
Gomphonema acuminatum Ehr.	+			+		+	+	+	+	4	2	5
Gomphonema angustatum (Kütz.) Rabenhorst									+	-	-	-
Gomphonema angustum Agardh									+	4	1	1
Gomphonema augur Ehr.	+									4	1	4
Gomphonema gracile Ehr.	+			+			+	+		3	1	3
*Gomphonema intricatum*Kützing				+			+	+	+	-	-	-
Gomphonema micropus Kütz.				+			+	+		4	2	5
Gomphonema olivaceoides Hustedt	+			+			+	+	+	-	-	-
Gomphonema olivaceum (Horn.) Breb.	+	+	+	+	+	+	+	+	+	5	2	5
Gomphonema parvulum (Kütz.) Kütz.	+			+	+		+	+	+	3	4	5
Hantzschia amphioxys (Ehr.) Grunow				+	+		+	+		3	2	7
Mastogloia smithii Thwaites						+				4	-	-
Meridion circulare Ag.		+	+		+	+			+	4	2	7
Navicula agrestis Hustedt				+	+					3	-	-
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 gregaria Donkin					+	+				4	4	5

Navicula placentula (Placoneis)				+			+	+		4	2	5
Navicula radiosa Kützing	+	+	+	+	+	+	+	+	+	3	2	4
Navicula reinhardtii Grun.		+	+		+					5	2	5
Navicula tenella Hustedt									+	-	-	-
Navicula tripunctata (O. F. Müller) Bory	+	+	+	+	+	+	+	+	+	4	2	5
*Navicula viridula (*Kütz.) Ehr.				+	+		+	+		4	2	5
Nitzchia acicularis (Kützing) W. Smith	+	+	+							4	4	5
Nitzschia amphibia Grunow	+		+	+			+	+	+	4	3	5
Nitzschia incospicua Grun.					+	+				4	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 viridis (Nitzsch) Ehr.		+	+		+	+			+	3	3	7
Rhoicosphaenia abbreviata (Ag.) Lange-Bertalot									+	4	2	5
Rhoicosphaenia curvata (Kütz.) Grun.		+	+							-	-	-
Rhopalodia gibba (Ehr.) Müller	+	+					+			5	3	5
Stauroneis phoenicentron Ehr.	+	+	+			+				3	3	4
Stephanodiscus astraea				+	+		+	+		-	-	-
Stephanodiscus hantzschii Grun.	+	+	+						+	5	4	6
Surirella minuta Breb.		+	+							4	3	5
Surirella ovalis Breb.				+			+	+		4	4	5
Tabellaria fenestrata (Lyngb.) Kützing	+				+	+				3	1	2

Annex 6: Ecological characteristics of dominant periphyton species

Ecological characteristics of dominant species in the periphyton community

Dominant species **comment**

Dominant species	**comment**
Achnanthes minutissima Kützing	Can live both in oligotrophic an eutrophic conditions, is not able to live in very acidic conditions or environments with low electrolyte habitats, already under alpha, beta mesosaprobie vitality strongly decreases
Achnanthes minutissima var. affinis (Grun.) Lange-Bertalot	can live in oliogosaprobic, oligotrophic to eutrophic conditions weak alkaline conditions, mostly found in calcareous conditions. Often occurs in habitats with high electrolyte content
Amphora ovalis Kützing	appear in oligo- to eutrophic water bodies. Appear frequently but not very numerous. Medium to high electrolyte content, higher trophical states are preferred under oligotrophic and mesotrophic conditions only few individuals appear
Amphora pediculus (Kütz.) Grunow	lives in oligosaprobic and beta- mesosaprobic habitats, very broad trophic spectrum, missing in conditions with low electrolyte contents and acidic conditions
Cocconeis pediculus	lives in medium to high trophic state, does not appear in conditions with low electrolyte content, circumneutral to acidid conditions or oligotrophic habitats
Cocconeis placentula Ehr.	broader spectrum than Cocconeis pediculus, in contrast appears in conditions of low electrolyte content and medium trophic levels
Cyclotella radiosa (Grun.) Lemm.	appears in eutrophic conditions, was found in acidic or brackish water bodies, neutral waters and very polluted lakes
Cymbella affinis Kützing	indicator of very good ecological water quality, rarely found in calcerous, oligotrophic lakes and rivers

Dominant species	**comment**
Cymbella microcephala Grun. (Encyonopsis microcephala)	can live in slightly acidic to alkaline conditions and low to medium electrolyte conditions, **if the habitat is oligosaprobic.** Occurs in oligo- to slightly eutrophic coditions
Cymbella minuta (Encyonema minutum)	Occurs in non- disturbed habitats (oligo- to mesotrophic conditions) with a medium electrolyte content. Can be easily confused with other species
Cymbella tumida	Appears frequently but with small populations in meso- to eutrophic water bodies with medium electrolyte content
Diatoma vulgaris Bory	Appears in medium to high trophical conditions, also in lakes independend of ecozone but more frequent in rivers
Eunotia praerupta Ehr.	Mostly found in undisturbed, oligodistrophic habitats with low electrolyte content on silicates.Never appears numerously.
Fragilaria capucina (Desm.) Rabenhorst	most likely in oligotrophic to mesoeutrophic, slightly acidic to alkaline waterbodies with low to medium electrolyte content but not very reliable
Fragilaria crotonensis Kitton	mostly found in oligotrophic to slightly eutrophic mostly slightly alkaline conditions with medium electrolyte content. Decreases with increasing sewage input (still debated)
Fragilaria pinnata Ehr.	Broad trophic tolerance, almost reaching over the whole spectrum. Negative reaction to beta- mesosaprobic conditions. Prefers non-acidic conditions. Also appears in circumneutral conditions with low electrolyte content
Gomphonema olivaceoides	Mostly appears widly spread but with high numbers of individuals in calcareous lakes with medium nutrient content

Dominant species	comment
Gomphonema olivaceum (Horn.) Breb.	Mostly found in eutrophic, calcareous conditions with moderate electrolyte content. Saprobic tolerance reaches from oligosaprobic to critial threshold between beta and alpha mesosaprobic conditions.
Gomphonema parvulum (Kütz.) Kütz. (Gomphonema parvulius)	widely spread in oligotrophic habitats with low electrolyte contents. Mostly appears in slightly acidic conditions in lakes. Appears together with acidophilic species

Annex 7: New and rare algal species found in July 2016

NEW SPECIES IN 2016

Craticula cuspidata

Occurrence and ecology: widespread and often occurring in waters with higher content of electrolytes up to brackish waters, tolerant respect of organic contaminants to the α-mesosaprobic zone, avoids pollution by industrial waste.

Navicula oblonga

Occurrence and ecology: optimum of occurrence lies in calcium-rich lakes, was observed in waters of varying state trophy in small population. Infrequent in alcalic streams and small rivers on lowlands.

RARE SPECIES = PRESENT ONLY AT 1 OR 2 SITES

Achnanthes hungarica

Occurrence and Ecology: Found in waters of higher trophic level and higher electrolyte contents. This species is hypereutraphentic, alkaliphilous (mainly occourring at pH>7)and has low oxygen requirements.

Achnanthes lanceolata v. elliptica Cleve sensu Straub

Occurrence and Ecology: Ecological amplitude very broad, from neutral waters to alkaline, low electrolyte to -rich, oligotrophic to -rich, oligotrophic to polytrophic waters up to B-mesosaproben stress level. Absent in acidic habitats, however, also widely found in stagnant waters.

Aulacoseira granulata (Ehr.) Ralfs

The classical indicator species of eutrophic water areas.

Caloneis silicula (Ehr.) Cleve

Found in meso-eutraphentic waters with pH index above 7.

Cymbella caespitosum

Found very often in eutrophic waters with moderate electrolyte content, but tolerant of oligotrophic to eutrophic.

Cymbella turgida (Greg.) Cleve

This freshwater species is widespread, which makes it a weak bioindicator of water quality. It appears in low quantity of small specimens.

Eunotia intermedia

Infrequent in holarctic regions but moderatly to very abundant in places. Records from North America can be confirmed. In other cases misidentifications cannot be excluded or are ever very likely. Smaller single, in particular narrower specimens from the cell cucle are difficult to differentiate from E. subarcuatoides. Autecology is the same as for majority of Eunotia species: occurrence not in ombrotrophic but minerotropfic, moderatly acidic waters with low specific conductivity, coomonly associated with numerous other acidophilous diatoms, mainly in sprongs and streams, predominantly in higher mountains.

Eunotia bilunaris Ehr.

One of the most frequent and abundant Eunotia taxa living epiphytic in all regions of Europe and the Holarctic Plant Realm. Predominantly occuring in oligotrophic to dystrophic waters with low electric conductance and low pH, like fens, raised peat bogs, springs. However, resembling populations can also occur in eutrophic ponds or lakes with moderately gigher electrolyte content. Until recently they could not be morphologically distinguished. Numerous more or less similar populations live in other plant realms, particularly in the paleotropics and Neotraphics.

Fragilaria capitata Ehr.

This freshwater species is widespread, which makes it a weak bioindicator of water quality.

Fragilaria capucina v. amphcephala

This species is an indicator of excellent ecological quality. It has found in patchy form in oligotrophic to mesotrophic lakes of pre-alpine and alpine region. Also, this species has found in the middle of lake. However, few occurance recorded from lakes to the highlands and the North German Lowlands. It is rarely found in rivers.

Fragilaria constricta Ehr.

Stenotermic species of freshwaters, found often in the north parts of Europe. Mainly occuring in oligotraphentic waters with pH index below 7.

Fragilaria vaucheriae (Kütz.) Carlson

Still difficult to assess proliferation in the water types and ecological amplitude due to difficult identification and demarcation.

Gomphonema angustatum (Kütz.) Rabenhorst

Currently very poor knowledge, because the concept of this type prior to the revision by Reichardt (1999) was still unclear or completely wrong. Secured findings as to the identity, in boggy, circumneutral waters, such as meadow trenches source ponds with dead plant materials. Therefore humidic acid and not oligotrophic. Own (not quite unambiguous) finds from major rivers, such as the Lower Elbe, in historical preparations.

Gomphonema angustum Agardh

Typical kind of very hard waters, springs in the lime rock, loess, in tuffs, incrusted in moss lawns, there almost always individual-rich. Where such habitats are absent, G. angustum is substituted with other, perhaps similar Gomphonema kinds.

Gomphonema augur Ehr.

Distribution and ecology difficult to characterize. Airborne with mostly individual-poorer populations, especially in alkaline, nutrient-rich lakes and larger rivers, saprobie-tolerant up to the critical load factor (β - α - mesosaprob).

Mastogloia smithii Thwaites

On the European Baltic coasts widespread brackish water kind, not seldom, however, also in lakes of the interior with middle and higher elektrolyte content. These waters are predominantly nourish-rich in material, however, there are given also findings from oligotroph and oligo-mesotroph lakes which need to be checked for possible mistakes/confussion with M. lacustris.\

Navicula agrestis Hustedt

This freshwater species is found in hypertrophic waters.

Navicula dicephala (Ehr.) W. Sm.

Occurrence and Ecology: The type-specific occurrence of this new species is still little known. Scattered, locally moderate in individuals rich in eutrophic waters with moderate electrolyte content.

Navicula gastrum (Placoneis)

Occurrence and Ecology: Found in eutraphentic waters. Has high oxygen requirements (above 75%). Mainly occurring at ph>7. In lakes, more seldom in wild sows and rivers of the lowland with middle to high electrolyte content with mostly individuenarmen populations seeming. In the low mountain ranges and in the subalpinen space very seldom. The habitats are meso-to eutroph and oligosaprob.

Nitzschia micropus

Pinnularia gibba Ehr.

Hypereutraphentic, cosmopolitan, in places abundant in waters with low to average electrolyte content, especially in spring-like locations. P. gibba was observed and described as a species, which prefers waters extremely poor in carbonate (springs and low moors), however, she also comes in strongly with sewage loaded to rivers before. It could concern different Taxa. After data of the waters supervision the spreading main focus lies in densilikatisch gepagten waters of the Mittelgebrige and the Northwest-German lowland. In the foothills of the Alps and the alkaline waters of her Mountain is rare the kind against it very seldom.

Rhoicosphaenia abbreviata (Ag.) Lange-Bertalot

Cosmopolitan species inhabiting freshwaters with moderately high electrolyte content and brackish-waters.

Suririella minuta Breb.

Because of preferences toward waters with smaller electrolytic conductivity, this species is use as a indicator of low thropic state- mesotrophy, weak eutrophy.