Phytoplankton and periphytic analysis as indicators of water quality in Lake Durowskie in Wągrowiec, Poland

03th - 17th July, 2011

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1. Introduction and Aims

The communities of aquatic organisms are known as important indexes for pollution in water bodies. Phytoplankton/Periphyton are sensitive indicators, as their structure and metabolism changes quickly in response to environmental changes (Wasielewska, 2006).

During the summer school (4 July – 17 July 2011), hosted by University of Adam Mickiewicz in Poznan, an investigation to evaluate the current ecological status of Lake Durowskie was conducted. The procedure was done by investigating Phytoplankton/Periphyton communities distribution and their taxonomic composition according to directives of the Water Framework Directive. The aims have been determined as followed:

- assess the trophic level of the lake on the basis of phytoplankton biomass and periphytic diatom species;
- compare phytoplankton and periphytic composition and distribution in eight representative sites of the lake;
- see if there is spatial or temporal difference in phytoplankton distribution across the lake;
- estimate water quality according to the WFD based on periphytic diatom's index;
- Evaluate if restoration project which started in 2008 has advanced.

2. Materials and Methods

2.1 Investigation Area:

Lake Durowskie is located near the city of Wagrowiec in Poland.

Morphometry of the lake Durowskie:

surface:	143.7 ha
volume:	11,322,900 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:	1,581.3 ha
share of agricultural area:	58.26%
share of forests:	33.52%
urban area:	8.25%

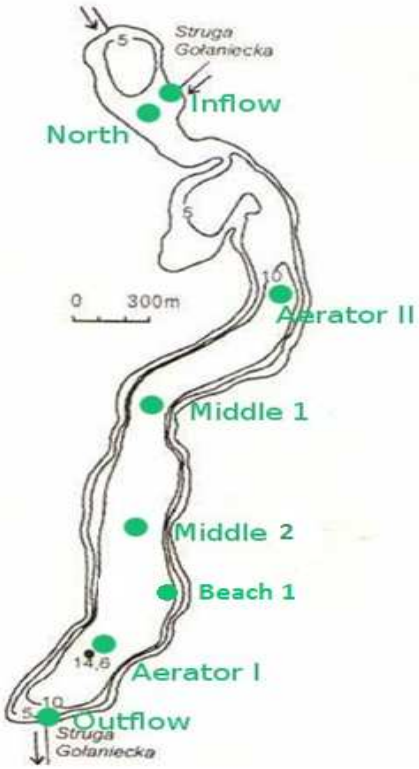

Fig. 1 Map of Lake Durowskie and indicated sites investigated

2.2 Methods

For phytoplankton analysis water samples were collected from eight stations namely Aerator 1, Aerator 2, Middle 1, Middle 2, Inflow and Outflow, Beach 1 and North (fig. 1) in the pelagic zone (0m-3m), for 6 days, from July 4 to July 9, 2011 .The samples were preserved immediately with Lugol`s solution allowed to be settled for at least 24 hours. Also periphytic communities were collected for a calculation of a diatom analysis.

In the laboratory, phytoplanktonic and periphytic diatom species were identified to their respective species and the biomass of each species was calculated. After the analysis the mixed trophic index of phytoplankton and the Diatom index at the periphytic sites was predicted to give a suggestion of the trophic state of Lake Durowskie. Moreover, the Jaccard and Shannon-Weaver index were determined to compare the variations of phytoplankton communities between 2008 and 2011.

3.Results and Discussion

3.1 Phytoplankton communities

In laboratory analysis a total amount of **254** species of phytoplankton have been identified. The dominating groups are *Bacillariophyceae* and *Chlorophyta* (Fig. 2). Aerator 1 shows the highest biodiversity of all sites. Dominating species is chlorophyta. In comparison to the previous year, the number of *Cyanobacteria* decreased. The Inflow and North part of the lake is dominated by *Bacillariophyceae and Chlorophyta*.

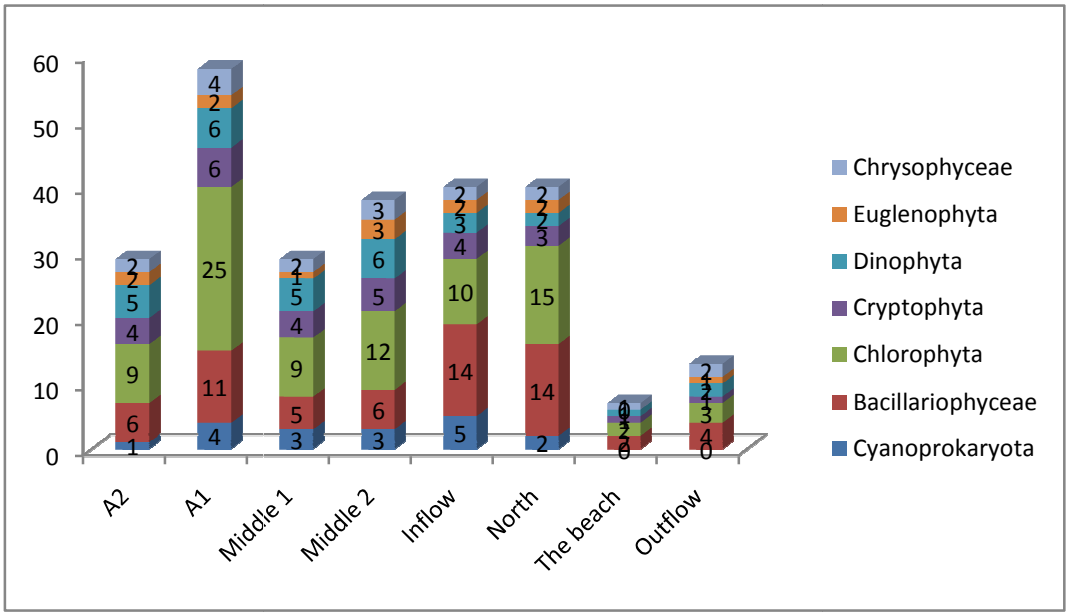

Fig. 2 Number of species per site

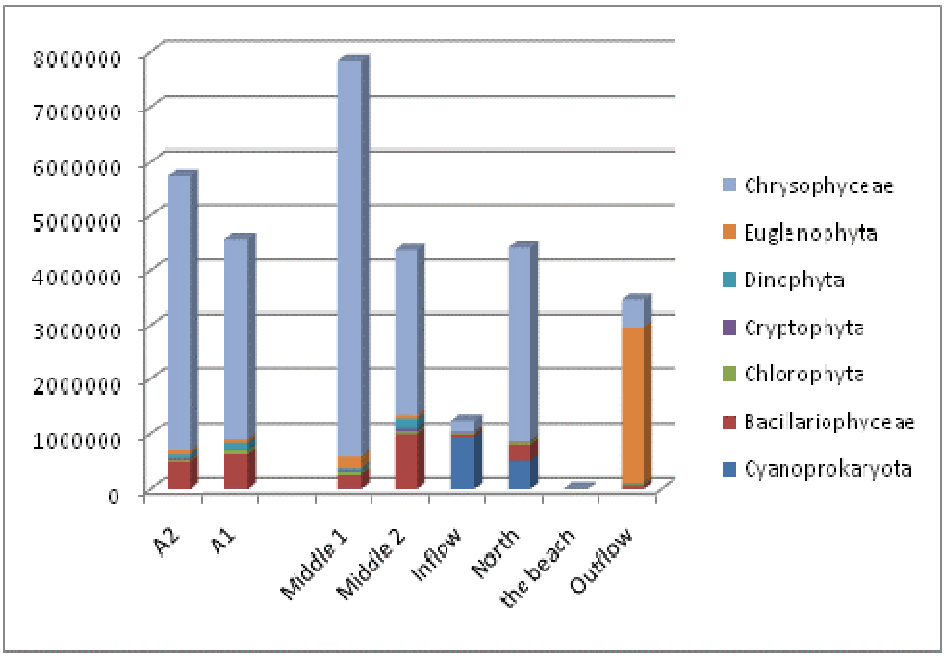

Fig. 3 Number of cells per liter of lake Durowskie

Fig.3 and 4 show that Lake Durowskie is highly dominated both in cell numbers and biomass by euthrophic indicator algae species, such as diatom species*, Staurastrum gracile Ralfs, Sphaerocystis planctonica* (Korsikov) *Bourrelly, Phacotus lenticularis* (Ehr.) Stein*, Fragilaria crotonensis* Kitton*, Asterionella formosa* Hasall*, Cyclotella radiosa* (Grun.) Lemm.*, Cyclotella ocellata* Pant.

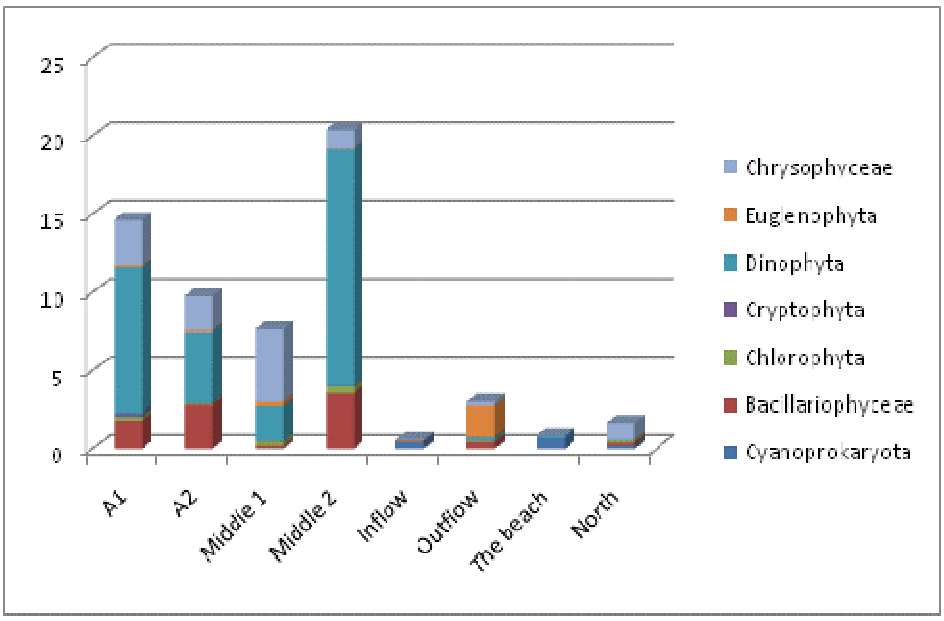

Fig. 4 Phytoplankton biomass (mg/l)

In terms of biomass, the highest number of *Chrysophyceae* was noticed near the Aerator 1. It is caused by the higher weight of cells of that group. They are taken to the upper part of the lake due to water column interferences.

Cyclotella ocellata and *Cyclotella radiosa* are bioident of water. Higher amount of *Cyclotella ocellata* indicates better water quality (Fig.5). Nevertheless more cells of *C. radiosa* were found, though the difference in cell numbers is rather small. However, both species appeared in the same sites, which demonstrates an improvement of the water quality.

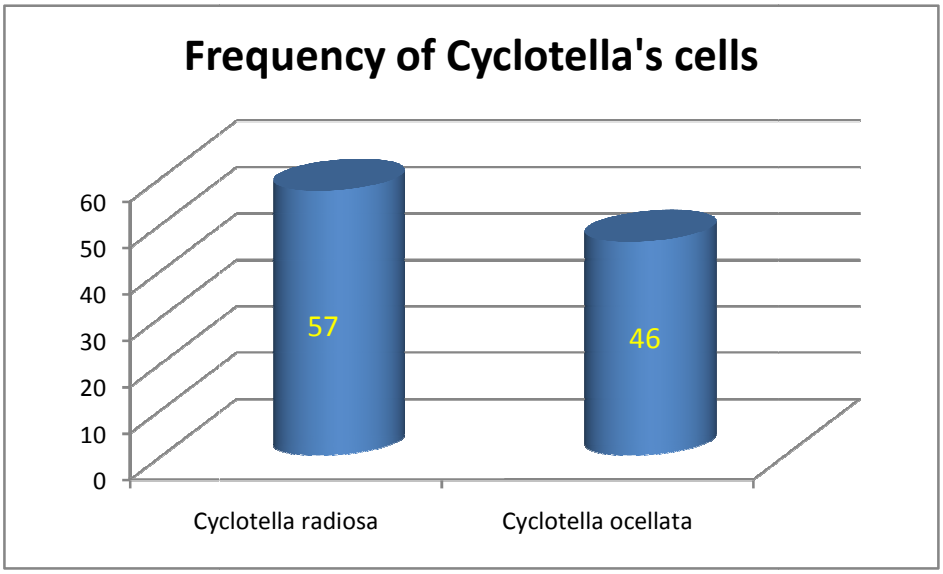

Fig. 5 Frequency of Cyclotella's cells

3.2 Mixed Phytoplankton Index

The mixed Phytoplankton Index is based on the number of species from all sorts taxonomical groups of algae and it is given by:

Mixed Index of Phytoplankton = *Cyanobacteria* + *Chlorococcales* + *centric diatoms* + *euglenoids / desmids*.

The scale: eutrophy > 3.0 > mesotrophy >1.0 > oligotrophy > 0.2 > dystrophy

Tab. 1 Mixed Phytoplankton Index

Station	2008	2009	2010	2011	Trophy
Aerator 1	9,67	16	8,3	9	Eutrophy
Aerator 2	-	26	11,5	5	Eutrophy
Middle 1	-	9	12,5	13	Eutrophy
Middle 2	-	-	8,3	18	Eutrophy
Inflow	-	-	1,8	17	Eutrophy
Outflow	-	-	6,5	5	Eutrophy
North	-	-	11,5	5,3	Eutrophy
Beach	-	-	-	3	Eutrophy

Table 1 shows the trophic levels of all investigated sites in the period of 2008-2011. The general trophy situation is improving. In comparison to the previous years there is a decrease of eutrophication in almost all sites excluding Inflow and Middle 2. At the Beach, North and Aerator 2, the restoration towards olgotrophic water quality has advanced. The examined Beach station reached with a value of 3 almost a mesotrophic status.

3.3 Jaccard Index

The Jaccard coefficient measures similarity between sample sets. It runs from 0 – 1 and is given for the conducted investigation in table 2.

The value of the index for the comparison of the year 2010 and 2011 is 0,42. Meaning that 42% of the present phytoplankton composition can be explained with species of 2010.

Tab. 2 Jaccard-Index

Year	2009	2010	2011
2008	0,84	0,51	0,43
2009	~	0,48	0,28
2010	0,48	~	0,42

3.4 Shannon-Weaver Index

The Shannon-Weaver index, measures biodiversity in categorical data. Typically the value of the index ranges from 1.5 to 3.5, though values beyond these limits may be encountered. Because the Shannon Index gives a measure of both species numbers and the evenness gives a value of their abundance. It is particularly useful when comparing similar ecosystems, habitats or timeseries, as it can highlight one example being richer or more even than another.

A decrease of the index of all sites compared to 2010 has been observed. Highest value has the inflow with a value of 2,8 (2010: 3.3). Aerator 1 shows the biggest dynamic with a shift from 3.3 in 2010 to 1.13 in 2011.

A reason might be the enhanced zooplankton population (table 3) due to anthropogenous biomanipulation (introduction of pikes). The increased Zooplankton pressure on Phytoplankton leads to a Phytoplankton community consisting of colony building, spiny, with thick cell walls and large cells. Dominating species are therefore Chrysophyceae, highest amount of individuals, e.g. *Dinobryon divergens* and Dinophyta, highest amount of biomass, e.g. *Ceratium hirundinella*

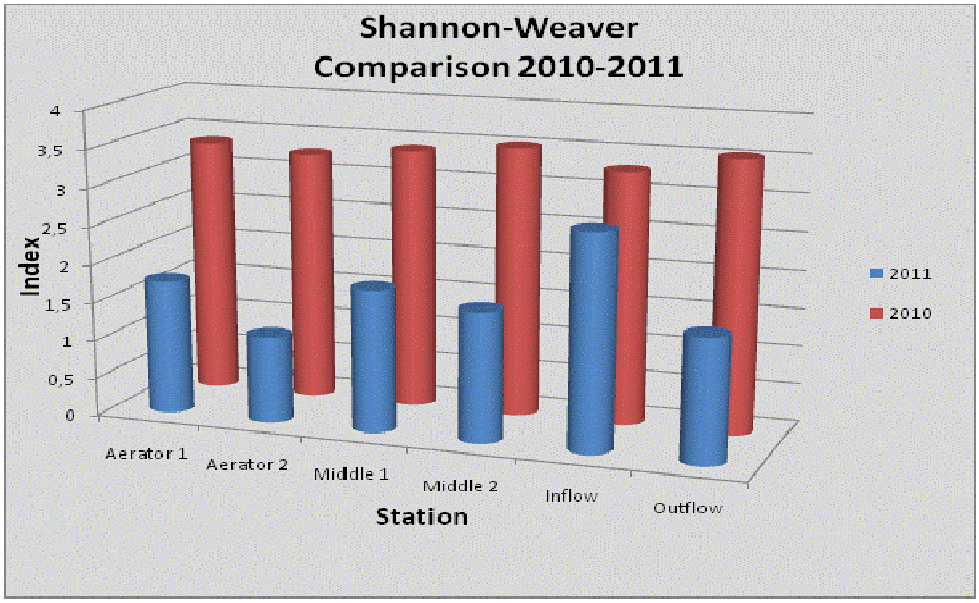

Fig. 6 Shannon-Weaver Index comparison 2010 to 2011

Tab. 3 Species of Zooplankton found in Lake Durowskie

Rotifera	**Cladocera**	**Copepoda**
Keratella cochlearis f. typica	*Bosmina longirostris*	*Cyclopoida sp.*
Keratella quadrata	*Chydorus sphaericus*	
Keratella cochlearis f. tecta	*Daphnia hyalina*	
Polyarthra sp.		
Pompholyx sulcata		

4. Water quality estimation

4.1 Periphytic species

Periphyton are benthic algae that grow attached to surfaces such as rocks or larger plants. It is a primary producer and a sensitive indicator of environmental change in waters bodies. Because periphyton is attached to the substrate, this assemblage integrates physical and chemical disturbances to the stream reach. The periphyton assemblage serves as a good biological indicator due to:

- a naturally high number of species
- a rapid response time to both exposure and recovery
- identification to a species level by experienced biologists
- ease of sampling, requiring few people
- tolerance or sensitivity to specific changes in environmental condition are known for many species

For the assessment of ecological status of lake Durowskie, the taxonomic composition and abundance of the species were investigated and compared to the specific reference conditions for different types of lakes. For the research project presented in this report, benthic diatoms were investigated along the Lake's shoreline. Eight different sites presented characteristic species composition and abundance. On a final analysis, 56 taxa were deemed to be useful indicators for the assessment of the ecological status of different sampling sites, but the abundance of these

species has to be taken into consideration. A formula was developed to calculate a Diatom Index of ecological status using the sum of the abundances of particular species per trophic and sensitivity category (Picińska-Fałtynowicz, 2006). Using this calculated index, each sampling site was assigned to one of the five ecological quality classes according the Water Framework Directive.

In Figure 7 a comparison of oxygen demands of phytoplankton species in 2010 and 2011 was made. Noteworthy is the development of more species with a high oxygen demand, indicating a higher oxygen availability in the literal zone in the Durowskie lake for the year 2011.

Very good 100%	Achnanthes minutissima (56)	Achnanthes minutissima (10)
Good 75%	Cyclotella radiosa (40)	Cyclotella radiosa (28)
Moderate 50%	Fragilaria capucina (74)	Gyrosigma attenuatum (25)
Poor 30%	Gomphonema parvulum (10)	Surirella ovalis (6)
Bad 10%	Cyclotella meneghiniana (6)	Cyclotella meneghiniana (1)

Fig. 7 Peryphiton species preferences for oxygen in litoral zone 2011-2010

4.2 Diatom Index

In order to calculate the diatom index, the trophy index (1), the index of referential species (2) and the their standardization had to be calculated (3, 4).

Formula:

TJ = □ (TJi * wTJi*Li)/ □ (wTJi*Li) **1**

TJi: value of the sensitivity of species for the trophy 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

pGR= (NB – (NC+ ND)) / (NB + NC+ ND) **2**

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

ZTJ= (1-((TJ-1) *0,25) **3**

ZpGR= (pGR+1)*0,5 **4**

Diatom Index is calculated with equation (5).

DI= (ZTJ + ZpGR)/2 **5**

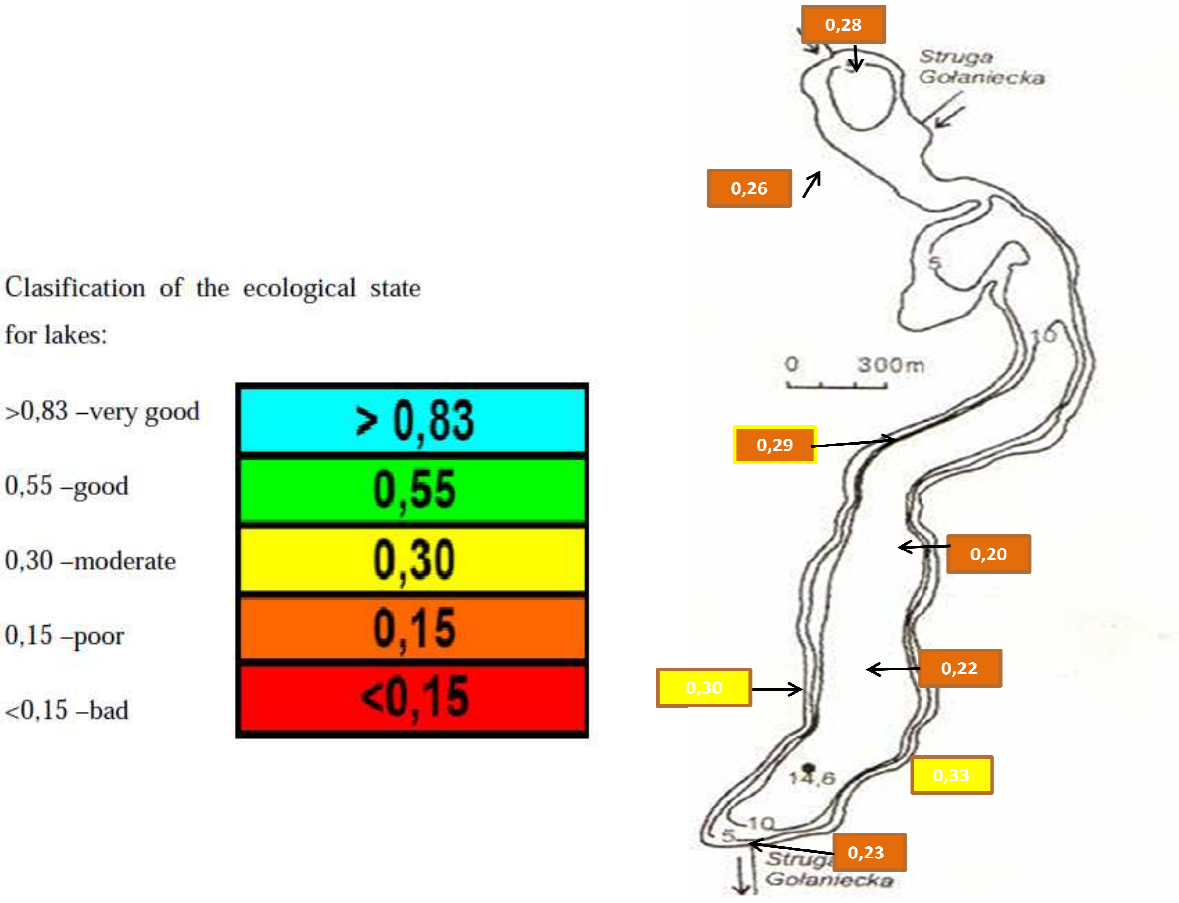

Fig. 8 Diatom Index 2011

In comparison to the year 2010, the Diatom Index has decreased in all investigated sites. Both north and south of the lake Durowskie indicate poor water quality (Fig. 8.), except for 2 sites with moderate quality. It means that the ecological quality also decreased. Only 2 out of 8 sites are still at similar level. An explanation could be a water lever rise caused by floods and unusual seasonal precipitation amounts. Furthermore the disturbance of the water column by wind leads to an additional nutrient availability for phytoplankton.

5. Freshwater red algae

Hildenbrandia rivularis belongs to the family of phyllum Rhodophyta. It represents the red algae occurring in fresh inland waters. This specific algae is listed as a threatened algae species in Poland. On the basis of habitat conditions it prefers to grow in shaded waters with fast currents. It tends to aggregate also in wavy zones and stony grounds. *Hildenbrandia rivularis* tolerates some nutrient enrichment but it is also sensitive to organic pollution. It grows in calcium rich waters with low conductivity and high oxygen content, therefore its presence indicates an improvement in water quality.

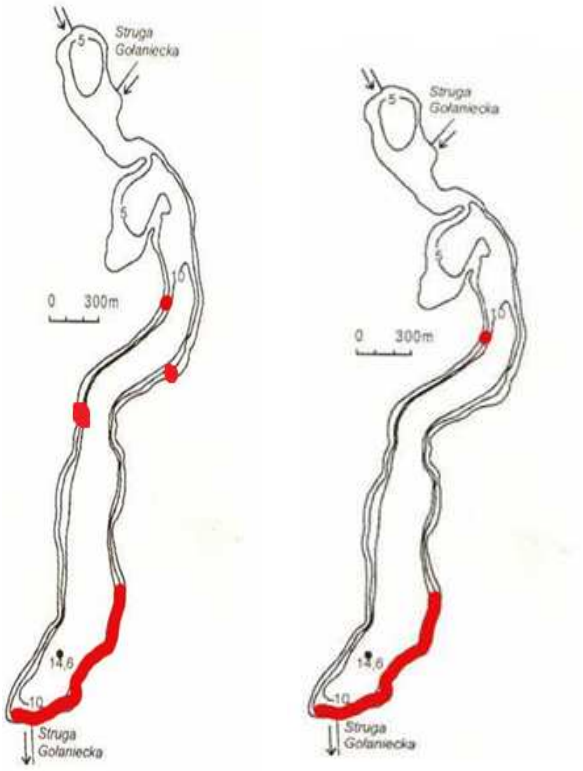

Fig. 9 Hildebrandia rivularis 2011 and 2010

The position of *Hildenbrandia rivularis* was observed on the east, west and south shore (majority of distributon) of lake Durowskie. In comparison to 2010 the red algae was observed in 2 sites additional (Fig. 9).

6. Conclusions

Considering the biological water quality assessment using phytoplankton it is obvious that Lake Durowskie, although still eutrophic, shows some positive development towards better water quality in 2011. This can be proven by the decrease in number of cyanobacteria, but increase in green algae, dinoflagellates and diatoms biomass as well as an increase in number of taxa in general. Moreover, on one hand the Mixed Trophic Index decreased at some sites of the lake but on the other it also improved at other sites.

Furthermore, comparing the current investigation to 2010, Hildenbrandia rivularis distribution increased in the litoral area. This red algae is seen in the shady calcareous region of the south west of the lake and is a good indicator of the ongoing water quality improvement.

Water transparency in the lake is good (according to the WFD), however the nutrient load remains at high levels causing huge algal biomass production. The transparency can be explained with the biomanipulation of the lake (introduction of pikes).

The dissolved oxygen content in the litoral zone has increased, because there is a higher abundance of species which prefer very well oxygenated waters.

In comparison to 2010 the diatom Index has decreased in all investigated sites. Both north and south of the lake Durowskie indicate poor water quality, except for 2 sites with moderate quality.

The program started in the year 2008 and showed a constant ecological improvement up to 2010. In 2011 the diatom index and the mixed phytoplankton index suggest that water quality has decreased in lake Durowskie. However the restoration program should be continued and further measures should be taken. Though the temporarily

deterioration of the water quality can be explained with a cold and windy springtime, unusual weather patterns and a higher nutrient input by the inflowing waters.

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ANNXES
Phytoplankton

Annex 1. Phytoplankton of Lake Durowskie in July 2011 (A1- Aerator 1, A2 – Aerator 2).

	North	Inflow	A2	Middle 1	Middle 2	A1	Outflow	Beach	Frequency [%]
Cyanoprokaryota									
Chroococcus limneticus Lemm.				+	+				11
Chroococcus turgidus (Kütz.) Naeg.						+			4
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.		+							4
Limnothrix redekei (Van Goor) Meffert	+	+		+	+	+			21
Microcystis aeruginosa Kützing		+				+			7
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg		+							4
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+	+	+			36
Bacillariophyceae									
Achnanthes minutissima Kützing	+	+							7
Amphora ovalis Kützing	+					+			7
Asterionella formosa Hasall	+		+	+	+	+	+	+	79

Cocconeis placentula Ehr.						+			4
Cyclotella ocellata Pant.	+	+	+	+	+	+	+		46
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+	+	+	+		57
Cymbella affinis Kützing		+							4
Cymbella microcephala Grun.	+								4
Cymbella minuta Hilse ex Rabenhorst		+			+	+			11
Diatoma vulgare Bory						+			4
Fragilaria capucina (Desm.) Rabenhorst	+					+			7
Fragilaria crotonensis Kitton	+	+	+	+	+	+	+	+	89
Fragilaria pinnata Ehr.	+								4
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+	+	+			46
Fragilaria ulna var. angustissima Sippen	+								4
Gomphonema olivaceum (Horn.) Breb.		+							4
Gomphonema parvulum (Kütz.) Kütz.		+							4
Navicula radiosa Kützing	+	+	+			+			18
Nitzschia sinuata (W. Sm.) Grunow		+							4
Nitzschia palea (Kütz.) W. Smith	+	+							7
Nitzschia sigmoidea (Ehr.) W. Smith	+	+							7
Pinnularia viridis (Nitzsch) Ehr.		+							4
Chlorophyta									
Characium aqngustatum A. Braun		+				+			11
Chlamydomonas globosa Snow	+								4
Closterium acutum var. variabile (Lemm.) Krieg.						+			7
Coelastrum astroideum De Notaris	+				+	+			14
Cosmarium abbreviatum Raciborski	+	+				+			11
Cosmarium margaritatum (Turp.) Ralfs			+						4

Cosmarium phaseolus Brebisson in Ralfs	+					+			7
Desmodesmus communis (Hegew.) Hegew.		+	+	+	+	+			29
Desmodesmus grahneisii (Heynig) Fott							+		4
Dictyosphaerium pulchellum Wood	+					+			7
Didymocystis planctonica Korsikov	+				+				7
Elkatothrix gelatinosa Wille				+					4
Golenkinia radiata Chodat					+	+			7
Micractinium crassisetum Hortobagyi			+	+	+	+			32
Micractinium pusillum Fresenius						+			7
Monoraphidium contortum (Thur.) Kom.-Legn.		+		+		+			11
Nephrocytium limneticum (G. M. Sm.) G. M. Sm.	+								4
Oocystis lacustris Chodat	+	+	+		+	+			29
Palmelochette tenerrima Kors.					+				4
Pediastrum boryanum (Turpin) Meneg.	+		+	+	+	+			29
Pediastrum tetras (Ehr.) Ralfs						+			4
*Phacotus lenticularis (*Ehr.) Stein	+	+	+	+	+	+	+		46
Phacotus lendneri Chodat.									4
Scenedesmus bicaudatus Dedusenko	+								4
Scenedesmus ecornis (Ehr.) Chod.						+			7
Scenedesmus dimorphus (Turp.) Kütz.						+			4
Scenedesmus obtusus Meyen					+				4
Scenedesmus regularis Swirenko						+			4
Scenedesmus verucosus Roll	+					+			7
Sphaerocystis planctonica (Korsikov) Bourrelly	+	+	+	+	+	+	+		54
Tetraedron minimum (A. Br.) Hansgirg		+	+	+		+			14
Tetraedron triangulare (Chod.) Kom.		+							4
Tetrastrum glabrum (Roll) Ahlstr. et Tiff	+					+			7

Tetrastrum staurogeanieforme (Schroed.) Lemm.		+				+			11
Treubaria schmidlei (Schroeder) Fott et Kovacik								+	4
Mongeotia sp						+		+	7
Staurastrum gracile Ralfs	+		+	+	+	+			61
Cryptophyta									
Chroomonas acuta Uterm.						+		+	11
Cryptomonas erosa Ehrenberg	+	+	+	+	+	+	+		68
Cryptomonas marssonii Skuja			+	+	+	+			21
Cryptomonas ovata Ehrenberg	+	+			+	+			14
Cryptomonas rostrata Troitzskaja emend I. Kiselev		+	+	+	+	+			36
Rhodomonas minuta Skuja	+	+	+	+	+	+			29
Dinophyta									
Peridinopsis berolinense (Lemm.) Bourrelly			+	+	+	+		+	46
Ceratium hirundinella (F. B. Müller) Bergh			+	+	+	+			71
Gymnodinium aeruginosum Stein					+	+			11
Peridiniopsis cuningtonii Lemm.		+	+	+	+	+	+		46
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+	+	+	+		61
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	+	+	+	+	+	+			46
Euglenophyta									
Trachelomonas hispida (Perty) Stein					+	+			11
Trachelomonas volocina Ehrenberg	+	+	+						11
Trachelomonas planctonica Swirenko	+								4
Euglena pisciformis Klebs		+			+				7

Colacium vesiculosum Ehr.			+	+	+	+	+		61
Chrysophyceae									
Erkenia subaequiciliata Skuja						+			11
Dinobryon divergens Imhof	+	+	+	+	+	+	+		82
Chrysococcus rufescens Klebs					+	+		+	11
Dinobryon bavaricum Imhoff	+	+	+	+	+	+	+		4

Annex 2. Comparison of species taxa composition in difefrent investigated years in July in Lake Durowskie.

	2008	**2009**	**2010**	**2011**
Cyanoprokaryota				
Anabaena flos-aquae Brebisson		+		
Aphanizomenon aphanizomenoides (Forti) Hort. & Kom.	+			
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+
Aphanizomenon gracile Lemmerman	+			
Aphanizomenon isatschenkoi (Usacc.) Pros. - Lavrenko	+	+	+	
*Aphanocapsa grevillei (*Ber.) Rabenhorst		+		
Aphanocapsa incerta (Lemm.) Cronberg et Komarek	+	+	+	
*Arthrospira massartii*Kuff.		+		
Chroococcus limneticus Lemm.	+	+		+
Chroococcus turgidus (Kűtz.) Naeg.		+		+
Cyanogranis feruginea (Wawrik) Hind.		+	+	
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.			+	+
Limnothrix lauterbornii(Schmidle) Anagn.		+		

Limnothrix redekei (Van Goor) Meffert	+		+	+
Lyngbya hieronymusii Lemm.		+		
Microcystis aeruginosa Kützing	+			+
Microcystis flos-aquae (Wittrock) Kirchner			+	
Jaaginema gracile (Bocher) Anagn. et kom.		+		
Phormidium granulatum Gardn. Anagn.	+	+	+	
Phormidium tenue (Agards ex Gomont) Anagn. et kom.		+		
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg		+	+	+
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	+	+	+	+
Pseudanabaena limnetica (Lemm.) Kom.	+	+	+	
Spirulina laxissima (W. West)			+	
Bacillariophyceae				
Achnanthes exigua Grun.			+	
Achnanthes minutissima Kützing	+		+	+
Amphora ovalis Kützing	+	+	+	+
Amphora pediculus (Kütz.) Grun.			+	
Asterionella formosa Hasall		+		+
Cocconeis euglypta (Ehr.) Clevei	+			
Cocconeis placentula Ehr.	+		+	+
*Cyclotella atomus*Hustedt		+		
Cyclotella meneghiniana Kütz.	+	+	+	
Cyclotella ocellata Pant.	+		+	+
Cyclotella operculata (Ag.) Kützing	+	+	+	
Cyclotella radiosa (Grun.) Lemm.	+	+	+	+
Cymbella affinis Kützing				+
Cymbella microcephala Grun.				+
Cymbella minuta Hilse ex Rabenhorst	+		+	+

Diatoma vulgare Bory				+
Fragilaria capucina (Desm.) Rabenhorst				+
Fragilaria crotonensis Kitton	+	+		+
Fragilaria pinnata Ehr.	+			+
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+
Fragilaria ulna var. *angustissima* Sippen	+	+	+	+
Gomphonema olivaceum (Horn.) Breb.			+	+
Gomphonema parvulum (Kütz.) Kütz.				+
Melosira varians Ag.	+			
Navicula cincta (Ehr.) Ralfs	+	+	+	
Navicula mensiculus Schumann	+			
Navicula radiosa Kützing			+	+
Naviula sp.			+	
Nitzschia palea (Kütz.) W. Smith				+
Nitzschia sigmoidea (Ehr.) W. Smith				+
Nitzschia sinuata (W. Sm.) Grunow				+
Pinnularia viridis (Nitzsch) Ehr.				+
Placoneis gastrum(Ehr.) Meresch.		+		
*Staurosira construens*Ehr.		+		
Chlorophyta				
*Ankistrodesmus falcatus(*Corda) Ralfs		+		
Characium aqngustatum A. Braun		+		+
Chlamydomonas globosa Snow	+	+	+	+
Chlamydomonas passiva Skuja			+	
*Chlamydomonas reinchardtii*Dangeard		+		
Closterium acutum var. *variabile* (Lemm.) Krieg.	+		+	+
Coelasrum astroideum De Notaris			+	+
Coelastrum microporum Naegel.			+	

Coelastrum reticulatum (Dang.) Senn	+	+		
Cosmarium abbreviatum Raciborski	+		+	+
*Cosmarium exiguum*W. Archer		+		
Cosmarium margaritatum (Turp.) Ralfs				+
Cosmarium phaseolus Brebisson in Ralfs	+		+	+
Cosmarium regnellii Wille	+	+	+	
Crucigenia tetrapedia (Kirchner) W. et G.S. West			+	
Desmodesmus communis (Hegew.) Hegew.	+	+	+	+
Desmodesmus grahneisii (Heynig) Fott				+
Desmodesmus naegellii (Meyen) Hegew.			+	
Desmodesmus opoliensis (Rchter) Hegew.			+	
Desmodesmus subspicatus (Chod.) Hegew. et Schmidt	+		+	
Dictyosphaerium pulchellum Wood	+	+	+	+
Didymocystis planctonica Korsikov				+
Elkatothrix gelatinosa Wille			+	+
Golenkinia radiata Chodat	+		+	+
Kirchneriella contorta var. *elegans* (Schmidle) Bohlin	+			
Koliella longiseta (Vischer) Hindak	+			
Micractinium crassisetum Hortobagyi				+
Micractinium pusillum Fresenius				+
Mougeotia sp				+
Monoraphidium arcuatum (Kors.) Hindak	+			
Monoraphidium circinale (Nyg.) Nygaard	+			
Monoraphidium contortum (Thur.) Kom.-Legn.	+	+	+	+
Monoraphidium griffithii (Berk.) Kom.-Legn.	+		+	
Monoraphidium irregulare (G.M. Sm.) Kom.-Legn.	+		+	
Monoraphidium komarkovae Nygaard	+	+	+	
Monoraphidium minutum(Nageli) Kom. - Legn.		+		
Monoraphidium obtusum (Kors.)Kom. - Legn.	+			

Nephrocytium limneticum (G. M. Sm.) G. M. Sm.				+
Oocystis lacustris Chodat	+	+	+	+
Palmelochette tenerrima Kors.				+
Pandorina morum (O.F. Müller) Bory			+	
Pediastrum boryanum (Turpin) Meneg.			+	+
Pediastrum tetras (Ehr.) Ralfs			+	
Phacotus lendneri Chodat.				+
*Phacotus lenticularis (*Ehr.) Stein	+			+
Pteromonas angulosa (Carter) Lemm.		+	+	
Pteromonas angulosa (Carter) Lemm.			+	
Pteromonas cordiformis Lemm.			+	
Scenedesmus acuminatus (Lager.) Chodat			+	
Scenedesmus bicaudatus Dedusenko			+	+
Scenedesmus dimorphus (Turp.) Kütz.		+		+
Scenedesmus ecornis (Ehr.) Chod.			+	+
Scenedesmus obtusus Meyen				+
Scenedesmus regularis Swirenko		+		
Scenedesmus verucosus Roll				+
Sphaerocystis planctonica (Korsikov) Bourrelly				+
Staurastrum gracile Ralfs			+	+
Tetraedron caudatum (Corda) Hansgirg	+		+	
Tetraedron minimum (A. Br.) Hansgirg	+	+	+	+
Tetraedron triangulare (Chod.) Kom.	+	+		+
Tetrastrum glabrum (Roll) Ahlstr. et Tiff			+	+
Tetrastrum staurogeanieforme (Schroed.) Lemm.			+	+
Treubaria schmidlei (Schroeder) Fott et Kovacik		+	+	+
Cryptophyta				
Chroomonas acuta Uterm.	+			

Cryptomonas erosa Ehrenberg	+	+	+	+
*Cryptomonas gracilis*Skuja		+		
Cryptomonas marssonii Skuja	+	+	+	+
Cryptomonas ovata Ehrenberg	+	+	+	+
Cryptomonas rostrata Troitzskaja emend I. Kiselev	+		+	+
*Rhodomonas globosa*Skuja		+		
Rhodomonas minuta Skuja	+	+	+	+
Dinophyta				
Ceratium hirundinella (F. B. Müller) Bergh	+	+		+
Gymnodinium aeruginosum Stein	+			
Gymnodinium albulum Lindemann	+			
Peridiniopsis cuningtonii Lemm.	+	+	+	+
Peridinium cinctum (O.F. Müller) Ehrenberg	+	+	+	+
Peridinopsis berolinense (Lemm.) Bourrelly	+	+	+	+
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	+		+	+
Euglenophyta				
Colacium vesiculosum Ehr.		+		+
Euglena pisciformis Klebs		+		+
Phacus orbicularis Hubner	+	+		
Trachelomonas hispida (Perty) Stein	+		+	+
Trachelomonas planctonica Swirenko	+		+	+
Trachelomonas volocina Ehrenberg	+		+	+
Chrysophyceae				
Chrysococcus rufescens Klebs				+
Dinobryon bavaricum Imhoff		+	+	+
Dinobryon crenulatum W. et G.S. West		+	+	+

Dinobryon divergens Imhof		+	+	
Dinobryon sociale Ehrenberg	+		+	+
Erkenia subaequiciliata Skuja	+	+	+	

Annex 3. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 4 July 2011 (A1 – aerator 1, A2 – aerator 2)

	0m	0 m	0 m	1m	3m
	Aerator 1	The beach	Middle 2	Aerator 1	Aerator 1
	04.07.11	04.07.11	04.07.11	04.07.11	04.07.11
Cyanoprokaryota					
Chroococcus turgidus (Kűtz.) Naeg.	1				
Limnothrix redekei (Van Goor) Meffert	1				
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	1				
Bacillariophyceae					
Amphora ovalis Kützing	1				
Asterionella formosa Hasall	7200	800		49600	
Cocconeis placentula Ehr.	1				
Cyclotella ocellata Pant.	1				
Cyclotella radiosa (Grun.) Lemm.			3200	12800	88000
Diatoma vulgare Bory	1				
Fragilaria capucina (Desm.) Rabenhorst	1				
Fragilaria crotonensis Kitton	4000	4000	4800	40000	7200
Fragilaria ulna (Nitzsch) Lange-Bertalot	800				
Navicula radiosa Kützing	1				800
Chlorophyta					

Characium aqngustatum A. Braun	1				
Closterium acutum var. *variabile* (Lemm.) Krieg.	1				
Coelastrum astroideum De Notaris	1			800	
Cosmarium abbreviatum Raciborski	1				
Desmodesmus communis (Hegew.) Hegew.	1				800
Dictyosphaerium pulchellum Wood	1				
Golenkinia radiata Chodat				800	
Micractinium crassisetum Hortobagyi	1				
Oocystis lacustris Chodat	800			4000	
Pediastrum boryanum (Turpin) Meneg.				800	
Pediastrum tetras (Ehr.) Ralfs				4800	
*Phacotus lenticularis (*Ehr.) Stein	1				
Phacotus lendneri Chodat.	1				
Scenedesmus ecornis (Ehr.) Chod.	2400			7200	
Scenedesmus dimorphus (Turp.) Kütz.	1				
Scenedesmus regularis Swirenko	1				
Scenedesmus verucosus Roll	1				
Sphaerocystis planctonica (Korsikov) Bourrelly	1				800
Tetrastrum glabrum (Roll) Ahlstr. et Tiff	1				
Treubaria schmidlei (Schroeder) Fott et Kovacik		2400			
Mongeotia sp		800		2400	
Staurastrum gracile Ralfs	1				
Cryptophyta					
Chroomonas acuta Uterm.		2400	6400	54400	
Cryptomonas erosa Ehrenberg	2400			7200	
Cryptomonas ovata Ehrenberg	800				
Cryptomonas rostrata Troitzskaja emend I. Kiselev	800			4000	20000
Rhodomonas minuta Skuja					1600

Dinophyta					
Peridinopsis berolinense (Lemm.) Bourrelly	800	1600			
Ceratium hirundinella (F. B. Müller) Bergh	1			3200	
Gymnodinium aeruginosum Stein	2400		1600	1600	
Peridiniopsis cuningtonii Lemm.	1				
Peridinium cinctum (O.F. Müller) Ehrenberg	1				800
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	1				
Euglenophyta					
Colacium vesiculosum Ehr.	1				
Chrysophyceae	6400			7200	12000
Dinobryon sociale Ehrenberg	4000	3200	3200		
Dinobryon divergens Imhof				53600	

Annex 4. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 5 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle2	A1
	05.07.11	05.07.11	5.07.11	05.07.11
Cyanoprokaryota				
Aphanizomenon flos-aquae (L.) Ralfs		1600		2400
Limnothrix redekei (Van Goor) Meffert		1600		
Microcystis aeruginosa Kützing				524
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.		1600		800

Bacillariophyceae				
Asterionella formosa Hasall	148800		140800	63200
Cyclotella ocellata Pant.	800	800		2400
Cyclotella radiosa (Grun.) Lemm.	800			4800
Cymbella minuta Hilse ex Rabenhorst				800
Fragilaria crotonensis Kitton	144800		101600	21600
Fragilaria ulna (Nitzsch) Lange-Bertalot	1600	24000	2400	8800
Chlorophyta				
Characium aqngustatum A. Braun				6400
Cosmarium phaseolus Brebisson in Ralfs				800
Desmodesmus communis (Hegew.) Hegew.	800			
Micractinium crassisetum Hortobagyi	1600			
Monoraphidium contortum (Thur.) Kom.-Legn.		800		
Oocystis lacustris Chodat			800	
Pediastrum boryanum (Turpin) Meneg.			800	2400
*Phacotus lenticularis (*Ehr.) Stein	1600			1600
Scenedesmus obtusus Meyen			800	
Sphaerocystis planctonica (Korsikov) Bourrelly	800	800		800
Staurastrum gracile Ralfs	6400		5600	2400
Cryptophyta				
Cryptomonas erosa Ehrenberg	6400			1600
Cryptomonas marssonii Skuja				1600
Cryptomonas rostrata Troitzskaja emend I. Kiselev		1600		
Rhodomonas minuta Skuja	800			
Dinophyta				

Peridinopsis berolinense (Lemm.) Bourrelly		800	4000	3200
Ceratium hirundinella (F. B. Müller) Bergh	3600		11200	16000
Peridiniopsis cuningtonii Lemm.	800	800	7200	5600
Peridinium cinctum (O.F. Müller) Ehrenberg	800		800	21840
Euglenophyta				
Colacium vesiculosum Ehr.	8800		1053	12800
Chrysophyceae				
Erkenia subaequiciliata Skuja				1600
Dinobryon divergens Imhof	852800		253600	131200

Annex 5. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 6 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	0m	1m	0m
	Middle 1	Middle 2	A1	A1	Outflow
	06.07.11	06.07.11	06.07.11	06.07.11	06.07.11
Cyanoprokaryota					
Chroococcus limneticus Lemm.		800			
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	4800			1600	
Bacillariophyceae					
Asterionella formosa Hasall	22400	101600	117600	36800	18400
Cyclotella ocellata Pant.		800	1600		800
Cyclotella radiosa (Grun.) Lemm.		5600	7600		8000
Fragilaria crotonensis Kitton	4000	286400	40000	112800	42400
Fragilaria ulna (Nitzsch) Lange-Bertalot	14400				

Chlorophyta					
Desmodesmus grahneisii (Heynig) Fott					1600
Micractinium crassisetum Hortobagyi	3200		4000		
Micractinium pusillum Fresenius				800	
Monoraphidium contortum (Thur.) Kom.-Legn.			1600		
Oocystis lacustris Chodat			2400		
*Phacotus lenticularis (*Ehr.) Stein				800	3200
Sphaerocystis planctonica (Korsikov) Bourrelly	2400		1600		20800
Tetraedron minimum (A. Br.) Hansgirg			800		
Tetrastrum staurogeanieforme (Schroed.) Lemm.			2400		
Staurastrum gracile Ralfs		11200	800	800	
Cryptophyta					
Cryptomonas erosa Ehrenberg	800	5600	6400	800	4800
Cryptomonas marssonii Skuja	4000	800	21600		
Cryptomonas rostrata Troitzskaja emend I. Kiselev	3200		12000		
Rhodomonas minuta Skuja			6000		
Dinophyta					
Peridinopsis berolinense (Lemm.) Bourrelly	7200	2400	3200		
Ceratium hirundinella (F. B. Müller) Bergh	4000	4500	5600	7200	
Peridiniopsis cuningtonii Lemm.	7200		2400		800
Peridinium cinctum (O.F. Müller) Ehrenberg			16800	8800	9600
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly		800	2000		
Euglenophyta					
Trachelomonas hispida (Perty) Stein				800	
Colacium vesiculosum Ehr.		44000	38800	19200	2853600

Chrysophyceae					
Erkenia subaequiciliata Skuja					1600
Dinobryon divergens Imhof	68800	58400	548400	662400	490400

Annex 6. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 7 July 2011 (A1 – aerator 1, A2 – aerator 2)

	0m	0m	1m	1m	1m	1m
	Inflow	North	A2	Middle 1	Middle 2	A1
	07.07.11	07.07.11	07.07.11	07.07.11	07.07.11	07.07.11
Cyanoprokaryota						
Aphanizomenon flos-aquae (L.) Ralfs	3840	3200				7040
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.	10240					10240
Limnothrix redekei (Van Goor) Meffert	744960	424000		800		1169760
Microcystis aeruginosa Kützing	20480					20480
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	7680					7680
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	151040	59200		2400		212640
Bacillariophyceae						
Achnanthes minutissima Kützing	24320	1600				
Amphora ovalis Kützing		1				
Asterionella formosa Hasall		184000		29600	49600	76000
Cyclotella ocellata Pant.	2560	1600				
Cyclotella radiosa (Grun.) Lemm.	6400	1600	3200		800	
Cymbella affinis Kützing	1280					
Cymbella microcephala Grun.		1				
Cymbella minuta Hilse ex Rabenhorst	1280					

Fragilaria capucina (Desm.) Rabenhorst		1600				
Fragilaria crotonensis Kitton	1	44800	8800	20000	169600	171200
Fragilaria pinnata Ehr.		67200				
Fragilaria ulna (Nitzsch) Lange-Bertalot	2560	6400	2400	1600		
Fragilaria ulna var. *angustissima* Sippen		1600				
Gomphonema olivaceum (Horn.) Breb.	1280					
Gomphonema parvulum (Kütz.) Kütz.	1280					
Navicula radiosa Kützing	1	1600	800			
Nitzschia sinuata (W. Sm.) Grunow	2560					
Nitzschia palea (Kütz.) W. Smith	3840	1600				
Nitzschia sigmoidea (Ehr.) W. Smith	1	1600				
Pinnularia viridis (Nitzsch) Ehr.	1					
Chlorophyta						
Characium aqngustatum A. Braun	1280					
Chlamydomonas globosa Snow		4800				
Coelastrum astroideum De Notaris		1600				
Cosmarium abbreviatum Raciborski	1280	1				
Cosmarium phaseolus Brebisson in Ralfs		1				
Desmodesmus communis (Hegew.) Hegew.	2560					
Dictyosphaerium pulchellum Wood		6400				
Didymocystis planctonica Korsikov		1600				
Micractinium crassisetum Hortobagyi					1600	8600
Monoraphidium contortum (Thur.) Kom.-Legn.	2560					
Nephrocytium limneticum (G. M. Sm.) G. M. Sm.		1				
Oocystis lacustris Chodat	1280	9600	800			
Pediastrum boryanum (Turpin) Meneg.		1600		5600	800	
*Phacotus lenticularis (*Ehr.) Stein	3840	8000				
Scenedesmus bicaudatus Dedusenko		1				

Scenedesmus verucosus Roll		6400				
Sphaerocystis planctonica (Korsikov) Bourrelly	6400	4800		2400	800	
Tetraedron minimum (A. Br.) Hansgirg	2560		800			
Tetraedron triangulare (Chod.) Kom.	1280					
Tetrastrum glabrum (Roll) Ahlstr. et Tiff		1600				
Tetrastrum staurogeanieforme (Schroed.) Lemm.	1280					
Staurastrum gracile Ralfs		6400		2400	800	2400
Cryptophyta						
Cryptomonas erosa Ehrenberg	3840	1600	4000			9440
Cryptomonas marssonii Skuja			1600			1600
Cryptomonas ovata Ehrenberg	1280	1				1281
Cryptomonas rostrata Troitzskaja emend I. Kiselev	2560		4000			6560
Rhodomonas minuta Skuja	11520	6400	2400			20320
Dinophyta						
Peridinopsis berolinense (Lemm.) Bourrelly					800	
Ceratium hirundinella (F. B. Müller) Bergh			4800	14400	12800	12000
Peridiniopsis cuningtonii Lemm.	1					
Peridinium cinctum (O.F. Müller) Ehrenberg	1	1			9600	7200
Peridinium willei Huitfeld-Kaas						
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	1280	1600	2400		2400	
Euglenophyta						
Trachelomonas volocina Ehrenberg	1280	6400				
Trachelomonas planctonica Swirenko		1600				
Euglena pisciformis Klebs	2560					
Colacium vesiculosum Ehr.			20800	140000		18400

Chrysophyceae						
Erkenia subaequiciliata Skuja	145920	73600				
Dinobryon divergens Imhof	62720	3486400	444800	2240800	1077600	820000
Chrysococcus rufescens Klebs	2560					
Dinobryon bavaricum Imhoff		1600				

Annex 7. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 8 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle 2	A1
	08.07.11	08.07.11	08.07.11	08.07.11
Cyanoprokaryota				
Limnothrix redekei (Van Goor) Meffert			800	
Bacillariophyceae				
Asterionella formosa Hasall	6400	13600		11400
Cyclotella ocellata Pant.			800	
Cyclotella radiosa (Grun.) Lemm.				3200
Cymbella minuta Hilse ex Rabenhorst			800	
Fragilaria crotonensis Kitton		76800	1200	42400
Fragilaria ulna (Nitzsch) Lange-Bertalot			800	4000
Chlorophyta				
Desmodesmus communis (Hegew.) Hegew.			800	4000
Oocystis lacustris Chodat	800			
Palmelochette tenerrima Kors.			1600	
*Phacotus lenticularis (*Ehr.) Stein	800	800		6400
Sphaerocystis planctonica (Korsikov) Bourrelly				6400

Tetrastrum staurogeanieforme (Schroed.) Lemm.				3200
Staurastrum gracile Ralfs	800			6400
Cryptophyta				
Cryptomonas erosa Ehrenberg	1600	800	1600	6400
Cryptomonas rostrata Troitzskaja emend I. Kiselev				4800
Dinophyta				
Peridinopsis berolinense (Lemm.) Bourrelly			5600	1600
Ceratium hirundinella (F. B. Müller) Bergh		1600	8000	22400
Peridiniopsis cuningtonii Lemm.	1600		16000	3200
Peridinium cinctum (O.F. Müller) Ehrenberg			1600	800
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	800		16800	3200
Euglenophyta				
Trachelomonas hispida (Perty) Stein			2400	5600
Colacium vesiculosum Ehr.		57600		5600
Chrysophyceae				
Erkenia subaequiciliata Skuja	800			
Dinobryon divergens Imhof	474400	1057600	631200	335200

Annex 8. Number of phytoplankton species cells (ind./L) from Lake Durowskie in the 9 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle 2	A1
	09.07.11	09.07.11	09.07.11	09.07.11
Cyanoprokaryota				
Chroococcus limneticus Lemm.		1600	800	2400
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	1600		2400	4000
Bacillariophyceae				
Asterionella formosa Hasall	14400	30400	12800	44000
Cyclotella ocellata Pant.	800		1600	800
Cyclotella radiosa (Grun.) Lemm.	2400	3200	3200	
Fragilaria crotonensis Kitton	146400		97600	2400
Fragilaria ulna (Nitzsch) Lange-Bertalot			1600	
Chlorophyta				
Closterium acutum var. *variabile* (Lemm.) Krieg.				800
Coelastrum astroideum De Notaris			800	
Cosmarium margaritatum (Turp.) Ralfs	1600			
Desmodesmus communis (Hegew.) Hegew.	1600	800		
Didymocystis planctonica Korsikov			800	
Elkatothrix gelatinosa Wille		1600		
Golenkinia radiata Chodat			4000	
Micractinium crassisetum Hortobagyi	800	5600	4000	
Micractinium pusillum Fresenius				20800
Pediastrum boryanum (Turpin) Meneg.	800	800		
*Phacotus lenticularis (*Ehr.) Stein	6400	4000	11200	

Sphaerocystis planctonica (Korsikov) Bourrelly	4000		800	
Tetraedron minimum (A. Br.) Hansgirg		800		
Staurastrum gracile Ralfs	800	800	2400	4800
Cryptophyta				
Chroomonas acuta Uterm.				
Cryptomonas erosa Ehrenberg	9600	1600	16000	
Cryptomonas marssonii Skuja			2400	
Cryptomonas ovata Ehrenberg			13600	
Cryptomonas rostrata Troitzskaja emend I. Kiselev			16000	
Rhodomonas minuta Skuja		6400	2400	
Dinophyta				
Peridinopsis berolinense (Lemm.) Bourrelly	800	800		
Ceratium hirundinella (F. B. Müller) Bergh	35200	3200	30400	14400
Peridiniopsis cuningtonii Lemm.			3200	
Peridinium cinctum (O.F. Müller) Ehrenberg	9600	6400	34400	
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	800	800		800
Euglenophyta				
Trachelomonas volocina Ehrenberg	800			
Euglena pisciformis Klebs			16000	
Colacium vesiculosum Ehr.	48000	23200	3600	1600
Chrysophyceae				
Erkenia subaequiciliata Skuja		2400	16000	
Dinobryon divergens Imhof	3285600	3899200	1001600	1724000

Annex 9. Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 4 July 2011

	0m	0m	0m	1m	3m
	Aerator 1	Beach	Middle 2	Aerator 1	Aerator 1
	04.07.11	04.07.11	04.07.11	04.07.11	04.07.11
Cyanoprokaryota					
Chroococcus limneticus Lemm.	0,0001				
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.	0,0001				
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	0,0001				
Bacillariophyceae					
Amphora ovalis Kützing	0,0001				
Asterionella formosa Hasall	0,002	0,00033		0,02	
Cocconeis placentula Ehr.	0,0001				
Cyclotella ocellata Pant.	0,0001				
Cyclotella radiosa (Grun.) Lemm.			0,004	0,016	0,011
Diatoma vulgare Bory	0,0001				
Fragilaria capucina (Desm.) Rabenhorst	0,0001				
Fragilaria crotonensis Kitton	0,004	0,0044	0,0053	0,044	0,0098
Fragilaria ulna (Nitzsch) Lange-Bertalot	0,001				
Navicula radiosa Kützing	0,0001				
Naviula sp.					0,00198
Chlorophyta					
Characium aqngustatum A. Braun	0,0001				
Closterium acutum var. *variabile* (Lemm.) Krieg.	0,0001				
Coelastrum astroideum De Notaris	0,0001			0,002	
Cosmarium abbreviatum Raciborski	0,0001				
Desmodesmus communis (Hegew.) Hegew.	0,0001			0,00071	

				2	
Dictyosphaerium pulchellum Wood	0,0001				
Golenkinia radiata Chodat				0,0003	
Micractinium crassisetum Hortobagyi	0,0001				
Oocystis lacustris Chodat	0,002			0,01	
Pediastrum boryanum (Turpin) Meneg.				0,023	
*Phacotus lenticularis (*Ehr.) Stein	0,0001			0,003	
Phacotus lendneri Chodat.	0,0001				
Scenedesmus obtusus Meyen	0,0001				
Scenedesmus verucosus Roll	0,0001				
Sphaerocystis planctonica (Korsikov) Bourrelly	0,005			0,016	0,00182
Tetraedron caudatum (Corda) Hansgirg	0,0001				
Tetrastrum staurogeanieforme (Schroed.) Lemm.	0,0001				
Mongeotia sp		0,005			
Staurastrum gracile Ralfs		0,002		0,006	
Cryptophyta	0,0001				
Cryptomonas erosa Ehrenberg		0,0039	0,01	0,088	
Cryptomonas marssonii Skuja	0,003			0,002	
Cryptomonas rostrata Troitzskaja emend I. Kiselev	0,001				0,042
Rhodomonas minuta Skuja	0,0005			0,002	0,00113
Dinophyta					
Ceratium hirundinella (F. B. Müller) Bergh	0,077	0,15		0,309	
Gymnodinium albulum Lindemann	0,0001				
Peridiniopsis cuningtonii Lemm.	0,278		0,019	0,018	
Peridinium cinctum (O.F. Müller) Ehrenberg	0,0001				0,017
Peridinium willei Huitfeld-Kaas	0,0001				
	0,0001				

Euglenophyta					
Euglena limnophila Lemm.	0,0001				
Chrysophyceae					
Erkenia subaequiciliata Skuja	0,0003			0,0004	0,0007
Dinobryon sociale Ehrenberg		0,0015	0,0015		
Dinobryon divergens Imhof	0,001			0,024	

Annex 10. Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 5 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle 2	A1
	05.07.11	05.07.11	05.07.11	05.07.11
Cyanoprokaryota				
Aphanizomenon flos-aquae (L.) Ralfs		0,0031		0,004
Limnothrix redekei (Van Goor) Meffert		0,0005		
Microcystis aeruginosa Kützing				0,002
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.		0,002		0,001
Bacillariophyceae				
Asterionella formosa Hasall	9,06		0,575	0,025
Cyclotella ocellata Pant.	0,001	0,0008		0,002
Cyclotella radiosa (Grun.) Lemm.	0,001			0,005
Cymbella minuta Hilse ex Rabenhorst				0,001
Fragilaria crotonensis Kitton	0,159		0,111	0,023
Fragilaria ulna (Nitzsch) Lange-Bertalot	0,002	0,033	0,003	0,012

Chlorophyta				
Characium aqngustatum A. Braun				0,006
Cosmarium margaritatum (Turp.) Ralfs				0,003
Desmodesmus communis (Hegew.) Hegew.	0,001			
Micractinium crassisetum Hortobagyi	0,004			
Monoraphidium contortum (Thur.) Kom.-Legn.		0,00014		
Oocystis lacustris Chodat			0,002	
Pediastrum boryanum (Turpin) Meneg.			0,235	0,07
*Phacotus lenticularis (*Ehr.) Stein	0,001			0,001
Scenedesmus obtusus Meyen			0,001	
Sphaerocystis planctonica (Korsikov) Bourrelly	0,003	0,0018		0,001
Staurastrum gracile Ralfs	0,016		0,144	0,001
Cryptophyta				
Cryptomonas erosa Ehrenberg	0,01			0,002
Cryptomonas marssonii Skuja				0,002
Cryptomonas rostrata Troitzskaja emend I. Kiselev		0,003		
Rhodomonas minuta Skuja	0,001			
Dinophyta				
Peridinopsis berolinense (Lemm.) Bourrelly		0,007	0,368	0,029
Ceratium hirundinella (F. B. Müller) Bergh	0,542		10,834	1,5
Peridiniopsis cuningtonii Lemm.	0,009	0,009	0,832	0,064
Peridinium cinctum (O.F. Müller) Ehrenberg	0,017		0,017	1,22
Euglenophyta				
Colacium vesiculosum Ehr.	0,004		0,001	0,013
Chrysophyceae				

Erkenia subaequiciliata Skuja				0,001
Dinobryon divergens Imhof	0,389		0,115	0,059

Annex 11. Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 6 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	0m	1m	1m
	Middle 1	Middle 2	A1	A1	Outflow
	06.07.11	06.07.11	06.07.11	06.07.11	06.07.11
Cyanoprokaryota					
Chroococcus limneticus Lemm.		0,0001			
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	0,006			0,002	
Bacillariophyceae					
Asterionella formosa Hasall	0,009	2,28	1,0155	0,015	0,412
Cyclotella ocellata Pant.		0,001	0,002		0,0008
Cyclotella radiosa (Grun.) Lemm.		0,007	0,0095		0,01
Fragilaria crotonensis Kitton	0,004	0,32	0,177	0,124	0,047
Fragilaria ulna (Nitzsch) Lange-Bertalot	0,002				
Chlorophyta					
Desmodesmus grahneisii (Heynig) Fott					0,001
Micractinium crassisetum Hortobagyi	0,008		0,01		
Micractinium pusillum Fresenius				0,002	
Monoraphidium contortum (Thur.) Kom.-Legn.			0,0003		

Oocystis lacustris Chodat			0,006		
*Phacotus lenticularis (*Ehr.) Stein				0,001	0,003
Sphaerocystis planctonica (Korsikov) Bourrelly	0,055		0,003		0,047
Tetraedron minimum (A. Br.) Hansgirg			0,0001		
Tetrastrum staurogeanieforme (Schroed.) Lemm.			0,0004		
Staurastrum gracile Ralfs		0,03		0,002	
Cryptophyta					
Cryptomonas erosa Ehrenberg	0,001	0,009	0,01	0,001	0,008
Cryptomonas marssonii Skuja	0,005	0,001	0,0275		
Cryptomonas rostrata Troitzskaja emend I. Kiselev	0,007		0,025		
Rhodomonas minuta Skuja	0,003		0,004		
Dinophyta					
Peridinopsis berolinense (Lemm.) Bourrelly	0,066	0,02	0,029		
Ceratium hirundinella (F. B. Müller) Bergh		0,4	0,542	0,697	
Peridiniopsis cuningtonii Lemm.	0,083		0,111		0,009
Peridinium cinctum (O.F. Müller) Ehrenberg			0,3669	0,192	0,21
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly		0,006	0,0158		
Euglenophyta					
Trachelomonas hispida (Perty) Stein				0,008	
Colacium vesiculosum Ehr.		0,031	0,0215	0,014	2
Chrysophyceae					
Erkenia subaequiciliata Skuja					0,001
Dinobryon divergens Imhof	0,031	0,3	0,25	0,302	0,224

Annex 12. Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 7 July 2011 (A1 – aerator 1, A2 – aerator 2)

	0m	0m	1m	1m	1m	1m
	Inflow	North	A2	Middle 1	Middle 2	A1
	07.07.11	07.07.11	07.07.11	07.07.11	07.07.11	07.07.11
Cyanoprokaryota						
Aphanizomenon flos-aquae (L.) Ralfs	0,008	0,006				
Jaaginema pseudogeminatum (Schmid) Anagn. et Kom.	0,003					
Limnothrix redekei (Van Goor) Meffert	0,234	0,133		0,0025		
Microcystis aeruginosa Kützing	0,011					
Planktolyngbya limnetica (Lemm.) Kom. – Legn. Et Cronenberg	0,002					
Planktothrix agardhii (D.C. ex Gom.) Anagn. et Kom.	0,189	0,074		0,003		
Bacillariophyceae						
Achnanthes minutissima Kützing	0,007	0,001				
Amphora ovalis Kützing		0,0001				
Asterionella formosa Hasall		0,075		0,012	0,02	0,031
Cyclotella ocellata Pant.	0,001	0,0004				
Cyclotella radiosa (Grun.) Lemm.	0,008	0,002	0,004		0,001	
Cymbella affinis Kützing	0,007					
Cymbella microcephala Grun.		0,0001				
Cymbella minuta Hilse ex Rabenhorst	0,002					
Fragilaria capucina (Desm.) Rabenhorst		0,003				
Fragilaria crotonensis Kitton	0,0001	0,049	0,01	0,02	0,186	0,188
Fragilaria pinnata Ehr.		0,032				
Fragilaria ulna (Nitzsch) Lange-Bertalot	0,003	0,009	0,003	0,002		
Fragilaria ulna var. *angustissima* Sippen		0,004				

Gomphonema olivaceum (Horn.) Breb.	0,001					
Gomphonema parvulum (Kütz.) Kütz.	0,001					
Naviula sp.	0,0001	0,004	0,002			
Nitzschia sinuata (W. Sm.) Grunow	0,001					
Nitzschia palea (Kütz.) W. Smith	0,002	0,001				
Nitzschia sigmoidea (Ehr.) W. Smith	0,0001	0,017				
Pinnularia viridis (Nitzsch) Ehr.	0,0001					
Chlorophyta						
Characium aqngustatum A. Braun	0,001					
Chlamydomonas globosa Snow		0,001				
Coelastrum astroideum De Notaris		0,004				
Cosmarium abbreviatum Raciborski	0,001	0,0001				
Cosmarium phaseolus Brebisson in Ralfs		0,0001				
Desmodesmus communis (Hegew.) Hegew.	0,001					
Dictyosphaerium pulchellum Wood		0,031				
Didymocystis planctonica Korsikov		0,001				
Micractinium crassisetum Hortobagyi					0,004	0,004
Monoraphidium contortum (Thur.) Kom.-Legn.	0,001					
Nephrocytium limneticum (G. M. Sm.) G. M. Sm.		0,0001				
Oocystis lacustris Chodat	0,003	0,025	0,002			
Pediastrum boryanum (Turpin) Meneg.		0,047		0,165	0,023	
*Phacotus lenticularis (*Ehr.) Stein	0,003	0,006				
Scenedesmus bicaudatus Dedusenko		0,0001				
Scenedesmus verucosus Roll		0,008				
Sphaerocystis planctonica (Korsikov) Bourrelly	0,015	0,011		0,006	0,001	
Tetraedron minimum (A. Br.) Hansgirg	0,001		0,0001			
Tetraedron triangulare (Chod.) Kom.	0,001					
Tetrastrum glabrum (Roll) Ahlstr. et Tiff		0,001				

Tetrastrum staurogeanieforme (Schroed.) Lemm.	0,001					
Staurastrum gracile Ralfs		0,015		0,0062	0,002	0,006
Cryptophyta						
Cryptomonas erosa Ehrenberg	0,006	0,003	0,006			
Cryptomonas marssonii Skuja			0,002			
Cryptomonas ovata Ehrenberg	0,003	0,001				
Cryptomonas rostrata Troitzskaja emend I. Kiselev	0,006		0,008			
Rhodomonas minuta Skuja	0,008	0,005	0,002			
Dinophyta						
Peridinopsis berolinense (Lemm.) Bourrelly					0,007	
Ceratium hirundinella (F. B. Müller) Bergh			0,464	1,39	1,238	1,161
Peridiniopsis cuningtonii Lemm.	0,0001					
Peridinium cinctum (O.F. Müller) Ehrenberg	0,0001	0,0001			0,209	0,157
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	0,01	0,013	0,019		0,019	
Euglenophyta						
Trachelomonas volocina Ehrenberg	0,001	0,005				
Trachelomonas planctonica Swirenko		0,002				
Euglena pisciformis Klebs	0,01					
Colacium vesiculosum Ehr.			0,015	0,098		0,013
Chrysophyceae						
Erkenia subaequiciliata Skuja	0,009	0,0004				
Dinobryon divergens Imhof	0,019	1,08	0,203	2,34	0,491	0,674
Chrysococcus rufescens Klebs	0,002					
Dinobryon bavaricum Imhoff		0,001				

Annex 13 . Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 8 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle 2	A1
	08.07.11	08.07.11	08.07.11	08.07.11
Cyanoprokaryota				
Limnothrix redekei (Van Goor) Meffert			0,0002	
Bacillariophyceae				
Asterionella formosa Hasall	0,002	0,006		0,006
Cyclotella ocellata Pant.			0,001	
Cyclotella radiosa (Grun.) Lemm.				0,004
Cymbella minuta Hilse ex Rabenhorst			0,001	
Fragilaria crotonensis Kitton		0,084	0,001	0,047
Fragilaria ulna (Nitzsch) Lange-Bertalot			0,011	0,005
Chlorophyta				
Desmodesmus communis (Hegew.) Hegew.			0,001	0,003
Oocystis lacustris Chodat	0,002			
Palmelochette tenerrima Kors.			0,004	
*Phacotus lenticularis (*Ehr.) Stein	0,0006	0,0006		0,005
Sphaerocystis planctonica (Korsikov) Bourrelly				0,015
Tetrastrum staurogeanieforme (Schroed.) Lemm.				0,0001
Staurastrum gracile Ralfs	0,002			0,016
Cryptophyta				
Cryptomonas erosa Ehrenberg	0,002	0,001	0,003	0,01
Cryptomonas rostrata Troitzskaja emend I. Kiselev				0,01

Dinophyta				
Peridinopsis berolinense (Lemm.) Bourrelly			0,052	0,015
Ceratium hirundinella (F. B. Müller) Bergh		0,155	0,774	2,167
Peridiniopsis cuningtonii Lemm.	0,018		0,185	0,37
Peridinium cinctum (O.F. Müller) Ehrenberg			0,035	0,017
Peridinopsis elpatiewskyi (Ostenf.) Bourrelly	0,006		0,134	0,026
Euglenophyta				
Trachelomonas hispida (Perty) Stein			0,003	0,006
Colacium vesiculosum Ehr.		0,041		0,032
Chrysophyceae				
Erkenia subaequiciliata Skuja	0,00004			
Dinobryon divergens Imhof	0,216	0,482	0,288	0,153

Annex 14. Biomass of phytoplankton species (mg/L) from Lake Durowskie in the 9 July 2011 (A1 – aerator 1, A2 – aerator 2)

	1m	1m	1m	1m
	A2	Middle 1	Middle 2	A1
	09,07,11	09,07,11	09,07,11	09,07,11
Cyanoprokaryota				
Chroococcus limneticus Lemm,		0,0001	0,00005	
Planktothrix agardhii (D,C, ex Gom,) Anagn, et Kom,	0,002		0,003	
Bacillariophyceae				

Asterionella formosa Hasall	0,006	0,01	0,005	0,018
Cyclotella ocellata Pant,	0,001		0,002	0,0008
Cyclotella radiosa (Grun,) Lemm,	0,003	0,004	0,004	
Fragilaria crotonensis Kitton	0,161		0,0107	0,007
Fragilaria ulna (Nitzsch) Lange-Bertalot			0,002	
Chlorophyta				
Closterium acutum var, *variabile* (Lemm,) Krieg,				0,0003
Coelastrum astroideum De Notaris			0,002	
Cosmarium phaseolus Brebisson in Ralfs	0,008			
Desmodesmus communis (Hegew,) Hegew,	0,001	0,0007		
Didymocystis planctonica Korsikov			0,00007	
Elkatothrix gelatinosa Wille		0,002		
Golenkinia radiata Chodat			0,002	
Micractinium crassisetum Hortobagyi	0,002	0,014	0,010	0,053
Pediastrum boryanum (Turpin) Meneg,	0,023	0,024		
*Phacotus lenticularis (*Ehr,) Stein	0,005	0,003	0,009	
Sphaerocystis planctonica (Korsikov) Bourrelly	0,009		0,002	
Tetraedron minimum (A, Br,) Hansgirg		0,00009		
Staurastrum gracile Ralfs	0,002	0,002	0,006	0,012
Cryptophyta				
Cryptomonas erosa Ehrenberg	0,016	0,002	0,025	
Cryptomonas marssonii Skuja			0,003	
Cryptomonas ovata Ehrenberg			0,027	
Cryptomonas rostrata Troitzskaja emend I, Kiselev			0,033	
Rhodomonas minuta Skuja		0,004	0,001	
Dinophyta				

Peridinopsis berolinense (Lemm,) Bourrelly	0,007	0,007		
Ceratium hirundinella (F, B, Müller) Bergh	3,405	0,309	2,940	1,393
Peridiniopsis cuningtonii Lemm,			0,037	
Peridinium cinctum (O,F, Müller) Ehrenberg	0,21	0,139	0,751	
Peridinopsis elpatiewskyi (Ostenf,) Bourrelly	0,006	0,006		0,006
Euglenophyta				
Euglena pisciformis Klebs			0,062	
Colacium vesiculosum Ehr,	0,004	0,164	0,025	0,001
Chrysophyceae				
Erkenia subaequiciliata Skuja		0,0001	0,0009	
Dinobryon divergens Imhof	1,489	1,778	0,456	1,806

PERIPHYTON

Annex 15. Comparing diatoms taxa represented by the large cell numbers in periphyton communities of individual research stations in the littoral of Lake Durowskie in July 2011 (% oxygen according Van Dam et al (q004) ecological scale for diatoms).

		1	2	3	4	North-west	North	5
% oxygen		04.07.11	05.07.11	06.07.11	07.07.11	07.07.11	07.07.11	08.07.11
	Achnanthes lanceolata v. elliptica Cleve sensu Straub		+					
	Achnanthes lanceolta var. rostrata (Oestrup) Hustedt		+					
	Achanthes minutissima var. gracillima (Meister) Lange-Bert.				+	+	+	+
	Cocconeis placentula var. pseudolineata Geitler	+						
	Cyclotella steligera Cl. et Grun.	+				+		
	Encyonema minutum (Hilse ex Raben.) D. G. Mann	+	+	+	+	+		+
	Eunotia arcus Ehr.						+	
	Fragilaria capucina (Desm.) Rabenhorst	+	+	+	+	+	+	+

	Nitzschia denticula Grunow	+						
100	*Achnanthes exigua* Grun.	+	+		+	+	+	+
100	*Achnanthes minutissima* Kützing	+		+	+	+	+	+
100	*Achnanthes minutissima var. affinis* (Grun.) Lange-Bertalot		+			+		
100	*Cyclotella ocellata* Pant.	+		+	+	+	+	+
100	*Cyclotella operculata* (Ag.) Kützing		+		+	+	+	+
100	*Cymbella affinis* Kützing		+		+			+
100	*Cymbella microcephala* Grun.	+		+	+	+		+
100	*Eunotia praerupta* Ehr.	+		+	+	+	+	+
100	*Eunotia tenella* (Grun.) Hustedt						+	
100	*Fragilaria construens* (Ehr.) Grun.				+			+
100	*Fragilaria exigua* Grun.					+		
100	*Fragilaria pinnata* Ehr.	+	+	+	+	+	+	+
100	*Nitzschia angustata* (W. Smith) Grunow				+			+
100	*Tabellaria fenestrata* (Lyngb.) Kützing		+	+		+		
75	*Achnanthes conspicua* Mayer		+			+	+	

75	*Amphora ovalis* Kützing	+	+	+	+	+	+	+
75	*Amphora pediculus* (Kütz.) Grunow	+	+	+	+	+	+	+
75	*Asterionella formosa* Hass	+				+	+	
75	*Cocconeis pediculus* Ehr.			+	+			+
75	*Cyclotella atomus* (Hustedt)				+			+
75	*Cyclotella radiosa* (Grun.) Lemm.	+		+	+	+	+	+
75	*Diatoma vulgaris* Bory	+	+	+	+	+	+	+
75	*Epithemia sorex* Kütz.				+			+
75	*Epithemia turgida* (Ehr.) Kütz.			+	+			+
75	*Eunotia exigua* (Breb.) Rabenh.				+			+
75	*Fragilaria crotonensis* Kitton	+			+	+		+
75	*Fragilaria ulna* var. *angustissima* Sippen	+		+	+	+	+	+
75	*Gomphonema acuminatum* Ehr.	+	+	+	+	+	+	+
75	*Gomphonema olivaceum* (Horn.) Breb.	+	+	+	+	+	+	+
75	*Gomphonema truncatum Ehr.*							
75	*Meridion circulare* Ag.	+		+				
75	*Navicula radiosa* Kützing	+		+	+	+	+	+

75	*Navicula reinhardtii* Grun.		+					
75	*Navicula tripunctata* (O. F. Müller) Bory	+	+	+	+	+		+
75	*Nitzschia fonticola* Grun. in Cleve et Möller				+			+
75	*Nitzschia recta* Hantzsch	+		+		+		
75	*Pinnularia maior* (Kütz.) Cleve					+		
50	*Achnanthes lanceolata* (Breb.) Grunow				+	+		
50	*Cocconeis euglypta* (Ehr.) Clevei		+					
50	*Cocconeis placentula* Ehr.	+	+	+	+	+	+	+
50	*Cocconeis placentula var. lineata* (Ehr.) Van Heurck		+	+	+	+		+
50	*Encynomena silesiacaum* (Bleisch in Rabenh.) D. G. Mann			+				
50	*Fragilaria ulna* (Nitzsch) Lange-Bertalot	+		+	+	+	+	+
50	*Hippodonta capitata* Patrick in Patrick & Reimer		+			+	+	
50	*Navicula cincta* (Ehr.) Ralfs	+			+	+	+	+
50	*Navicula cryptocephala* Kütz.	+			+		+	+
50	*Nitzschia paleacea* Grun.							
50	*Nitzschia sigmoidea* (Ehr.) W. Sm.	+			+		+	+

50	*Pinnularia viridis* (Nitzsch) Ehr.		+					
50	*Stauroneis phoenicentron* Ehr.	+				+		
50	*Stephanodiscus astraea* (Ehr.) Grunow	+						
30	*Achanthes hungarica* (Grunow) Grunow in Cleve & Grunow				+	+		+
30	*Gomphonema parvulum* (Kütz.) Kütz.				+	+	+	+
30	*Navicula gregaria* Donkin				+			+
30	*Nitzschia palea* (Kütz.) *W. Sm.*	+	+		+	+	+	+
30	*Stephanodiscus hantzschii* Grun.					+		
10>	*Cyclotella meneghiniana* Kütz.	+	+	+	+	+		+