# Ecological state of lake Durowskie:

# Algae assessment

# 26th June - 3rd July 2022


Aaron Budde

Irina Burciu

Barbara Dylawerska

Koryna Lipowska

Elena Vasilache

Sophia Walter

**Supervisor**: Prof. Dr hab. Beata Messyasz

Table of Contents:

## Abstract

Lake Durowskie is a lake situated in Wągrowiec, in Northwestern Poland. It is an eutrophic lake and this situation is due to surface runoffs from agricultural fields that utilize pesticides, inorganic fertilizers, manure and other anthropogenic substances that affect lake-ecosystems. The Lake serves as a deposit point for four other lakes upstream which are connected to the study site by small streams or brooks.This also contributes to the levels of contamination in the lake. In 2009, a collaboration started between the participating universities and the local government for the ecological rehabilitation of the lake using three different methods: oxygenation of hypolimnetic waters with two mechanical wind aerators, phosphorus immobilization with iron treatment and biomanipulation measures by stocking pike fingerlings in the lake. The last method proved less effective. Since 2009 every year a summer school has been operated to monitor the lake's progress due to the applied measures.

Algae are good indicators of the ecological status of the lake thanks to the high diversity of species. They are sensitive indicators for physical-chemical properties of their environment and are irreplaceable in the food web due to their role as the basis of the autochthonous food pyramid. Also their role as primary producers of oxygen by photosynthesis marks its indisputable inalienability. In this study, samples were collected for both periphyton and phytoplankton in 12 different sites throughout the lake. From these samples, identification of the species was carried out and data was compiled to perform the deduction of specific indices and calculations. From the results, both periphyton and phytoplankton analysis showed clear indicators of a eutrophic lake. However, biodiversity and some mesotrophic areas are increasing, and this implies that the water quality of the lake has slightly improved from the previous years. Even with these small improvements, there are still management options that can be applied to achieve an optimal water quality for both the ecosystem and the people who use the lake as a source for recreation, bathing and tranquillity.

## 1. Introduction

Wągrowiec is a small town located in the Northwestern region of Poland, which is located about 50km to the north of Poznań. The town has a total land area of 17.91 $km^2$ and a population of about 25,000 people. It is known for its five interconnected lakes: Laskowickie, Grylewskie, Bukowieckie, Kobyleckie and Durowskie. The Struga Gołaniecka River flows through them and interconnects the five. The main lake that is a concern for the municipality is Durowskie Lake due to its attraction for tourism and recreational usage.

Durowskie is a postglacial lake, its surface has a size of around 143.7 ha and the maximum depth of the lake is at 14.6 m. When the interest on this lake began, it was strongly eutrophic with cyanobacterial water blooms. The lake's pollution is mainly due to industrial agriculture and domestic drains as the lake is surrounded by buildings and some agricultural fields. Surface runoffs, lateral runoff and shallow groundwater efflux from agricultural land are polluting the lake with mostly nitrogen (N), phosphorus (P) and potassium (K) mainly through fertilizers and pesticides which contain various organic contaminants. The level of pollution in Durowskie Lake, the last of the lake series, occurs to some level due to the other four interconnected lakes. The waters of those flows into the study site lake causing a significant accumulation of the contaminants. Anthropogenic activities like recreation and the disposal of sewage waste from houses also contribute significantly to the ecological state of the lake as it has a negative impact on the quality of the water. The challenges of the water quality preservation of surface water bodies formulated and instructed by the EC-Water Framework-Directive (DIRECTIVE 2000/60/EG) are obvious on the study site, thus one indicator group of the ecological status, the communities of algae, are investigated here.

Research and restoration measures started in 2009 and have the objective to restore the ecological status of the lake. There are three applied restoration measures which effectiveness to improve the quality of the lake is tested: the oxygenation of hypolimnetic waters and therefore phosphorus lake sediments using two mechanic aerators permanently located in two different points of the lake, which move due to wind energy; the phosphorus immobilization in the sediments through adding iron ions ($Fe^{2+}$) by inserting iron sulfate or iron chloride, whereas biomanipulation is performed through the insertion of pike in the lake. In fact, pikes are a highly predatory fish species and feed on zooplankton, which is predatory to phytoplankton. Storage therefore allows the increase of the zooplankton and consequently the decrease of phytoplankton. Currently, the latter method was less effective than the others.

Every summer, during the international summer school, it is monitored if the restoration measures at the study site have improved the water quality of the lake and trends of its ecological status are observed. This research assists the decision making of restoration and management measures of Lake Durowskie. The research considers different indicators in the lake, biological ones such as algae, macrophytes and macroinvertebrates but also physical-chemical and hydrological parameters.

Algae are a good indicator for the quality of water for different reasons. First of all, the algae are primary producers, hence they control the whole food web so any shifts in species can cause effects in higher trophic levels through feeding relationships, population growth or overall structure (McCormick, 1994); the algae then present a strong biodiversity and the presence of one or the other family is representative for the ecological status of lakes. Moreover, algae, with their coloring change, the transparency of water and decrease the depth of light. Therefore, algae are important in assessing the overall ecological status of lakes (Solheim et al., 2014).

This report focuses on different aspects of the algal communities, periphyton and phytoplankton. Through algae abundance, biomass, diversity, distribution and the relationship to water quality through oxygen, pH, and trophic level, the ecological status can be determined for Lake Durowskie. Comparative data analysis from 2016 to 2022 is another objective of this study to find progress of restoration efforts of the lake.

## 2. Materials and Methods

### 2.1 Study area

Lake Durowskie, the study site of this research project, is located in the town of Wągrowiec (52° N 49’ 06” and 17° E 12’ 01”). The 14.6 m deep, post-glacial lake is connected to four other upstream lakes and it is a tourist destination known for its sporting and beach facilities. The lake is also surrounded by various flora species. More detailed information about the lake can be seen in Table 1.

**Table 1**: Morphometry of the Lake Durowskie and its catchment area.

| Morphometric Parameters | Values |
|---|---|
| Surface area (ha) | 143.7 |
| Volume ($m^3$) | 11,322,900 |
| Maximum depth (m) | 14.6 |
| Average depth (m) | 7.9 |
| Total catchment area ($km^2$) | 236.1 |
| Direct catchment area (ha) | 1,581.3 |
| Agricultural land use (%) | 58.26 |
| Forest land use (%) | 33.52 |

| | |
|---|---|
| Urban land use (%) | 8.25 |

## 2.2 Sampling

Water samples from 12 different sites were taken for Periphyton analysis, while 8 sites served for research on Phytoplankton (cf. Figure 1 and Figure 2). Water samples of 30L were collected at different depths from 0 to 4 meters, then filtered using plankton nets to analyze the vertical distribution of phytoplankton and then preserved with Lugol's iodine. Samples were also taken from stones along the shore to analyze periphyton samples, also being preserved with Lugol's iodine.

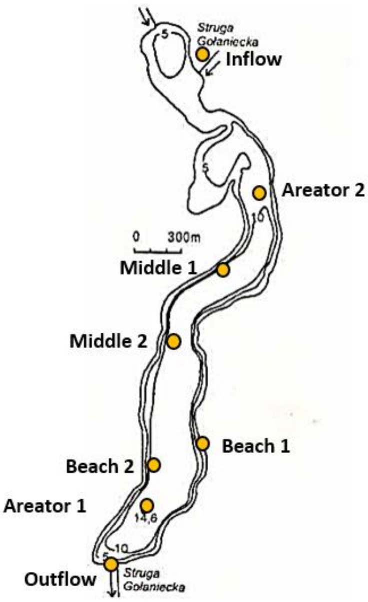


Figure 1: Phytoplankton sampling sites

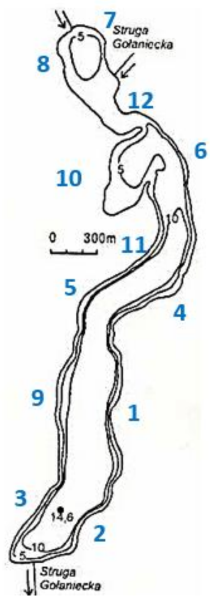


**Figure 2:** Periphyton sampling sites

*Physico-chemical parameters*

Physico-chemical parameters such as temperature, pH, and dissolved oxygen were analyzed at the various points of the Lake using the multi-parameter water quality meter (YSI 556) while the secchi disc was used to measure transparency. Water samples were also collected from the same sites to analyze chlorophyll-a.

# 3. Laboratory analysis

## 3.1 *Individual Measurements*

Quantitative analysis was carried out to determine the number of individual species (periphytons and phytoplanktons) per liter. The number of individual species per 100 cells was counted under the microscope, while the conversion factor was determined with the 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

The total number of individuals counted in 100 cells was multiplied by 800 to determine the individual number of cells per liter.

## 3.2 Biomass Measurements (mg/L)

To estimate the biovolume of 1 cell of algae species; the biovolume (1 cell) is multiplied by cell count in 1mL, then the value derived in step 1 gets divided by $10^9$ to get the biomass ($mgL^{-1}$). The biomass was always given to 3 decimal places.

# 4. Data Analysis

The phytoplankton data was used to calculate the Mixed Index, Jaccard Index, Diversity Index and PMPL Index, while the determination of the diatom index was achieved using Periphyton data.

### 4.1 Phytoplankton

Mixed Index of Nygaard

This method was developed depending on the number of species from all different taxonomic groups.

$$Mixed\ Index = \frac{Cyanobacteria + Chlorococcales + Centric\ diatomes + Euglenoids}{Desmids}$$

**Table 2:** Classes of different trophic levels

| | |
|---|---|
| **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

The Jaccard index is used to compare species in different sites.

$$Sj = \frac{a}{a + b + c}$$

$S_J$ = 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

Diversity and evenness of phytoplankton species in different sites can be measured by using the Shannon-Wiener diversity and evenness indices.

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

H' = Shannon index;

$p_i$ = relative abundance of each species in the site

$$E = \frac{H'}{H_{max}} = \frac{\sum \quad p_i \cdot log\ (p_i)}{log(S)}$$

E = Evenness (equitability);

S = Total number of species at each site

Phytoplankton Multimetric for Polish Lakes (PMPL Index)

Parameters which are important for this index are Chlorophyll-a, the total biomass and the biomass of cyanobacteria. These parameters range from value 1 to 5. Also, this index is used as a tool for an evaluation of the ecological status in the European Union according to the Water Framework Directive 2000/60/EG.

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

YCh = Chlorophyll-a concentrations
YBm = General biomass of phytoplankton
YCy = Biomass of cyanobacteria

**Table 3:** Value obtained for PMPL is indicating different classes of trophic 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 |

## 4.2 Periphyton

Periphyton species were collected from submerged stones at 12 sites along the lake shore. Samples were preserved using Lugol's iodine solution before taking the samples to the laboratory for analysis. The diatom index was used to determine the ecological status of the lake. Diatom index can only be determined when at least 10 species sensitive to trophic level are present in a sample. To calculate the Diatom index, the Trophy index (TJ), the index of referential species (pGR) and their standardization are needed. For estimation of oxygen saturation, trophy and alkalinity, van Dam's ecological indicators values were used (VAN DAM ET AL., 1994).

<u>Trophy index (TJ)</u>

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

*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)

*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,

$$Z - TJ = 1 - ((TJ - 1) \cdot 0.25)$$
$$Z - pGR = (pGR + 1) \cdot 0.5$$

Diatom Index

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

**Table 4:** Obtained value for the Diatom index indicates ecological status for the lake as below

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

.

# 5. Results

## 5.1 Phytoplankton

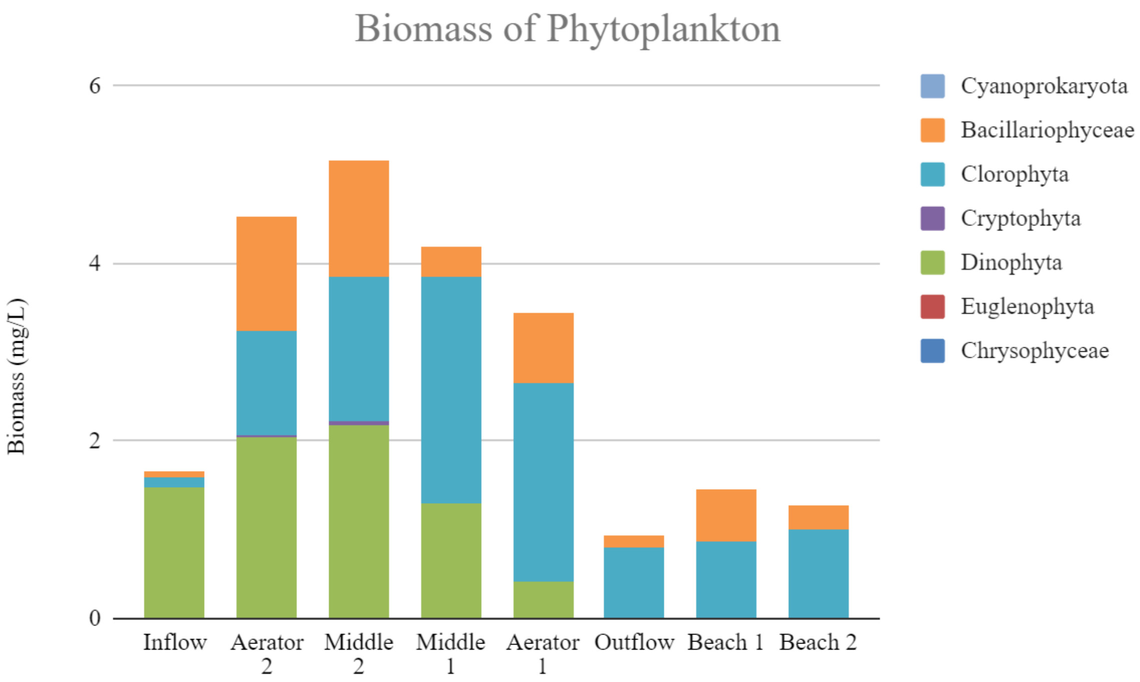


**Figure 3:** Phytoplankton group biomass for each sampling site

According to the biomass estimations, the plankton groups with the highest biomass values were Dinophyta, Chlorophyta and Bacillariophyceae. The phytoplankton group with the lowest biomass value was Chrysophyceae (Fig. 3).

The dominant phytoplankton species in the sites Inflow, Aerator 2 and Middle 2 was *Ceratium hirudinella*, while the dominant phytoplankton species in the sites Middle 1, Aerator 1, Outflow, Beach 1 and Beach 2 was *Coelastrum reticulatum*. *Fragilaria crotonensis* was also among the dominant species in the sites Aerator 2, Middle 2, Aerator 1, Outflow, Beach 1 and Beach 2 (Fig 4).

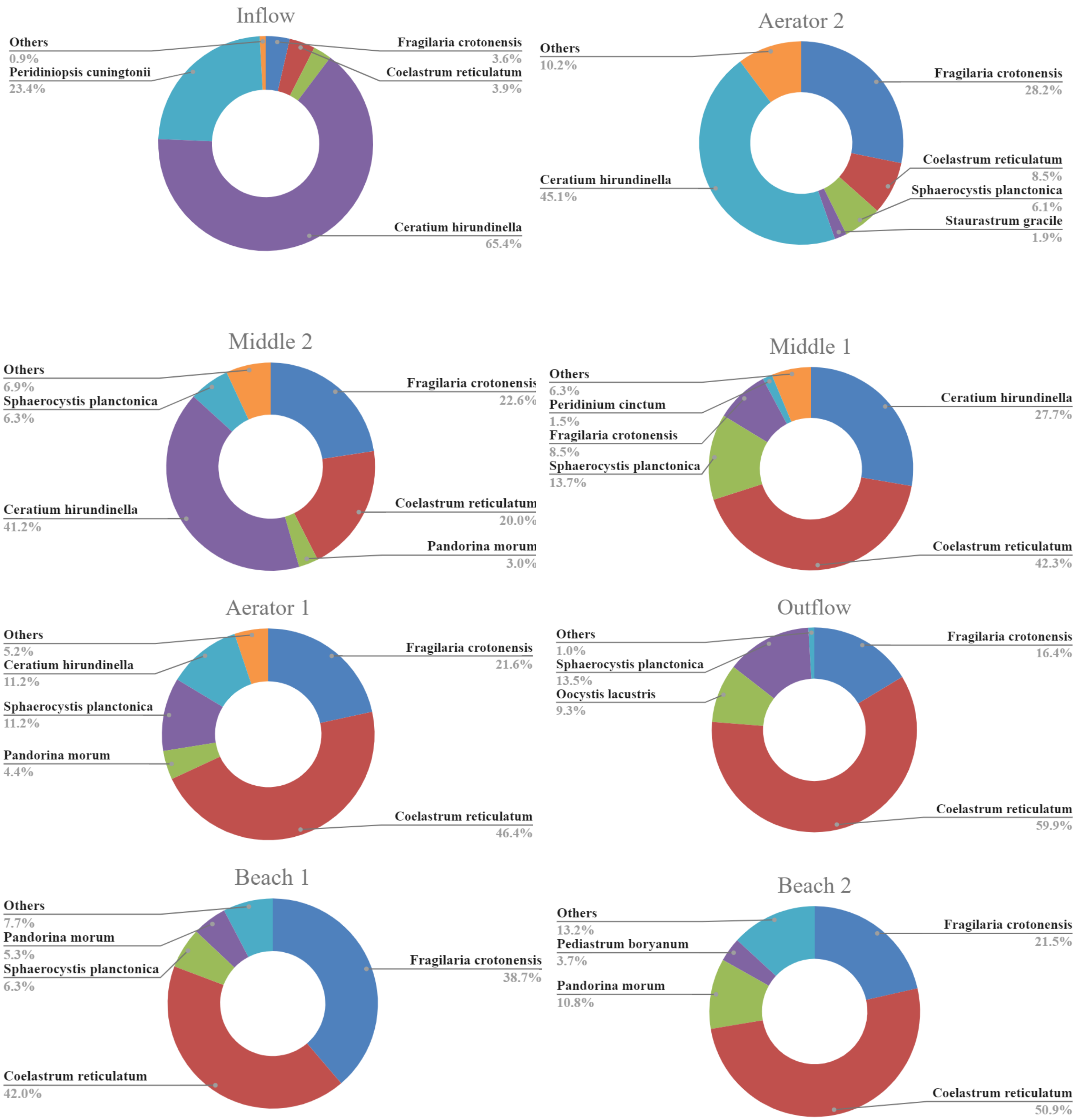


**Figure 4:** Dominant phytoplankton species by biomass percentages for each sampling site

### 5.1.1 Species composition of phytoplankton in 2008-2022

A total of 45 phytoplankton species were identified during laboratory studies. The number of phytoplankton species in 2022 is smaller compared to previous years (Fig. 5). The results of the water sample tests show that the total number of phytoplankton species varied between sites (Fig. 6). The most phytoplankton cells were found on Beach 2, in the Middle 2 and at Aerator 2. The lowest number of cells was found with Inflow and Middle 2.

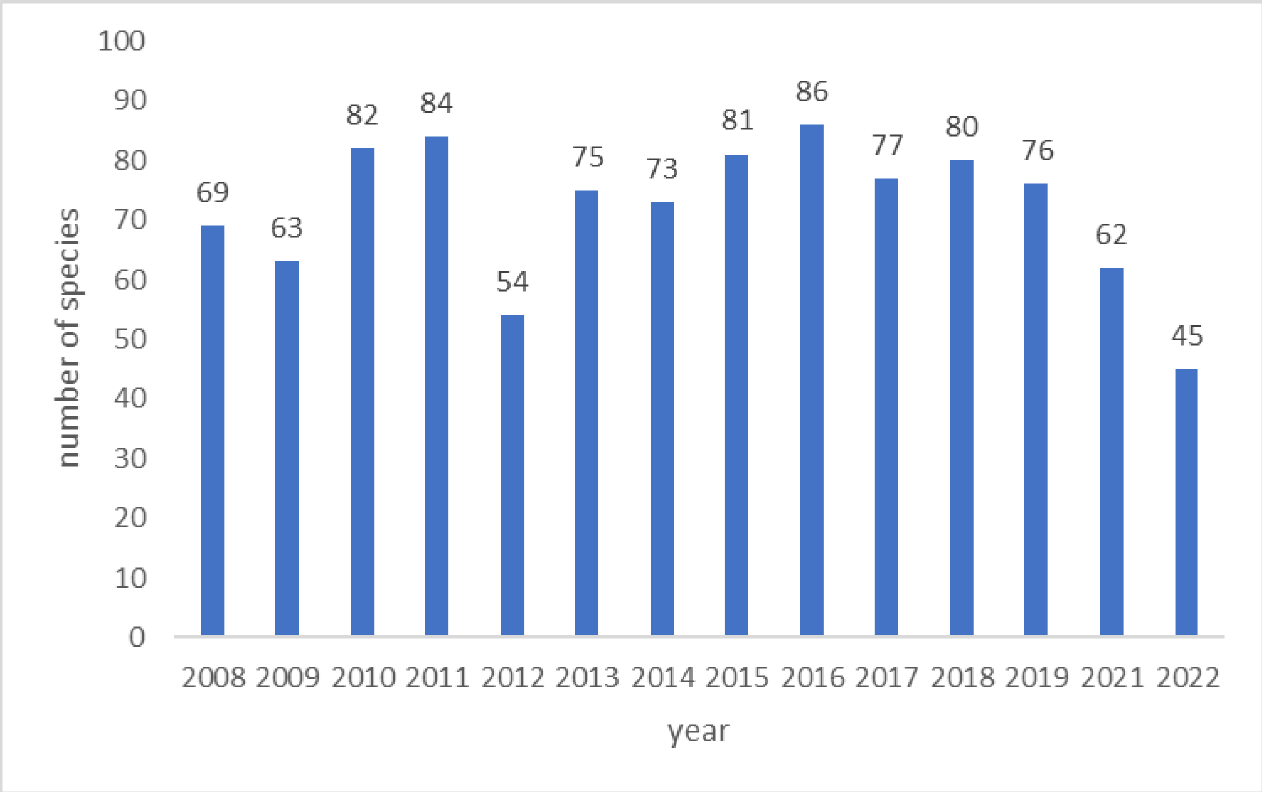


**Fig. 5:** Total species composition of phytoplankton in 2008-2022

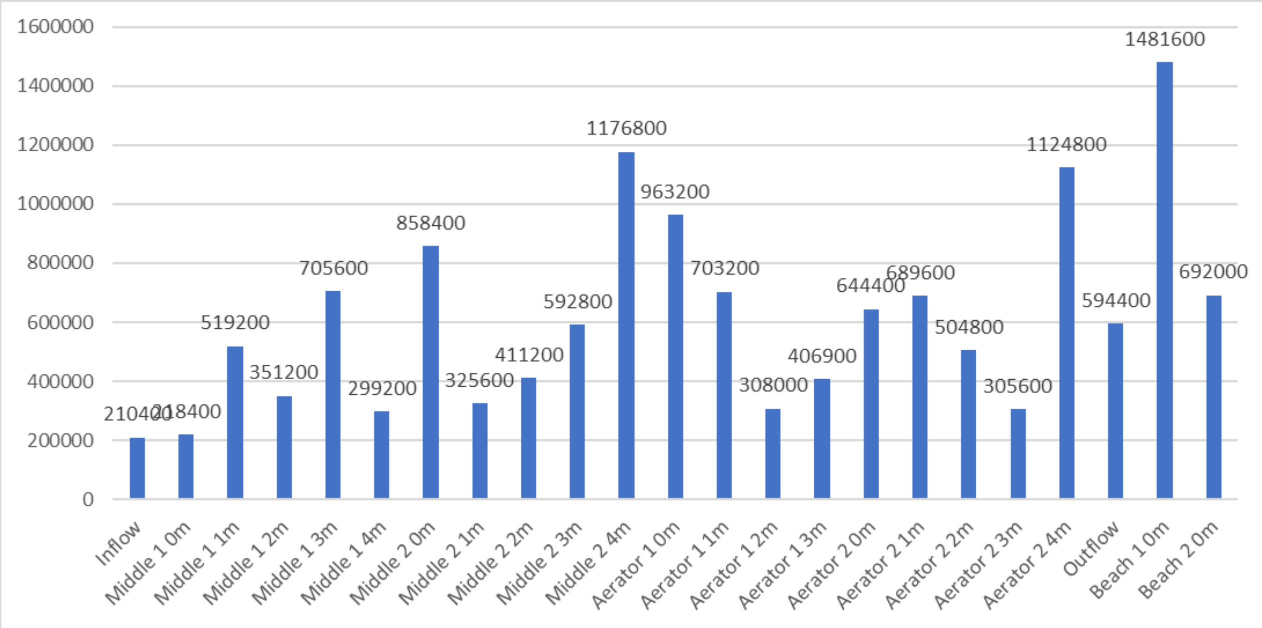


**Fig. 6:** The number of phytoplankton for each site and depth

### 5.1.2 Mixed Index of Nygaard

The Mixed Nygaard Index shows the trophic conditions of Lake Durowskie, which for 2022 is 8.26. This means that the water reservoir is distinguished by a hypertrophic state except for the Inflow and Outflow sites where the state was eutrophic.

Two indicators were taken into account when calculating this indicator. The first is the number of algae species that have occurred in the lake. The second is the number of desmidia species that are indicators of clean waters. The Nygaard index is the proportion of these two groups, and the water quality is determined on the basis of this ratio.

**Table 5:** Development of Mixed Index of Nygaard for lake Durowskie in a time period of 13 years.

| STATION | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | - | 1.8 | 17 | 9 | 19 | 3.8 | 17 | 7 | 9 | 7 | 8.7 | 3.5 |
| Aerator 1 | 26 | 11.5 | 5 | 8 | 14 | 20 | 4.3 | 12 | 8 | 8 | 3.8 | 11.5 |
| Middle 1 | 9 | 12.5 | 13 | 3 | 5.5 | 11 | 4.8 | 7.7 | 6 | 4.8 | 2.8 | 10 |
| Middle 2 | - | 8.3 | 18 | 9 | 7.5 | 20 | 4 | 8.5 | 6 | 5 | 4 | 10.5 |
| Beach 1 | - | - | 3 | 9 | 7 | 5 | 5.5 | - | 3 | 3 | 3 | 5.5 |
| Beach 2 | - | - | - | 5 | 6 | 10 | 12 | - | 5 | 5 | 2.5 | 4.8 |
| Aerator 2 | 16 | 8.3 | 9 | 7 | 8 | 9 | 6.7 | - | 7 | 5 | 4 | 7.5 |
| Outflow | - | 6.5 | 5 | - | 12 | 8 | 8 | 14 | 5 | 4 | 4 | 3 |

| | |
|---|---|
| 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 |

### 5.1.3 Jaccard Index

The Jaccard index is a statistic used to measure the similarity and diversity between phytoplankton communities in comparable research years (2008 to 2019 compared with 2022). The Jaccard index is notably different to the previous years. The value of 2022 contains the smallest Jaccard index which means that in this year of research there were fewer common species than in previous years.

**Table 6:** Development of Jaccard indices for lake Durowskie in a time period of 13 years.

| year | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2008 | 84 | 51 | 43 | 33 | 40 | 52 | 82 | 35 | 40 | 36 | 46 | 16 |
| 2009 | - | 48 | 28 | 20 | 29 | 35 | 39 | 13 | 34 | 31 | 29 | 13 |
| 2010 | - | - | 42 | 42 | 62 | 47 | 37 | 35 | 38 | 41 | 46 | 16 |
| 2011 | - | - | - | 34 | 58 | 47 | 50 | 40 | 38 | 48 | 42 | 19 |
| 2012 | - | - | - | - | 77 | 49 | 59 | 47 | 38 | 39 | 42 | 20 |
| 2013 | - | - | - | - | - | 52 | 78 | 45 | 46 | 45 | 51 | 20 |
| 2014 | - | - | - | - | - | - | 57 | 40 | 48 | 48 | 58 | 21 |
| 2015 | - | - | - | - | - | - | - | 43 | 47 | 50 | 57 | 19 |
| 2016 | - | - | - | - | - | - | - | - | 42 | 52 | 44 | 21 |
| 2017 | - | - | - | - | - | - | - | - | - | 52 | 54 | 21 |
| 2018 | - | - | - | - | - | - | - | - | - | - | 48 | 20 |
| 2019 | - | - | - | - | - | - | - | - | - | - | - | 20 |
| 2021 | - | - | - | - | - | - | - | - | - | - | - | 21 |

### 5.1.4 Diversity Index

Shannon-Wiener index It is the most widely used indicator of biodiversity. Its value determines the probability that two individuals drawn from the sample will belong to different species. The index has the highest values when the share of species is regular. The graph shows that the lowest species diversity is in the area of Inflow and Beach 1 and Beach 2. The greatest biodiversity is at Arator 1, Outflow and Middle 2.

Evenness index refers to how close in numbers each species in an environment is. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically. Evenness ranges from 0 to 1. In the case of Lake Durowskie, the diversity index is very low. The values are the same as in the case of Shannon-Wiener index.

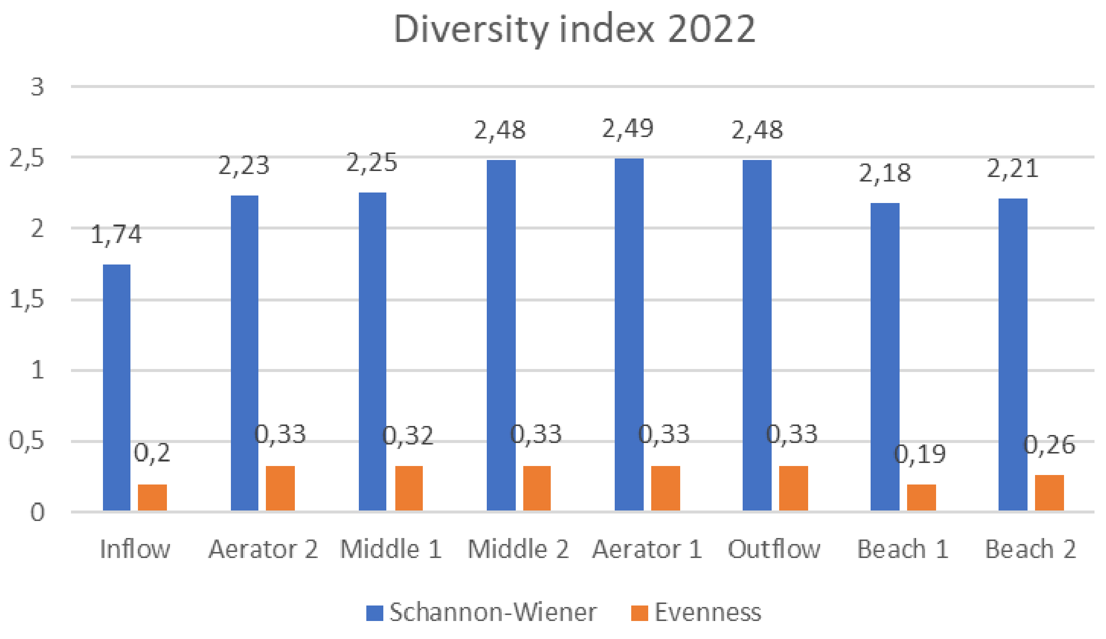


**Fig. 7**: Diversity index based on Shannon-Wiener diversity

### 5.1.5 Phytoplankton Multimetric for Polish Lakes (PMPL Index)

PMPL is an indicator used in Poland. It is used to determine the ecological status of waters based on phytoplankton. The average is created in the vertical profile of the epilimnion in the water column. Three variables are taken into account: the biomass of phytoplankton, the number of cyanobacteria in the biomass and the concentration of chlorophyll-a.

In the study year 2022 the ecological status of lake Durowskie is provable and significantly better than in previous years. For the first time in several years, in 2022, the PMPL index was found at a good level, except for the Inflow, and Aerator 2, where the PMPL value is at a moderate level.

**Table 7:** PMPL Index for 2016-2022

| Year\Station | Inflow | Aerator 2 | Middle 1 | Middle 2 | Aerator 1 | Outflow |
|---|---|---|---|---|---|---|
| 2022 | 2.51 | 1.03 | 1.61 | 1.41 | 2.25 | 1.26 |
| 2021 | 2.97 | 2.65 | 2.38 | 2.41 | 3.06 | 3.39 |
| 2019 | 3.46 | 2.81 | 2.67 | 2.63 | 2.58 | 2.52 |
| 2018 | 3.32 | 2.8 | 2.79 | 2.78 | 2.61 | 2.63 |
| 2017 | 3.4 | 2.74 | 2.78 | 2.78 | 2.78 | 2.5 |
| 2016 | 3.7 | 2.78 | 2.76 | 2.76 | 2.76 | 2.53 |

| Ecological status | PMPL |
|---|---|
| Very good | 0.0 - 1.0 |
| Good | 1.01 - 2.0 |
| Moderate | 2.01 - 3.0 |
| Poor | 3.01 - 4.0 |
| Bad | 4.01 - 5.0 |

## 5.2 Periphyton

Periphyton is a complex community of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. Periphyton covers most submerged substrates, ranging from sand over macrophytes to rocks (J.A. Peters, D.M. Lodge, 2009). In oligotrophic lakes, even those with few macrophytes for periphyton to grow on, periphyton can be an important component of whole-lake primary production. In eutrophic lakes, however, phytoplankton is more abundant which then reduces periphyton and macrophyte abundance. Periphyton is a common food source for invertebrates and some amphibians (J.A. Peters, D.M. Lodge, 2009).

Diatoms are among the most important and prolific microscopic sea organisms and serve directly or indirectly as food for many animals. Diatoms are unicellular eukaryotes with nano-patterned silica cell walls and they contribute to around 20% of the global primary production (Thomas Mock, Linda K. Medlin, 2012).

The map below (Fig. 8) shows the diatom index calculated in 2022 in comparison with previous years (from 2016 to 2022). The diatom indices, representing the ecological status of the lake, are constantly differing and at some sites even worsening. As an example, site 8 shows a concerning decline of water quality (diatom index drops from 0.38 in 2018 to 0.16 in 2022) which seems to be in line with new tourist homes in the proximity. This site has to be highly observed in the future. The values settle between moderate and poor ecological status.

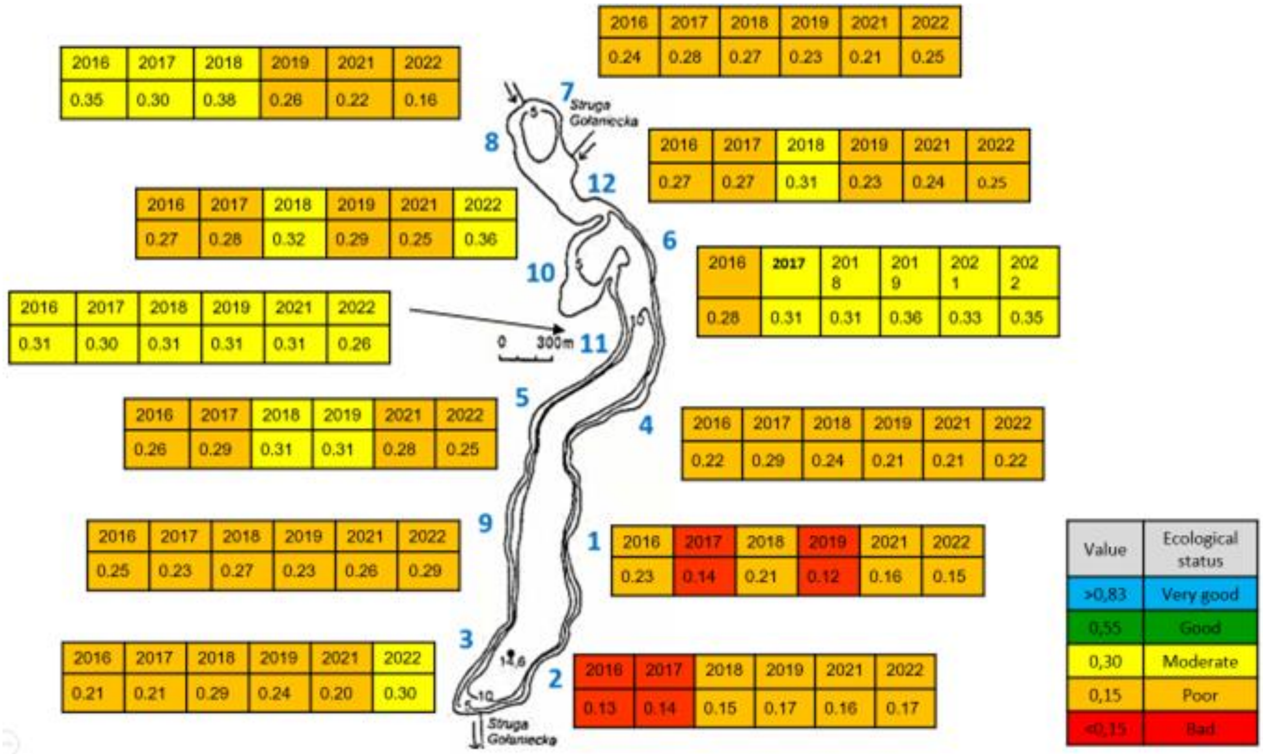


**Fig. 8:** Diatom indices in a time period from 2016 to 2022 as an indicator for the biological state

Table 8 shows the dominant diatoms in the periphyton community, in percentage of the total, across the twelve sites where samples were taken. It can be noted that the most dominant species is Achnanthes minutissima *Kützing* which is present in 10 out of 12 sites (around 84% of appearance).

Achnanthes minutissima *Kützing* is a species with a very broad ecological amplitude, therefore it can easily adapt to any trophic condition. This is probably the reason why it was abundant in the majority of the sites. However, it requires high oxygen saturation (>75%) and circumneutral pH (van Dam et al, 1994). As a pioneer it can form massive associations, specifically on plant substrates in lake littorals.

The second most abundant species are *Cymbella affinis* Kützing, *Cymbella microcephala* Grunow and *Fragilaria capucina* (Desm.) Rabenhorst with an appearance of around 58%. *Cymbella affinis* Kützing can be used as an indicator of very good water quality. It is rarely found in calcareous, oligotrophic lakes and rivers. *Cymbella microcephala* Grunow can live in slightly acidic to alkaline conditions and low to medium electrolyte conditions, if the habitat is oligo saprobic. It occurs in oligo- to slightly eutrophic conditions. *Fragilaria capucina* (Desm.) Rabenhorst is most likely to be found in oligotrophic to mesotrophic, slightly acidic to alkaline water bodies with low to medium electrolyte content. The next species is *Cymbella minuta* with a percentage of around 42% of appearance. It occurs in non- disturbed habitats with oligo- to mesotrophic conditions with a medium electrolyte content.

**Table 8:** Dominants in periphyton community.

| | Taxon | site 1 | site 2 | site 3 | site 4 | site 5 | site 6 | site 7 | site 8 | site 9 | site 10 | site 11 | site 12 | appearance in % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Achnanthes minutissima *Kützing* | | 11,47 | 0,08 | 11,37 | 13,68 | 6,68 | 0,07 | | 5,06 | 4,23 | 7,36 | 18.65 | *83,33%* |
| 2 | Cymbella affinis *Kützing* | | | 0,08 | | | | 0,05 | 2,76 | 11,57 | 9,80 | 5,83 | 5.25 | *58,33%* |
| 3 | Cymbella microcephala *Grunow* | 10,27 | 7,02 | 0,07 | 12,43 | | | | 1,44 | 7,64 | 6,53 | | | *58,33%* |
| 4 | Fragilaria capucina (*Desm.) Rabenhorst* | 7,12 | 7,49 | 0,07 | 5,53 | | | 0,08 | 1,92 | | | 5,83 | | *58,33%* |
| 5 | Cymbella minuta | | | | | 0,06 | 3,21 | 0,07 | | 4,34 | 4,05 | | | *41,67%* |
| 6 | Amphora ovalis *Kützing* | 4,63 | 5,38 | | | | | | 2,14 | | | 14,66 | | 33,33% |
| 7 | Fragilaria crotonensis *Kitton* | 9,05 | | | 5,10 | 0,04 | | | | 5,68 | | | | 33,33% |
| 8 | Gomphonema olivaceum | | | 0,11 | | 0,11 | | | 1,30 | | 13,40 | | | 33,33% |
| 9 | Cocconeis placentula *Ehrenberg* | | | | 4,39 | | 5,81 | | | | | | 12.21 | *25,00%* |
| 10 | Achnathes minutisima *var. affinis* | | | | | | 5,23 | | | | | 6,46 | | 16,67% |
| 11 | Asterionella formosa | 6,23 | 5,21 | | | | | | | | | | | 16,67% |
| 12 | Fragilaria construens | | | | | 0,04 | | 0,08 | | | | | | 16,67% |
| 13 | Fragilaria pinnata | | | | | | 5,95 | | | | | | 5.88 | 16,67% |
| 14 | Amphora pediculus *(Kütz.) Grunow* | | | | | 0,04 | | | | | | | | *8,33%* |
| 15 | Meridion circulare | | | | | | | | | | | | 5.82 | *8,33%* |

### 5.2.1 State of trophy, $O_2$ and pH-value

In the following part the states of the trophic level, the pH-values and the content of oxygen in the 12 sampling sites are presented (Fig. 9, Fig. 10, Fig. 11).

In just a third of the sampling sites periphyton occurred which is an indicator of an oligotrophic state, whereas the abundance of those was less than 3%. The abundance of specimens adapted to mesotrophic conditions was about 10% in total, while the lowest value was detected in site 2 near the Outflow and the highest value at Beach 2. Therefore 60% of periphyton species indicating a eutrophic state of the waterbody were present at each site in arithmetic mean within a range from 50% near Aerator 1 and 65% near the Outflow. Taxa as indicators for a  hypertrophic state were found on ¾ of the sites, in an arithmetic mean of 3%, nevertheless the significantly highest amount of those was found at site 10 near Aerator 2. About 25% of all species throughout all sites belonged to the group of *others* which are not connected to a certain trophic state. There is no clear gradient detectable form the northern site of the lake to the southern site, but it can be stated that the highest trophy level was found at site 10 in the north and the lowest at site 6 directly adjacent (Fig. 7).

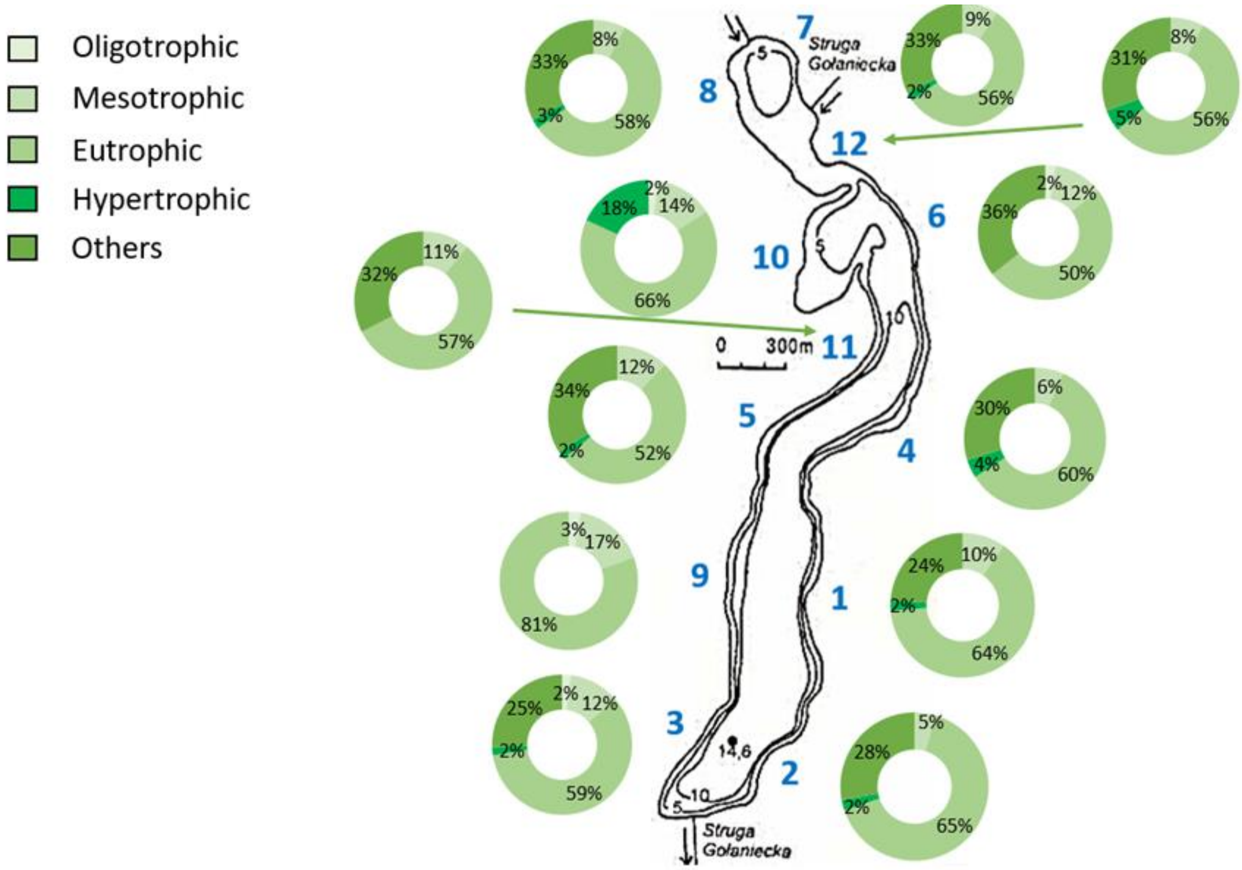


**Fig. 9:** Trophic state of the 12 periphyton sampling sites in the study year 2022

The abundance of algae adapted to high oxygen levels reached values up to 74% whereas the lowest value was at sites 1 and 5 with 55%. On average, 60% of all specimens at all sites were high-oxygen level indicator species. The second most abundant group were those adapted to middle oxygen contents in the water with a total arithmetic mean of about 25%. The lowest oxygen level regarding the taxas which were found were detected at site 5 with 21% followed by site 12 with 16%. At each site about 8% of the species which were found weren't linked to a certain oxygen state. As before there is no clear distribution between the northern and the southern side of the lake visible (Fig. 8).

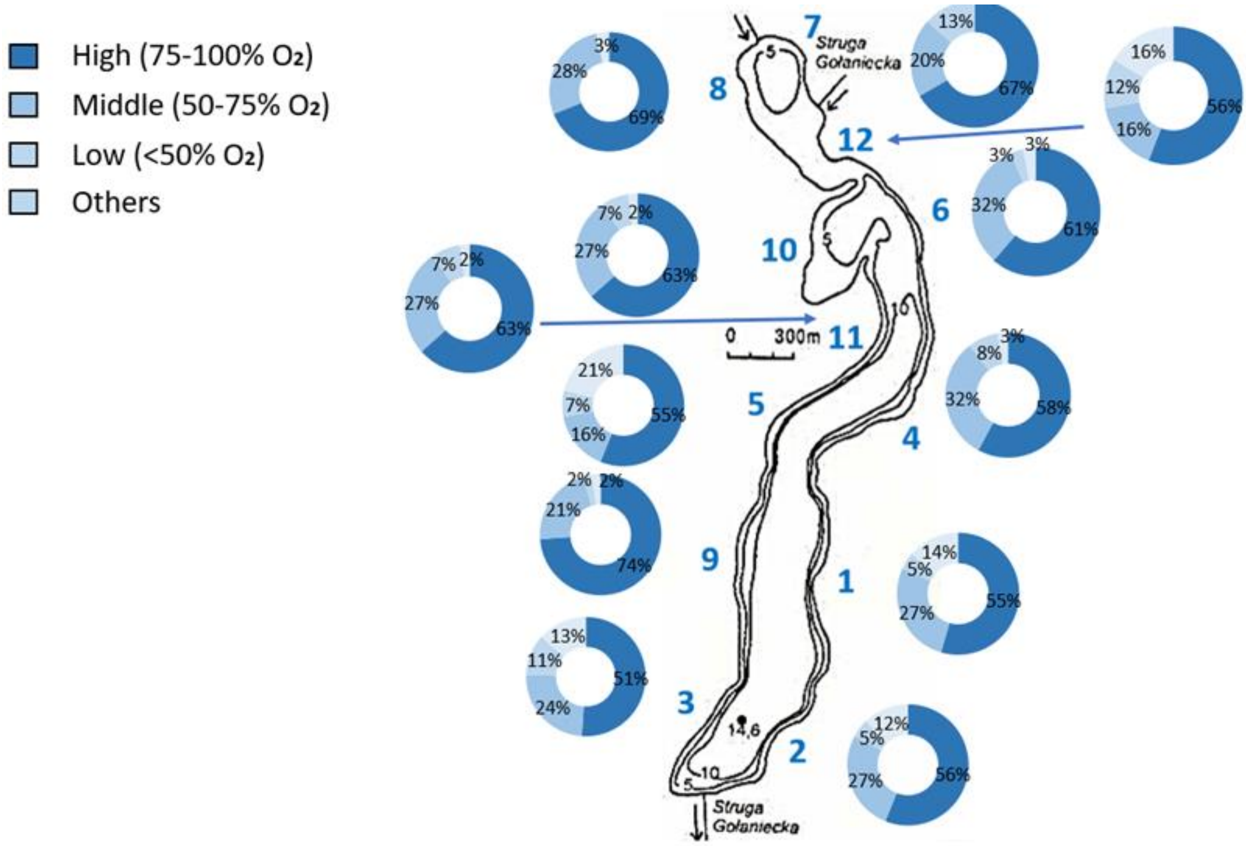


**Fig. 10:** Oxygen level of the 12 periphyton sampling sites in the study year 2022

It is clearly recognizable that most species which were found were indicators for an alkaliphilus state with a total mean value of more than 71%. The peak was detected in site 8 whereas the lowest abundance of those specimens was found in site 1. The taxa which dwell under circumneutral conditions were abundant at each sampling point with an overall occurrence of 20%. The group of the acidophilus periphyton species were the most rare ones. Despite they occured at every site except site 4, their share was just about 5% on average. The group of 'Others' was found at half of the site but with an arithmetic mean of 9% on the sites where this group was found, they had an inferior role (Fig. 9).

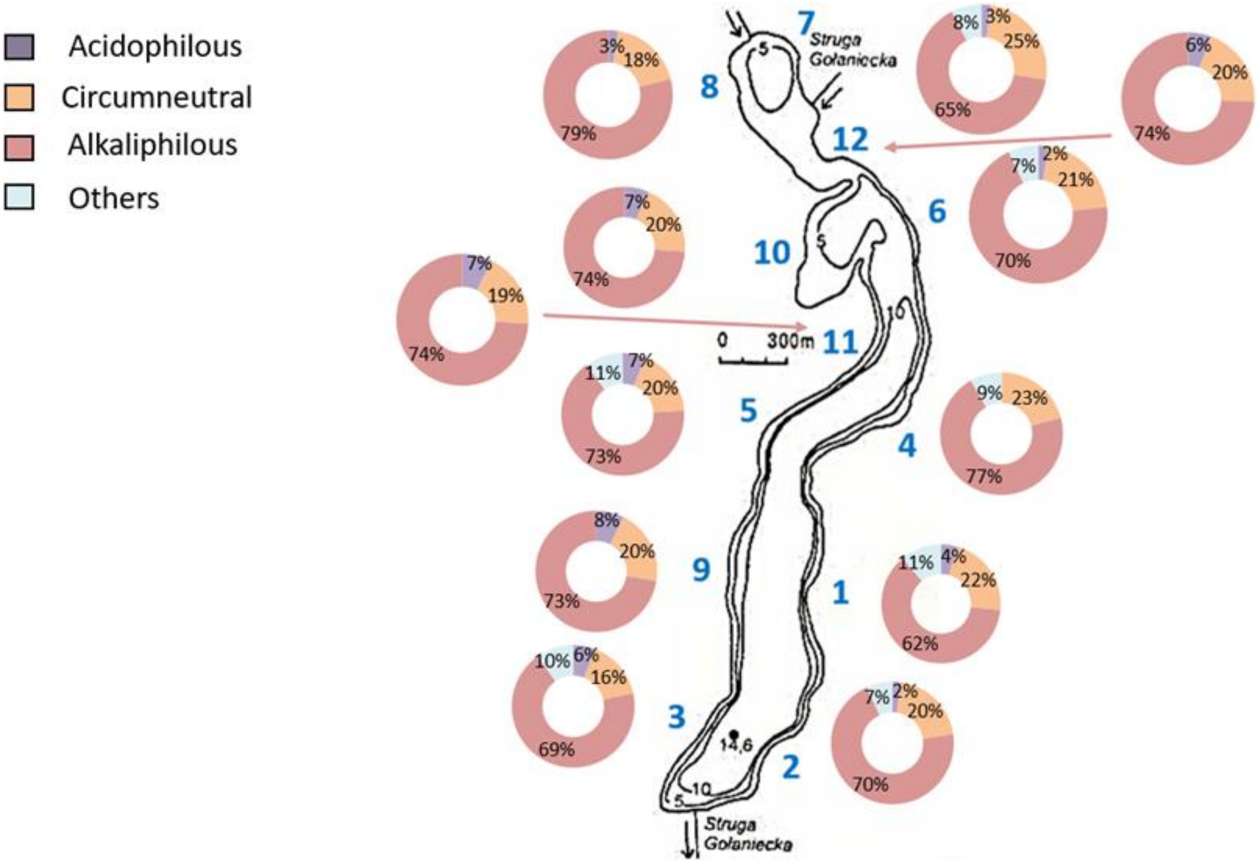


**Fig. 11:** pH levels of the 12 periphyton sampling sites in the study year 2022

## 6. Discussion

### 6.1 Phytoplankton

The sampling site with the highest phytoplankton biomass registered this year was Middle 2, followed by Aerator 2 and Middle 1. The sampling site with the highest biomass in 2021 was Aerator 1, which came in fourth this year. As for the individual phytoplankton groups, Chlorophyta achieved the highest values, followed closely by Dinophyta, last year's most abundant group in terms of biomass. The abundance of Chlorophyta may be due to the warm weather, which is favorable for their reproduction (Reynolds, 2006).

In terms of biomass, the dominant species this year, similarly to 2021, was *Ceratium hirundinella*, mostly because it is large in size, has a thick cell wall and is known for its strong motility, which makes it less likely to be consumed by zooplankton. The second dominant species according to biomass was *Coelastrum reticulatum*, a chlorococcal algae associated with enriched shallow conditions (Reynolds, 2006).

This year's analyzes show that the value of PMPL is different than in previous years. The results indicate that Lake Durowskie is in a good condition in terms of phytoplankton value. This means that cyanobacteria, which have a significant impact on the trophy of the lake, are sparse in the species composition of the phytoplankton of the studied reservoir. This condition is due to the reclamation treatment. PiX was sprinkled in water to precipitate phosphorus from the water column into sediment.

The Jaccard index is notably different to the previous years. The value of 2022 contains the smallest Jaccard index which means that in this year of research there were fewer common species than in previous years. The reasons may be a too narrow time period for sampling and analysis, or simply better water conditions.

The Nygaard index at the level of 8.25 proves the hypertrophic state of the lake. Compared to previous years, this state has changed from eutrophic to this even more trophic state.

## 6.2 Periphyton

From the results, oxygen preference for periphyton species is in the high range. Figure 10 shows that the rate of high oxygen is in the 51 % to 74 % range. However, site 9 had the highest oxygen preference of 74%. With the overall preference for higher oxygen levels for the algae species, it can be concluded that the oxygen levels are adequate. This is because with more oxygen more species of algae can thrive (Bennion, Fluin and Simpson, 2004).

Results from our sample sites also show that the dominant trophic level was eutrophic (Fig. 9). The decrease in mesotrophic levels from last year's result shows that there is an overall increase in eutrophication. This change in trophic level indicates that water quality has declined from last year based on the species and other parameters observed.

The pH distribution from Figure 11, shows that most sites are in the 70% range of alkaliphilous. Sites with a rising amount of alkaliphilous species indicate that the lake is in an eutrophic state (Scott, Lucas and Wilson, 2005).

The diatom index shows that the overall water quality of Lake Durowskie is still in the poor to moderate range. There are some exceptions, for example site 10 and 6 which are located close to Aerator 2 as well as site 3 which is in proximity of Aerator 1. The Northern part of the lake is shallow and hence, more of a distribution of aquatic plants. Therefore, the North's diatom index is in the more moderate range than the Southern one. Furthermore, site 8 shows a concerning decline in the diatom index which is probably in line with five new tourist residencies which are very close to the shoreline that are most likely not connected to the wastewater treatment system of the municipality. An indicator for the decline in water quality further is the observation of *Ceratophyllum demersum* at that site. It is an invasive species that inhibits the growth of phytoplankton and cyanobacteria leading to a loss of biodiversity. There is a high risk of increase in *Ceratophyllum*, hence site 8 has to be highly observed in the future and additional measures should be undertaken to impede the anthropopressure.

## 7. Conclusion

1. In this study year the ecological state of the lake was significantly improved compared to the years before.
2. The ecological state of the lake based on Nygaard index changed from eutrophic to hypertrophic after a few years. Also PMPL showed an improvement in the ecological status of the lake. However, the DI does not reflect the increase in the cleanliness of the lake.
3. Despite the unfavorable weather conditions (high air temperatures), there are no cyanobacteria in the epilimnion layer of the lake, which indicates the effectiveness of the applied reclamation processes (PIX).
4. The lake has the lowest number of phytoplankton species compared to previous years (2008-2021).
5. Measures are very costly and time intensive and site 8 has shown how quickly the ecological status can drop if anthropogenic pressure occurs or rises.

**References**


Bennion, H., Fluin, J., & Simpson, G. L. (2004). Assessing eutrophication and reference conditions for Scottish freshwater lochs using subfossil diatoms. *Journal of applied Ecology,* 41(1), 124-138.

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Retrieved from: http://data.europa.eu/eli/dir/2000/60/oj.

J.A. Peters, & D.M. Lodge (2009). Littoral Zone. In: Gene E. Likens (Ed.): *Encyclopedia of Inland Waters.* Academic Press, 79-87, https://doi.org/10.1016/B978-012370626-3.00218-0.

McCormick, P. V., & Cairns, J. (1994). Algae as indicators of environmental change. *Journal of Applied Phycology*, *6*(5-6), 509-526.

Mock, Thomas and Linda K. Medlin (2012) Genomics and Genetics of Diatoms. *Advances in Botanical Research* 64: 245-284.

Reynolds, C.S. (2006). The Ecology of Phytoplankton (Ecology, Biodiversity and Conservation). Cambridge University Press.

Scott, D. M., Lucas, M. C., & Wilson, R. W. (2005). The effect of high pH on ion balance, nitrogen excretion and behaviour in freshwater fish from an eutrophic lake: a laboratory and field study. *Aquatic Toxicology*, 73(1), 31-43.

Solheim, A.L., Stina Drakare, G.P., Free, G., Järvinen, M. Trodd, W.  (2014). Water Framework Directive - Intercalibration Technical Report - Northern Lake Phytoplankton ecological assessment methods, Joint research centre, *Publications Office of the European Union*, 257 p.

Van Dam, H., Mertens, A. and Sinkeldam, J.A. (1994) A coded checklist and ecological indicator values of freshwater diatoms from The Netherlands. *Netherlands Journal of Aquatic Ecology* 28: 117–133.

## Annexes.

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

| Phytoplankton taxa | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Cyanoprokaryota* – cyanobacteria** | | | | | | | | | | | | | | |
| *Achronema articulatum* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Anabaena affinis Lemm.* | . | . | . | . | . | . | + | . | + | . | . | . | | - |
| *Anabaena lemmermnii* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *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 | + | + | + | . | . | + | . | . | . | + | + | . | + | - |
| *Anabaenopsis elenkini* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Aphnocapsa elebans* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *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. | . | + | . | . | . | . | . | + | . | . | . | . | - | - |
| *Merismopedia punctate* Meyen | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Microcystis aeruginosa* Kützing | + | . | . | + | + | + | + | + | + | + | + | + | + | + |
| *Microcystis flos-aquae* (Wittrock) Kirchner | . | . | + | . | . | + | . | . | . | . | . | . | - | - |
| *Microcystis wesebergii* (Kom) Kom. ex Kom. | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Jaaginema gracils* (Bocher) Anagn. et kom. | . | + | . | . | . | . | . | + | . | . | . | . | - | - |
| *Phormidium granulatum* Gardn. Anagn. | + | + | + | . | + | . | . | . | . | . | . | . | - | - |
| *Phormidium tenue* (Agards ex Gomont) Anagn. et kom. | . | + | . | . | . | . | . | . | . | + | . | . | - | - |
| *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 maior* 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 pediculus* Ehr. | . | . | . | . | . | . | . | . | . | + | . | . | - | - |
| *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 amphicephala* (Nageli) Kützing | . | . | . | . | . | . | . | . | . | + | . | . | - | - |
| *Cymbella lanceolata* Agardh | . | . | . | . | . | . | . | . | . | + | . | . | - | - |
| *Cymbella microcephala* Grun. | . | . | . | + | . | + | . | . | . | . | . | . | - | - |
| *Cymbella minuta* Hilse ex Rabenhorst | + | . | + | + | + | + | + | + | + | + | + | + | + | - |
| *Diatoma vulgare* Bory | . | . | . | + | . | . | . | + | . | . | . | . | - | - |
| *Fragilaria capucina* (Desm.) Rabenhorst | . | . | . | + | . | + | . | . | . | . | . | . | + | - |
| *Fragilaria crotonensis* Kitton | + | + | . | + | + | + | + | + | + | + | + | + | + | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fragilaria pinnata* Ehr. | + | . | . | + | . | . | + | + | . | . | . | . | - | + |
| *Fragilaria ulna* (Nitzsch) Lange-Bertalot | + | + | + | + | + | + | + | + | + | + | + | + | + | - |
| *Fragilaria ulna* var. *angustissima* Sippen | + | + | + | + | + | + | + | + | . | + | + | + | + | - |
| *Gomphonema acuminatum* Ehr. | . | . | . | . | + | + | + | . | . | . | . | + | - | - |
| *Gomphonema olivaceum* (Horn.) Breb. | . | . | + | + | . | . | + | . | . | + | . | + | - | - |
| *Gomphonema parvulum* (Kütz.) Kütz. | . | . | . | + | . | . | . | . | + | . | . | . | - | - |
| *Gyrosigma attenuatum* | . | . | . | . | . | . | . | . | . | . | . | + | - | - |
| *Melosira granulata* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Melosira varians* Ag. | + | . | . | . | . | . | . | . | . | . | . | . | | - |
| *Meridion circulare* (Greville) Agardh | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Hippodonta capitata* (Ehr.) L-B. Metz. et Witk. | . | . | . | . | . | + | . | + | + | . | . | . | - | - |
| *Navicula cincta* (Ehr.) Ralfs | + | + | + | . | . | + | + | + | . | + | . | + | - | - |
| *Navicula mensiculus* Schumann | + | . | . | . | . | . | . | . | . | . | . | . | | - |
| *Navicua obonga* | . | . | . | . | . | . | . | . | . | . | . | + | - | - |
| *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. | . | + | . | . | . | . | . | . | + | . | + | . | - | - |
| *Stephanodiscus hantzschii* Grunow | . | . | . | . | . | . | . | . | . | . | + | . | + | - |
| ***Chlorophyta - green algae*** | | | | | | | | | | | | | | |
| *Actinastrum hantzschii* Lagerh. | . | . | . | . | . | . | . | . | + | . | . | . | - | - |
| *Akyra lanceolata* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Ankistrodesmus bibrianus* | . | . | . | . | . | . | . | . | . | . | . | + | - | - |
| *Ankistrodesmus falcatus* (Corda) Ralfs | . | + | . | . | . | . | . | . | . | + | + | . | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Botryococcus braunii* Kütz. | . | . | . | . | . | + | + | + | + | + | + | + | + | + |
| *Characium aqngustatum* A. Braun | . | + | . | + | + | + | + | + | + | . | + | . | - | - |
| *Chlamydomonas globosa* Snow | + | + | + | + | . | + | . | . | . | . | . | . | + | - |
| *Chlamydomonas passiva* Skuja | . | . | + | . | . | + | + | + | . | . | . | . | - | - |
| *Chlamydomonas reinchardtii* Dangeard | . | + | . | . | . | . | . | + | . | . | . | . | - | - |
| *Chlorela oocystoides* Hindak | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Closterium acutum* var. *variabile* (Lemm.) Krieg. | + | . | + | + | . | . | . | + | + | + | + | + | + | - |
| *Coelasrum astroideum* De Notaris | . | . | + | + | + | + | . | + | + | + | + | + | + | + |
| *Coelastrum cambricum* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Coelastrum microporum* Naegel. | . | . | + | . | . | . | . | . | . | + | . | . | - | - |
| *Coelastrum reticulatum* (Dang.) Senn | + | + | . | . | . | . | + | . | + | + | + | . | + | + |
| *Coenocystis planctonica* Korshikov | . | . | . | . | . | . | . | . | + | . | + | + | + | |
| *Cosmarium abbreviatum* Raciborski | + | . | + | + | + | + | + | . | . | . | . | . | - | - |
| *Cosmarium formosulm Lund* | . | . | . | . | . | . | . | . | . | . | . | + | - | - |
| *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 | + | + | + | . | + | . | + | + | + | + | + | + | - | - |
| *Crucigenia quadrata* | | | | | | | | | | | | | | + |
| *Crucigeniella apiculata* | | | | | | | | | | | | | | + |
| *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 | . | . | + | + | . | + | + | + | + | + | + | + | + | + |
| *Eutetramorus plantonicus* (Korschikov) Bourrelly | . | . | . | . | . | . | . | . | . | . | + | + | - | - |
| *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* Naegeli | . | . | . | . | . | . | . | . | + | . | . | . | + | - |
| *Nephrocytium limneticum* (G. M. Sm.) G. M. Sm. | . | . | . | + | . | . | . | . | . | . | . | . | - | - |
| *Oocystis borgei* | | | | | | | | | | | | | - | + |
| *Oocystidium ovale* (Korshikov) | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Oocystis lacustris* Chodat | + | + | + | + | + | . | + | + | + | + | + | + | + | - |
| *Oocystis romboides* (Ehr.) De Toni | . | . | . | . | . | . | . | . | . | . | + | . | | - |
| *Oedogonium sp.* | . | . | . | . | . | . | . | + | . | + | . | . | - | - |
| *Palmelochette tenerrima* Kors. | . | . | . | + | . | . | . | . | . | . | . | . | | - |
| *Pandorina morum* (O.F. Müller) Bory | . | . | + | . | . | + | . | . | . | + | . | + | - | - |
| *Pediastrum angulosum* | | | | | | | | | | | | | - | + |
| *Pediastrum biradiatum* | . | . | . | . | . | . | . | .. | + | . | . | . | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pediastrum boryanum* (Turpin) Meneg. | . | . | + | + | + | + | + | + | + | + | + | + | + | + |
| *Pediastrum simplex* Meyen | . | . | . | . | . | + | . | . | + | + | . | . | - | - |
| *Pediastrum duplex* Meyen | . | . | . | . | . | + | + | + | + | + | + | + | - | - |
| *Pediastrum duplex var. gracillium* West | . | . | . | . | . | . | . | . | + | . | . | . | - | + |
| *Pediastrum tetras* (Ehr.) Ralfs | . | . | + | . | . | . | + | . | . | . | . | . | - | - |
| *Phacotus lendneri* Chodat. | . | . | . | + | + | . | . | . | . | . | . | . | - | - |
| *Phacotus lenticularis (*Ehr.) Stein | + | . | . | + | + | + | + | + | + | + | + | + | + | + |
| *Plankosphaceeria gelatinosa* G.M. Smith | . | . | . | . | . | . | . | . | + | . | + | . | - | + |
| *Provasoliella saccata* (Skuja) Ettl | . | . | . | . | + | . | . | . | . | . | . | . | - | - |
| *Provasiorella* sp. | . | . | . | . | . | . | + | . | . | . | . | . | - | - |
| *Pteromonas angulosa* (Carter) Lemm. | . | + | + | . | . | . | . | . | + | . | . | . | - | - |
| *Pteromonas cordiformis* Lemm. | . | . | + | . | . | . | . | . | + | . | . | . | - | - |
| *Radiococcus nimbatus* (De Wildeman) Schmidle | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Scenedesmus acuminatus* (Lager.) Chodat | . | . | + | . | + | . | + | + | + | + | + | + | - | - |
| *Scenedesmus bicaudatus* Dedusenko | . | . | + | + | + | . | . | . | + | . | . | . | - | - |
| *Scenedesmus dimorphus* (Turp.) Kütz. | . | + | . | + | . | . | . | . | . | . | . | . | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scenedesmus ecornis* (Ehr.) Chod. | . | . | + | + | + | . | + | . | + | . | + | . | - | - |
| *Scenedesmus ellipticus* Corda | . | . | . | . | . | . | . | . | . | . | + | + | - | - |
| *Scenedesmus obtusus* Meyen | . | . | . | + | . | . | . | . | . | + | . | . | + | - |
| *Scenedesmus regularis* Swirenko | . | + | . | . | . | . | . | . | . | . | . | . | - | - |
| *Scenedesmus verucosus* Roll | . | . | . | + | . | . | . | . | . | . | . | . | - | - |
| *Spirogyra sp.* | - | - | - | - | - | - | - | - | - | - | - | - | + | - |
| *Sphaerocystis planctonica* (Korsikov) Bourrelly | . | . | . | + | + | + | + | + | + | + | + | + | + | + |
| *Staurastrum chaetoceras* (Schroeder) Smith | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| *Staurastrum gracile* Ralfs | . | . | + | + | + | + | + | + | + | + | + | + | + | + |
| *Staurastrum paradoxum* Meyen | . | . | . | . | . | . | + | . | . | . | . | . | - | - |
| *Staurastrum tetracerum* Ralfs ex Ralfs | . | . | . | . | . | . | . | . | + | + | + | . | + | |
| *Tetrastrum komarekii* | | | | | | | | | | | | | - | + |
| *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 | . | + | + | + | . | + | + | . | . | . | . | + | - | - |
| *Ulothrix zonata* (Weber & Mohr) Kutzing | . | . | . | . | . | . | . | . | . | . | + | . | - | - |
| ***Cryptophyta - cryptophytes*** | | | | | | | | | | | | | | |
| *Chroomonas acuta* Uterm. | + | . | . | . | + | . | + | . | . | . | . | . | - | - |
| *Cryptomonas erosa* Ehrenberg | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Cryptomonas gracilis* Skuja | . | + | . | . | . | . | . | . | . | . | . | . | - | - |
| *Cryptomonas marssonii* Skuja | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Cryptomonas ovata* Ehrenberg | + | + | + | + | + | + | + | + | + | + | + | + | - | |
| *Cryptomonas rostrata* Troitzskaja emend I. Kiselev | + | . | + | + | + | + | + | + | + | + | + | + | + | + |
| *Rhodomonas minuta* Skuja | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| ***Dinophyta - dinophytes*** | | | | | | | | | | | | | | |
| *Ceratium hirundinella* (F. B. Müller) Bergh | + | + | . | + | + | + | + | + | + | + | + | + | + | + |
| *Ceratium cornutum* (Ehr) Clap.& Lachman | . | . | . | . | . | . | . | + | . | . | . | . | - | - |
| *Gymnodinium aeruginosum* Stein | + | . | . | . | . | + | . | + | . | . | . | . | - | - |
| *Peridiniopsis cuningtonii* Lemm. | + | + | + | + | + | + | + | + | + | + | + | + | + | + |
| *Peridiniopsis polonicum* | . | . | . | . | . | . | . | . | . | . | . | + | - | - |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *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 | . | + | . | + | . | . | . | + | + | . | . | . | - | + |
| *Euglena viridis* | | | | | | | | | | | | | | + |
| *Phacus caudatus* Hubner | . | . | . | . | . | . | . | + | . | . | . | . | - | + |
| *Phacus longicaulola* | | | | | | | | | | | | | - | + |
| *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.**

| | Inflow | Middle 1 | Middle 2 | Aerator 1 | Aerator 2 | Outflow | Beach 1 | Beach 2 |
|---|---|---|---|---|---|---|---|---|
| | 27.06.2022 | 27.06.2022 | 28.06.2022 | 27.06.2022 | 28.06.2022 | 29.06.2022 | 29.06.2022 | 29.06.2022 |
| ***Cyanoprokaryota*** | | | | | | | | |
| *Merismopedia glauca* (Ehr.) Kützing | | | | + | | | | |
| *Microcystis aeruginosa* Kützing | | | | | | | + | |
| *Planktothrix agardhii* (D.C. ex Gom.) Anagn. et Kom. | + | + | + | + | + | + | | + |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Bacillariophyceae*** | | | | | | | | |
| *Asterionella formosa* Hasall | | + | | | + | | + | |
| *Cyclotella ocellata* Pant. | | | | + | | | + | |
| *Cyclotella radiosa* (Grun.) Lemm. | | + | + | + | + | | + | |
| *Fragilaria crotonensis* Kitton | + | + | + | + | + | + | + | + |
| *Navicula radiosa* Kutz | + | + | | + | | | | |
| | | | | | | | | |
| ***Chlorophyta*** | | | | | | | | |
| *Botryococcus braunii* Kutzing | | | | | | | | + |
| *Coelastrum astroideum* De Notaris | | + | + | | + | | + | |
| *Coelastrum microporum* Naegeli | | | + | + | | | | |
| *Coelastrum reticulatum* (Dangeard) Senn | + | + | + | + | + | + | + | + |
| *Cosmarium phaseolus* Brebisson in Ralfs | | | | | + | | | |
| *Crucigeniella apiculata* (Lemm.) Kom. | | | | | + | | | + |
| *Crucigenia quadrata* Mooren | | | + | | | | | |
| *Desmodesmus communis* (Hegew.) Hegew. | | + | | | | | | |
| *Dicellula geminata* (Printz) Korshikov | | | | + | | | | |
| *Dictyosphaerium pulchellum* Wood | | + | + | | | | | |
| *Elkatotrix gelatinosa* Wille | | | + | + | | | | |
| *Micractinium pusillum* Fresenius | | | + | | | | | |
| *Oocystis borgei* Snow | | | | + | | | | |
| *Oocystis lacustris* Chodat | | | + | + | + | + | | + |
| *Pandorina morum* (O.F. Muller) Bory | + | | + | + | + | | + | |
| *Pecliastrum angulosum* Ehr. ex Meneg. | | + | | | | | | |
| *Pediastrum boryanum* (Turpin) Meneg. | | + | + | + | + | | | + |
| *Pediastrum duplex* Meyen | | + | | | | | + | |
| *Phacotus lenticularis (*Ehr.) Stein | | | | + | + | | | |
| Planktosphaeria gelatinosa | | + | + | | | | | |
| *Sphaerocystis planctonica* (Korsikov) Bourrelly | | + | + | + | + | + | + | + |
| *Staurastrum gracile* Ralfs | | + | + | + | + | | + | + |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Tetrastrum komarekii* Hindak | | + | | | + | + | | + |
| *Tetrastrum staurogeanieforme* (Schroed.) Lemm. | | + | | + | + | | | |
| | | | | | | | | |
| ***Cryptophyta*** | | | | | | | | |
| *Cryptomonas erosa* Ehrenberg | | | + | + | + | | | |
| *Cryptomonas marssonii* Skuja | | | | + | | | | |
| *Cryptomonas rostrata* Troitzskaja emend I. Kiselev | | | + | + | + | | | |
| *Rhodomonas minuta* Skuja | | | + | + | + | | | |
| | | | | | | | | |
| ***Dinophyta*** | | | | | | | | |
| *Ceratium hirundinella* (F. B. Müller) Bergh | + | + | + | + | + | | + | |
| *Peridiniopsis cuningtonii* Lemm. | + | + | | + | | | + | |
| *Peridinium cinctum* (O.F. Müller) Ehrenberg | | + | + | | | | | |
| *Peridinopsis elpatiewskyi* (Ostenf.) Bourrelly | | + | | | | | | |
| | | | | | | | | |
| ***Euglenophyta*** | | | | + | | | | |
| *Euglena viridis* (O.F. Mueller) Ehr. | | | + | | | | | |
| *Phacus longicauda* (Ehr.) Dujardin | | | | + | | | | |
| *Trachelomonas hispida* (Perty) Stein | | | + | | | | | |
| *Trachelomonas volvocina* Ehr. | + | | | | | | | |
| | | | | | | | | |
| ***Chrysophyceae*** | | | | | | | | |
| *Dinobryon divergens* Imhof | | | + | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Annex3. Average number of phytoplankton species cells (ind./L) from different depth in Lake Durowskie.**

| | 0 m | 0m | 1m | 2 m | 3m | 4 m | 0m | 1m | 2m | 3m | 4m | 0m | 1m | 2m | 3m | 0m | 1m | 2m | 3m | 4 m | 0m | 0m | 0m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inflow | Middle 1 | Middle 1 | Middle 1 | Middle 1 | Middle 1 | Middle 2 | Middle 2 | Middle 2 | Middle 2 | Middle 2 | Aerator 1 | Aerator 1 | Aerator 1 | Aerator 1 | Aerator 2 | Aerator 2 | Aerator 2 | Aerator 2 | Aerator 2 | Outflow | Beach 1 | Beach 2 |
| | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 28.06.2022 | 28.06.2023 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 29.06.2022 | 29.06.2022 | 29.06.2022 |
| ***Cyanoprokaryota*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Merismopedia glauca* (Ehr.) Kützing | | | | | | | | | | | | | | | 11200 | | | | | | | | |
| *Microcystis aeruginosa* Kützing | | | | | | | | | | | | | | | | | | | | | | 800 | |
| *Planktothrix agardhii* (D.C. ex Gom.) Anagn. et Kom. | 800 | | | | 2400 | | | | | | 6400 | | 800 | 1600 | 800 | | | | | 800 | 800 | | 1600 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Bacillariophyceae*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Asterionella formosa* Hasall | | | | 800 | | | | | | | | | | | | 9200 | | | | 4000 | | 3200 | |
| *Cyclotella ocellata* Pant. | | | | | | | | | | | | 800 | | 1600 | | | | | | | | 800 | |
| *Cyclotella radiosa* (Grun.) Lemm. | | | 800 | | | | | 4800 | | 3200 | 2400 | 16800 | 800 | 1600 | 6900 | 2400 | | 1600 | 1600 | 4000 | | 4800 | |
| *Fragilaria crotonensis* Kitton | 132000 | 32800 | 217600 | 260800 | 640800 | 254400 | 816800 | 256000 | 308800 | 478400 | 980800 | 584800 | 525600 | 197600 | 338400 | 537600 | 634400 | 432000 | 186400 | 1024000 | 342400 | 1238400 | 605600 |
| *Navicula radiosa* Kutz | 1600 | | | 800 | | | | | | | | | | | 1600 | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Chlorophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Botryococcus braunii* Kutzing | | | | | | | | | | | | | | | | | | | | | | | 1600 |
| *Coelastrum astroideum* De Notaris | | 800 | 2400 | | 8000 | | 6400 | | | | | | | | | | | 3200 | | | | 2400 | |
| *Coelastrum microporum* Naegeli | | 1600 | | | | | | | | 20000 | | | | | 800 | | | | | | | | |
| *Coelastrum reticulatum* (Dangeard) Senn | 16800 | 124800 | 121600 | 21600 | | 24000 | | 40800 | 44000 | 17600 | 102400 | 253600 | 102400 | 64000 | 26400 | 38400 | | 24800 | 17600 | | 149600 | 160800 | 800 |
| *Cosmarium phaseolus* Brebisson in Ralfs | | | | | | | | | | | | | | | | 10400 | 3200 | | | | | | |
| *Crucigeniella apiculata* (Lemm.) Kom. | | | | | | | | | | | | | | | | 7200 | | | | | | | 7200 |
| *Crucigenia quadrata* Mooren | | | | | | | | | 4800 | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Desmodesmus communis* (Hegew.) Hegew. | | 800 | | | | | | | | | | | | | | | | | | | | | |
| *Dicellula geminata* (Printz) Korshikov | | | | | | | | | | | | | | 1600 | | | | | | | | | |
| *Dictyosphaerium pulchellum* Wood | | | 800 | | | | | | | | 8000 | | | | | | | | | | | | |
| *Elkatotrix gelatinosa* Wille | | | | | | | 1600 | | | | | 800 | | | | | | | | | | | |
| *Micractinium pusillum* Fresenius | | | | | | | | | 14400 | | | | | | | | | | | | | | |
| *Oocystis borgei* Snow | | | | | | | | | | | | | | 800 | | | | | | | | | |
| *Oocystis lacustris* Chodat | | | | | | | | 800 | | 4000 | | 3200 | | | 4000 | 10400 | | 36800 | 25600 | 3200 | 34400 | | 8000 |
| *Pandorina morum* (O.F. Muller) Bory | 9600 | | | | | | | | 4000 | | | 2400 | 8800 | 800 | | 8000 | | 2400 | 14400 | 800 | | 16000 | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pecliastrum angulosum* Ehr. ex Meneg. | | 1600 | | | | | | | | | | | | | | | | | | | | | |
| *Pediastrum boryanum* (Turpin) Meneg. | | 26400 | | | | | | | | | 800 | 800 | 24800 | | | | 1600 | | | 800 | | | 1600 |
| *Pediastrum duplex* Meyen | | | 800 | | | | | | | | | | | | | | | | | | | 1600 | |
| *Phacotus lenticularis (*Ehr.) Stein | | | | | | | | | | | | | | 800 | | | | 2400 | | | | | |
| Planktosphaeria gelatinosa | | 2400 | 8000 | | | 1600 | | 1600 | 800 | | 2400 | | | | | | | | | | | | |
| *Sphaerocystis planctonica* (Korsikov) Bourrelly | | 26400 | 164000 | 64000 | 51200 | 8000 | 28000 | 19200 | 33600 | 62400 | 26400 | 91200 | 38400 | 32800 | 7200 | 10400 | 23200 | | 20800 | 63200 | 56000 | 40000 | 52800 |
| *Staurastrum gracile* Ralfs | | | 1600 | | 1600 | 2400 | 2400 | | | 3200 | 2400 | 8000 | 1600 | 1600 | 800 | | 19200 | | 4800 | 1600 | | 10400 | 4800 |
| *Tetrastrum komarekii* Hindak | | 800 | | | | | | | | | | | | | | | 1600 | | 7200 | | 11200 | | 8000 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Tetrastrum staurogeanieforme* (Schroed.) Lemm. | | | | | | 4000 | | | | | | | | | 800 | 7200 | | 800 | 20800 | 12000 | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Cryptophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | 800 | | | 21600 | | | 1600 | | | | | 1600 | | | | |
| *Cryptomonas marssonii* Skuja | | | | | | | | | | | | | | | 800 | | | | | | | | |
| *Cryptomonas rostrata* Troitzskaja emend I. Kiselev | | | | | | | | | | | 1600 | | | | 800 | | | 800 | | | | | |
| *Rhodomonas minuta* Skuja | | | | | | | | | | | 800 | | | 800 | | | 800 | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Dinophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Ceratium hirundinella* (F. B. Müller) Bergh | 11200 | | 800 | | 1600 | 4000 | 1600 | 800 | 800 | 4000 | 19200 | | | | 4000 | 3200 | 5600 | | 4800 | 10400 | | 1600 | |
| *Peridiniopsis cuningtonii* Lemm. | 33600 | | | 1600 | | 800 | | | | | | | | 800 | 1600 | | | | | | | 800 | |
| *Peridinium cinctum* (O.F. Müller) Ehrenberg | | | | 1600 | | | | | | | 1600 | | | | | | | | | | | | |
| *Peridinopsis elpatiewskyi* (Ostenf.) Bourrelly | | | 800 | | | | | | | | | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Euglenophyta*** | | | | | | | | | | | | 800 | | | | | | | | | | | |
| *Euglena viridis* (O.F. Mueller) Ehr. | | | | | | | 800 | 800 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Phacus longicauda* (Ehr.) Dujardin | | | | | | | | | | | | | | 800 | | | | | | | | | |
| *Trachelomonas hispida* (Perty) Stein | | | | | | | 800 | | | | | | | | | | | | | | | | |
| *Trachelomonas volvocina* Ehr. | 4800 | | | | | | | | | | | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Chrysophyceae*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Dinobryon divergens* Imhof | | | | | | | | | | | 2400 | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

**Annex 4. Average biomass of phytoplankton species (mg/L) from different depth in Lake Durowskie**

| | 0m | 0m | 1m | 2m | 3m | 4m | 0m | 1m | 2m | 3m | 4m | 0m | 1m | 2m | 3m | 0m | 1m | 2m | 3m | 4m | 0m | 0m | 0m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inflow | Middle 1 | Middle 1 | Middle 1 | Middle 1 | Middle 1 | Middle 2 | Middle 2 | Middle 2 | Middle 2 | Middle 2 | Aerator 1 | Aerator 1 | Aerator 1 | Aerator 1 | Aerator 2 | Aerator 2 | Aerator 2 | Aerator 2 | Aerator 2 | Outflow | Beach 1 | Beach 2 |
| | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 27.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 28.06.2022 | 29.06.2022 | 27.06.2022 | 27.06.2022 |
| ***Cyanoprokaryota*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Merismopedia glauca* (Ehr.) Kützing | | | | | | | | | | | | | | | 0,002 | | | | | | | | |
| *Microcystis aeruginosa* Kützing | | | | | | | | | | | | | | | | | | | | | | 0,001 | |
| *Planktothrix agardhii* (D.C. ex Gom.) Anagn. et Kom. | 0,001 | | | | 0,003 | | | | | | 0,008 | | 0,001 | 0,002 | 0,001 | | | | | 0,001 | 0,001 | | 0,002 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Bacillariophyceae*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Asterionella formosa* Hasall | | | | 0,001 | | | | | | | | | | | | 0,002 | | | | 0,001 | | 0,006 | |
| *Cyclotella ocellata* Pant. | | | | | | | | | | | | 0,001 | | 0,001 | | | | | | | | 0,001 | |
| *Cyclotella radiosa* (Grun.) Lemm. | | 0,001 | | | | 0,005 | | 0,006 | | 0,004 | 0,003 | 0,021 | 0,001 | 0,002 | 0,008 | 0,003 | | 0,002 | 0,002 | 0,001 | | 0,006 | |
| *Fragilaria crotonensis* Kitton | 0,06 | 0,015 | 0,174 | 0,012 | | 0,115 | 0,37 | 0,116 | 0,14 | 0,217 | 0,444 | 0,265 | 0,238 | 0,089 | 0,153 | 0,244 | 0,287 | 0,196 | 0,084 | 0,464 | 0,155 | 0,561 | 0,274 |
| *Navicula radiosa* Kutz | 0,008 | | | 0,02 | | | | | | | | | | | 0,003 | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Chlorophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Botryococcus braunii* Kutzing | | | | | | | | | | | | | | | | | | | | | | | 0,007 |
| *Coelastrum astroideum* De Notaris | | 0,003 | | | 0,026 | | 0,002 | | | | | | | | | | | 0,01 | | | | | |
| *Coelastrum microporum* Naegeli | | 0,012 | | | | | | | | | | | | | 0,006 | | | | | | | | |
| *Coelastrum reticulatum* (Dangeard) Senn | 0,064 | 0,473 | 0,391 | 0,819 | | 0,09 | 0,254 | 0,155 | 0,167 | 0,067 | 0,388 | 0,961 | 0,388 | 0,242 | 0,01 | 0,146 | | 0,094 | 0,067 | 0,076 | 0,567 | 0,609 | 0,649 |
| *Cosmarium phaseolus* Brebisson in Ralfs | | | | | | | | | | | | | | | | 0,044 | 0,014 | | | | | | |
| *Crucigeniella apiculata* (Lemm.) Kom. | | | | | | | | | | | | | | | | 0,003 | | | | | | | 0,007 |
| *Crucigenia quadrata* Mooren | | | | | | | | | 7E-04 | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Desmodesmus communis* (Hegew.) Hegew. | | 0,001 | | | | | | | | | | | | | | | | | | | | | |
| *Dicellula geminata* (Printz) Korshikov | | | 0,004 | | | | | | | | 0,034 | | | | | | | | | | | | |
| *Dictyosphaerium pulchellum* Wood | | | | | | | | | | | | | | 3E-04 | | | | | | | | | |
| *Elkatotrix gelatinosa* Wille | | | | | | | 0,001 | | | | | 0,001 | | | | | | | | | | | |
| *Micractinium pusillum* Fresenius | | | | | | | | | 0,017 | | | | | | | | | | | | | | |
| *Oocystis borgei* Snow | | | | | | | | | | | | | | 0,002 | | | | | | | | | |
| *Oocystis lacustris* Chodat | | | | | | | 0,002 | | | 0,01 | | 0,008 | | 0,006 | 0,01 | | 0,027 | 0,094 | 0,065 | 0,008 | 0,088 | | 0,02 |
| *Pandorina morum* (O.F. Muller) Bory | 0,046 | | | | | | 0,134 | | 0,022 | | | 0,109 | 0,04 | 0,003 | | | | 0,012 | 0,069 | 0,004 | | 0,077 | 0,138 |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Pecliastrum angulosum* Ehr. ex Meneg. | | 0,02 | | | | | | | | | | | | | | | | | | | | | |
| *Pediastrum boryanum* (Turpin) Meneg. | | 0,024 | 0,023 | | | | | | | | 0,024 | 0,026 | 0,024 | | | | 0,047 | | | 0,024 | | 0,047 | 0,047 |
| *Pediastrum duplex* Meyen | | | 0,023 | | | | | | | | | | | | | | | | | | | 0,023 | |
| *Phacotus lenticularis (*Ehr.) Stein | | | | | | | | | | | | | | 0,001 | | | | 0,001 | | | | | |
| Planktosphaeria gelatinosa | | *0* | 0,01 | | | 0 | | *0,01* | 0,002 | | *0,01* | | | | | | | | | | | | |
| *Sphaerocystis planctonica* (Korsikov) Bourrelly | | 0,062 | 0,374 | 0,001 | 0,117 | 0,018 | 0,001 | 0,044 | 0,077 | 0,142 | 0,06 | 0,208 | 0,088 | 0,074 | 0,016 | 0,024 | 0,053 | 0,047 | 0,007 | 0,144 | 0,128 | 0,091 | 0,12 |
| *Staurastrum gracile* Ralfs | | | 0,041 | | 0,004 | 0,006 | 0,006 | | | 0,008 | 0,006 | 0,002 | 0,004 | 0,004 | 0,002 | 0,024 | 0,048 | | 0,012 | 0,004 | | 0,027 | 0,012 |
| *Tetrastrum komarekii* Hindak | | 0,001 | | | | | | | | | | | | | | | 3E-04 | | 0,001 | | 0,008 | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Tetrastrum staurogeanieforme* (Schroed.) Lemm. | | | | | | 0,001 | | | | | | | | | 3E-04 | 0,001 | | 1E-04 | 0,003 | 0,003 | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Cryptophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Cryptomonas erosa* Ehrenberg | | | | | | | | 0,001 | | | 0,035 | | | 0,002 | | | | | 0,003 | | | | |
| *Cryptomonas marssonii* Skuja | | | | | | | | | | | | | | | 0,001 | | | | 0,003 | | | | |
| *Cryptomonas rostrata* Troitzskaja emend I. Kiselev | | | | | | | | | | | | | | | 0,001 | | | 0,01 | | 0,003 | | | |
| *Rhodomonas minuta* Skuja | | | | | | | | | | | 0,001 | | | 0,001 | | | 0,001 | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Dinophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Ceratium hirundinella* (F. B. Müller) Bergh | 1,083 | | 0,774 | | | 0,387 | 0,154 | | 0,077 | 0,039 | 1,857 | | | | 0,386 | 0,031 | 0,542 | | 0,464 | 1,006 | | | |
| *Peridiniopsis cuningtonii* Lemm. | 0,388 | | | 0,018 | | 0,009 | | | | | | | | 0,009 | 0,018 | | | | | | | | |
| *Peridinium cinctum* (O.F. Müller) Ehrenberg | | | | 0,042 | | | | | | | 0,042 | | | | | | | | | | | | |
| *Peridinopsis elpatiewskyi* (Ostenf.) Bourrelly | | | 0,064 | | | | | | | | | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Euglenophyta*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Euglena viridis* (O.F. Mueller) Ehr. | | | | | | | 0,006 | 0,006 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Phacus longicauda* (Ehr.) Dujardin | | | | | | | | | | | | | | | 0,005 | | | | | | | | |
| *Trachelomonas hispida* (Perty) Stein | | | | | | | 0,001 | | | | | 0,001 | | | | | | | | | | | |
| *Trachelomonas volvocina* Ehr. | 0,005 | | | | | | | | | | | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |
| ***Chrysophyceae*** | | | | | | | | | | | | | | | | | | | | | | | |
| *Dinobryon divergens* Imhof | 0,001 | | | | | | | | | | 0,001 | | | | | | | | | | | | |
| *Total* | | | | | | | | | | | | | | | | | | | | | | | |

**Annex 5. Comparison of periphyton species composition in different investigated sites from 25th June to 29th 2018 in Lake Durowskie.**

| **Diatom taxa** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **pH** | **O** | **T** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Achnantes rostrata* Ostrup | | + | | + | | | | | | | | | - | - | - |
| *Achnanthes conspicua* Mayer | | + | | | + | | | + | | | | | 3 | 2 | 7 |
| *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 |
| *Amphora copulata* (Kützing) Sch. & Archibald | + | + | | + | | | | | | | | | - | - | - |
| *Amphora ovalis* Kützing | + | + | + | + | + | + | + | + | + | + | + | + | 4 | 2 | 5 |
| *Amphora pediculus* (Kütz.) Grunow | + | + | + | + | + | + | + | + | + | + | + | | 4 | 2 | 5 |
| *Asterionella formosa* Hass | + | + | + | | + | | + | + | + | + | | | 4 | 2 | 5 |
| *Caloneis bacillum* (Grun.) Meresz. | | + | | + | | | | + | | | + | + | 4 | 2 | 4 |
| *Caloneis silicula* (Ehr.) Cleve | | | | | + | | | | | | | | 4 | 2 | 4 |
| *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 silesiaca* (Bl.) Mann | | | + | + | | | | | | | | | 3 | 3 | 7 |
| *Cymbella tumida* (Bréb.) Van Heurck | | + | + | | | | | + | + | + | | | 4 | 1 | 4 |
| *Cymbella turgida* (Greg.) Cleve | + | | | | | | | | | | | | - | - | - |
| *Diatoma tenuis* Agardh | | | + | | + | | | | + | + | | | 4 | 3 | 5 |
| *Diatoma vulgaris* Bory | + | + | + | + | + | + | + | + | + | + | | | 5 | 2 | 4 |
| *Diploneis elliptica* (Kützing) Cleve | | | + | | + | + | | | + | + | | | 4 | 1 | 3 |
| *Encynomena silesiacaum* (Bleisch in Rabenh.) D. G. Mann | | | | | | | | | | | + | | | | |
| *Eunotia exigua* (Breb.) Rabenh. | + | | + | | + | | | | + | | | | 1 | 2 | 7 |
| *Eunotia bilunaris* (Ehr.) Mills | | | | | | + | | | | | | | | | |
| *Eunotia faba* (Ehr.) Grun. | | | | | + | | | | | | | | 2 | 1 | 2 |
| *Eunotia praerupta* Ehr. | + | + | + | | + | + | + | + | + | + | | + | 2 | 1 | 2 |
| *Fragilaria capitata* Ehr. | | + | | + | | | | + | + | | | + | - | - | - |
| *Fragilaria capucina* (Desm.) Rabenhorst | + | + | + | + | + | + | + | + | + | + | + | + | 3 | - | 3 |
| *Fragilaria capucina v. amphicephala* (Kützing) Lan.-Bertalot | | | + | | | | | | + | + | | | - | - | - |
| *Fragilaria construens* (Ehr.) Grun. | | + | + | | + | | + | + | | | | + | 4 | 1 | 4 |
| *Fragilaria crotonensis* Kitton | + | | + | | + | + | + | + | + | + | + | + | 4 | 2 | 3 |
| *Fragilaria dilatata* (Breb.) Lange-Bertalot | | | | + | | | | | | | | | | | |
| *Fragilari delicatissima* (Smith) Lange-Bertalot | | | | + | | | | | | | | | 3 | - | 3 |
| *Fragilaria exigua* Grun. | | | + | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Fragilaria martyi* (Heribaud) Lange-Bertalot | | | | | + | | | | + | + | | | - | - | - |
| *Fragilaria pinnata* Ehr. | | + | + | + | + | + | + | + | | + | + | + | 4 | 1 | 7 |
| *Fragilaria ulna* (Nitzsch) Lange-Bertalot | + | + | | + | + | + | + | + | | + | + | + | 4 | 3 | 7 |
| *Fragilaria ulna* var. *angustissima* Sippen | + | + | + | + | + | + | | + | | + | + | + | 4 | 2 | 7 |
| *Gomphonema acuminatum* Ehr. | + | | + | | + | + | | | + | + | + | | 4 | 2 | 5 |
| *Gomphonema 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 gastrum* (Ehr.) Kützing | | | + | | | | | | + | + | | | 4 | 4 | 5 |
| *Navicula gregaria* Donkin | | | | | | + | + | | | | + | | 4 | 4 | 5 |
| *Navicula oblonga (*Kützing) Kützing | | | + | | | | | | + | | | | - | - | - |
| *Navicula placentula (*Placeneis) | | | + | | + | | | | | + | | | 4 | 2 | 5 |
| *Navicula radiosa* Kützing | + | + | + | + | + | + | + | + | + | + | + | + | 3 | 2 | 4 |
| *Navicula reinhardtii* Grun. | | + | + | + | | | + | + | + | + | | + | 5 | 2 | 5 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Navicula tripunctata* (O. F. Müller) Bory | + | + | + | + | + | + | + | + | + | + | + | + | 4 | 2 | 5 |
| *Navicula veneta* Kützing | | | | + | | | + | + | + | + | | | 4 | 4 | 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 curvata* (Kütz.) Grun. | | + | | + | | + | | + | | | + | + | - | - | - |
| *Rhopalodia gibba* (Ehr.) Müller | + | + | + | | | + | | + | + | + | + | | 5 | 3 | 5 |
| *Stauroneis phoenicentron* Ehr. | + | + | | + | | + | | + | | | + | + | 3 | 3 | 4 |
| *Stephanodiscus astraea* (Kützing) Grunow | | | | | + | | + | + | + | + | | | - | - | - |
| *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 |
| *Tabellaria flocculosa* (Roth) Kütz. | | | | | | | | | | + | + | | 2 | 1 | 3 |
| *Nitzschia oblongella* Ostrup | | | | | | | | | | + | | | - | - | - |