Report

Summer School

Field Trip Hydrobiology Poland

Macrophytes as an indicator of environmental change in Durowskie Lake, Poland

Submitted by

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1. Introduction

Lakes are a vital part of the environment. They serve a purpose of refuge for a plethora of animal and plant species related to the water environment, which is why they represent a high degree of biodiversity. Those water bodies provide both shelter and food to the organisms living there.

Moreover, lakes are an important contribution for communities living in its' settings. It is serving the purpose of recreation for people living nearby, which can pursue a variety of water related hobbies, including sailing, water sports or swimming (Goldyn et al., 2013).

Lakes contain variating levels of nutrients and degrees of flora development, both surround and within. In view of those variations those lakes might then be classified as *eutrophic lakes* containing the highest concentration of nutrients, *oligotrophic lakes* containing the lowest, and *dystrophic lakes* where the functioning of the lake itself is disrupted heavily by a random factor. Furthermore there are also *hypertrophic lakes*, with an overflow of nutrients and phosphorus and nitrate compounds, most commonly due to sewage inflow. (Podbielkowski and Tomaszewicz, 1979).

Nowadays, the quality of many lake water bodies might be steadily decreasing due to local urban development and climate change. Owing to the increase of global temperature, the lakes might produce algae blooms much more often, which impacts negatively the water transparency and its quality. It might also trigger a decrease in the oxygenation of the water, which therefore might influence the fauna and flora. The quality of the lake is also affected by the quantity of nutrients, which might get to the water circuit from the sewage, local agricultural lands and the remains of dead plants. All of those influences factor algae blooms, which decrease the quality of water, and also might prove to be toxic.

These ecological challenges are also present at Durowskie Lake and thus been researched in detail annually since 2008. During this 11 years the state of the lake has been steadily improving, due to aerators construction and other activities, which were suggested by the experts from both Adam Mickiewicz University (Poznan, Poland) and Christian Albrecht University (Kiel, Germany). The state of the lake, according to the framework of ecological classes of Environmental Department of

Poland in 2008, has still not been achieved in a manner of *good* class, and it has stabilised upon the *moderate* class. It has improved from the initial state, since, by comparison, the initial class was *low*. The initial *low* state of the lake has been a result of years of sewage influx into the Struga Golaniecka river, which itself is an inflow to Durowskie Lake. Moreover the parts of the surrounding terrain has and is still used as agricultural farmland, which by fertilization had been severely impacted by phosphorus compounds which then flowed into the lake due to natural water circulation, increasing the eutrophication and the amount of phosphor in it. Struga Golaniecka's sewage influx has been shut down in 2006, nevertheless the lake has been already heavily eutrophisized and significantly differed from its normal state (Macroinvertebrate Report, 2014).

A significant event in the history of this lake was a great algae bloom throughout the wake in 2009. Due to this, the whole lake has been closed for recreational purposes, and Wagrowiec city council had introduced the restoration processes in which AMU was involved (Goldyn et al., 2013).

Among others macrophytes are a very important element of lakes due to their regulation functions. They heavily impact its' quality, because of the fact of their great biomass, which is then used by other organisms living in the lake. They provide food and refuge for zooplankton, fish and other wildlife species which have a regulating impact on phytoplankton growth. Macrophytes mostly consist of by water and rush plants. Those specimens produce oxygen, especially by leakage from their roots which is used by other organisms in the deeper parts of the lakes. Macrophytes are also a good indicator of those parts of lakes where the circuit of matter is the most intensive. Furthermore it is a direct barrier and a filter against compounds flowing form the catchment area. This barrier is also protecting the shores against erosion and they strengthen the shores themselves.

After their death however, macrophytes form nutrient-rich sediments on the bottom of the lake. Macrophytes and organic matter created by decaying plants impact heavily the physicochemical parameters like pH, O_2, and conductivity (Thomaz and da Cunha, 2010).

Upon very specific species of macrophytes assessments can be made of what the quality of the lake is, since some of those macrophytes are indicator organisms.

That is also why it is crucial to take them into account while restoration of the lake processes are designed[7].

The aim of this paper is therefore to describe the current state of macrophytes of the Durowskie Lake and the comparison of the results with previous years, to assess if the state of the lake has improved or decreased. In order to do that two indices, the Ecological State Macrophyte Index (ESMI) and the Macrophyte Index of Rivers (MIR) will be calculated, in accordance with Water Framework, and the quality of water will be evaluated[5,8]. Plant associations will be measured and processed in the Durowskie lake. Additionally, abundance and amount of plant species in the outflow river of Durowskie lake will be surveyed.

To sum up, the following questions will be addressed:

- What macrophyte associations are growing in and at the shoreline of Lake Durowskie?
- What size is each association constituting?
- What proportion are the submerged species constituting?
- How did the macrophyte data change compared to the previous years?
- What information can be drawn from changing sizes of indicator associations?
- Are the restoration treatments for improving the lake's water quality effective?

2. Materials and Methods

Study Area

The study area comprised of the *Durowskie Lake* (or *Durowo*), a postglacial (Riss glaciation) ribbon lake of 143.7 ha, located in Chodziez Lake District, part of the Greater Poland Lake District, upon the town of Wagrowiec. Resulting from its formation it has a quite significant length of 6 km and a maximum depth of 14 m. The Durowskie Lake consists of a large catchment area due to Struga Golaniecka river which flows through other lakes (Kobyleckie, Bukowieckie, Grylewskie) and feeds the water body. It consists mainly of forestry, agricultural land, and urban areas.

Field work

Based on an actual six-day field studies in the summer of 2019 in the area, empirical research was conducted assessing the biodiversity of the flora in the lake and specifically at the shoreline. Various methods were used. The size of plant associations along the lake shore were estimated visually, while taking points on a GPS device in order to process the localization data in GIS systems. First, the dominating and name-giving species was identified according to Braun-Blanquet methods. Afterwards the width and the length of the association areas were assessed This was done according to the Polish water framework directive, concerning the dominating macrophytes species index. The locations were reached by foot and by boat. Moreover, an anchor was used in order to approximate the submerged vegetation, i.e. mosses.

Data analysis

GIS WorkThe geographical raw data was processed with QGIS in order to convert them into spatial geopoints and then with ArcGIS to draw spatial polygons and calculate the size of the association areas for further statistical analysis.

Indices

To analyse the ecological conditions of the Durowskie Lake two indices were calculated, the Ecological State Macrophyte Index (ESMI) and the Macrophyte Index for Rivers (MIR). The ESMI is an index for assessing ecological conditions of lakes on basis of macrophytes compliant with the Water Framework Directive (Ciecierska, Kolada, 2014) whereas the MIR is an index for assessing the ecological conditions of rivers.

For ESMI calculations flora associations were measured and processed in the area of lake Durowskie, and upon those,the degree of biodiversity was calculated. The following formula was used for calculations:

With: H – diversity index of phytocenosis

n_i – area of polygons one of association in percent per cover

$$ESMI = 1 - \exp\left[-\frac{H}{H_{max}} \cdot Z \cdot exp\left(\frac{N}{P}\right)\right]$$

$$H = -\sum \frac{n_i}{N} \cdot \ln \frac{n_i}{N}$$

$$H_{max} = \ln S$$

$$Z = \frac{N}{P_{isob2.5}}$$

N – all cover of macrophytes

H_{max} - coefficient of variation of the theoretical maximum

S – number of associations

Z – occupancy index

isob2.5m – area of littoral limited by isobath 2.5 m

P – area of the lake

The index can have a value between 0 and 1. Value of zero indicate a complete degradation of the lake, whereas the index with the value of 1 indicates that the given flora is the most similar to the flora that is supposed to be there[5].

MIR however, is an indicator of trophic states of rivers. It is assessed by the coverage of indicator plants on a given river. This index is used to biomonitor the state of flowing rivers[8].

Following formula was used for MIR calculations:

$$MIR = \frac{\sum Li*Wi*Pi}{\sum Wi*Pi} * 10$$

With: L and W are indicator values for each species

P = percentage coverage (split into discrete categories) for that species

Table 1 shows the categories of different ecological conditions of ESMI and MIR with their threshold values.

Table 1: ESMI and MIR Classification of ecological conditions of lakes and rivers

Ecological status	ESMI Index	MIR Index
Very good	≥ 0,680	≥44.5
Good	≥ 0,410	44.5-35.0>
Moderate	≥ 0,205	35.0-25.4>
Poor	≥ 0,070	25.4-15.8>
Bad	< 0,070	<15.8

3. Results

Table 2 lists all associations identified and surveyed in lake Durowskie in 2019. Altogether there were 21 associations, four less than the previous years.

Table 2: Plant associations growing in Lake Durowskie 2019

Name association	***Total [m²]***	***% area***
Phragmitetum communis	64758,94	49%
Fontinaletum antipyreticae	38945,9	29%
Typhetum angustifoliae	11937,49	9%
Myriophylletum spicati	10597,54	8%
Nupharo-Nymphaeetum	4146,796	3%
Acoretum calami	669,3275	1%
Potametum perfoliati	462,7843	0%
Ceratophylletum demersi	398,954	0%
Caricetum ripariae	379,117	0%
Sparganietum erecti	292,7012	0%
Scirpetum lacustris	83,40309	0%
Glycerietum maximae	80,36526	0%
Thelypteridi-Phragmitetum	50,0866	0%
Butometum umbelati	45,79725	0%
Cicuto-Caricetum pseudocyperi	16,63538	0%
Typhetum latifoliae	16,58997	0%
Potametum lucentis	14,0287	0%
Eleocharitetum palustris	13,0189	0%
Najadetum marinae	5,697873	0%
Iridetum pseudacori	3	0%
Phalaridetum arundinaceae	2,5887	0%
Total	**132522**	**100%**

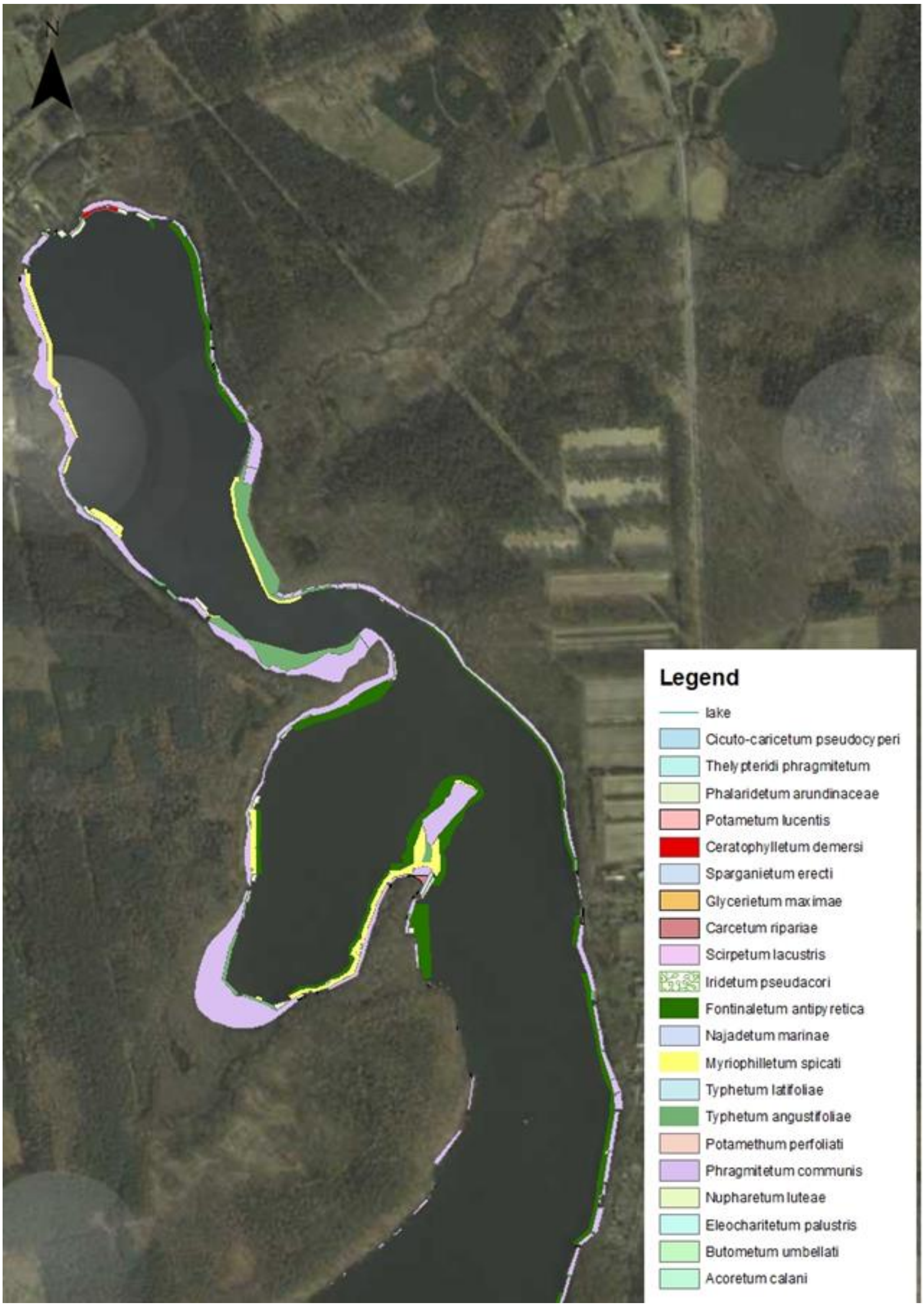

Figure 1: North part of Durowski Lake

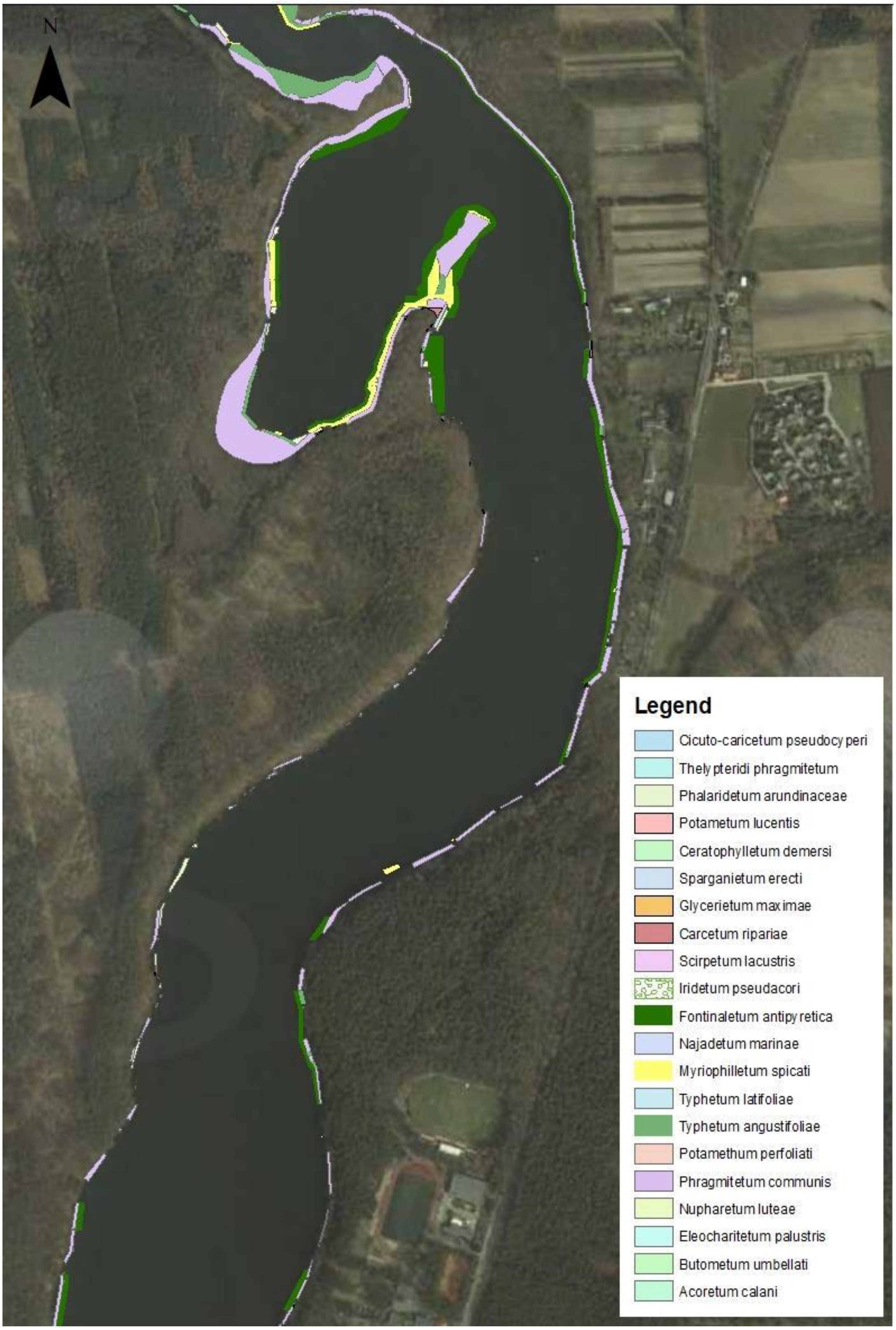

Figure 2: The central part of Lake Durowski

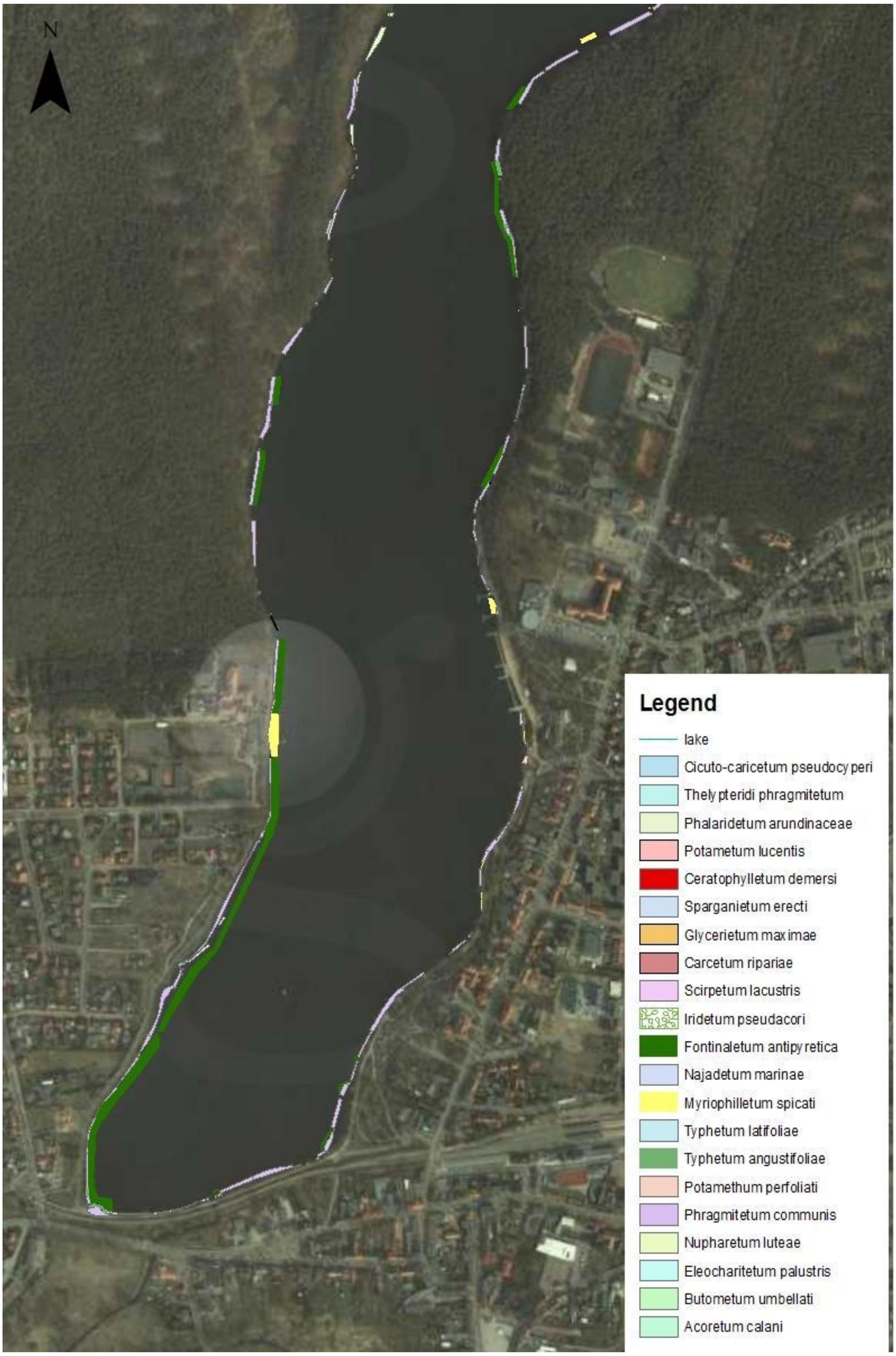

Figure 3: The south part of Durowski Lake

The most common macrophyte association on the surface of Lake Durowskie was *Phragmitetum communis*, as it covered 49% (see Figure 4) of all macrophytes in that lake. The second most common association was *Fontinaletum antipyreticae*, covering 29%. Amongst the 5 most popular associations one could also find *Typhetum angustifoliae* (9%), *Myriophylletum spicati* (8%) and *Nupharo-nymphaeetum* (3%), with the rest of the associations covering 2%.

In comparison to the results of 2018 research, the fastest developing association was *Fontinaletum antipyreticae*, which has more than doubled its coverage (it has increased by 130%). Out of the top five plant associations on our list only one other has increased its coverage, *Nupharo-nymphaeetum*, by a total of 4%.

Phragmitetum communis has decreased its coverage by 2% in comparison to 2018, *Typhetum angustifoliae* by 8%, and the biggest fall happened to *Myriophylletum spicati* with a 23% loss.

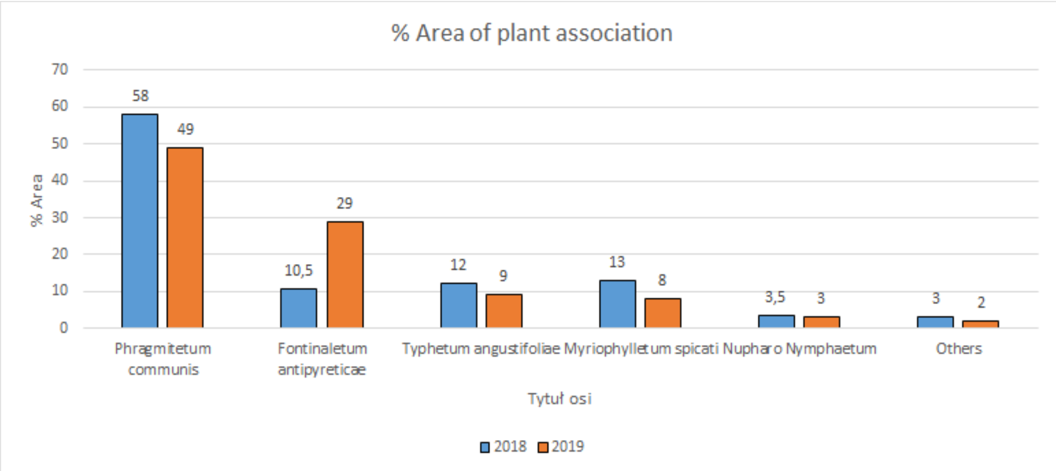

Figure 4: Five most occuring plant associations in comparison 2018 and 2019

Submerged associations

In 2019 Lake Durowskie at the moment of the research was represented 7 associations of water plants. It is worth noting that since the beginning of the previous years' research, there has been a great, thirteen-fold, increase in surface taken over by macrophytes and takes up now 54571 m² (Figure 5).

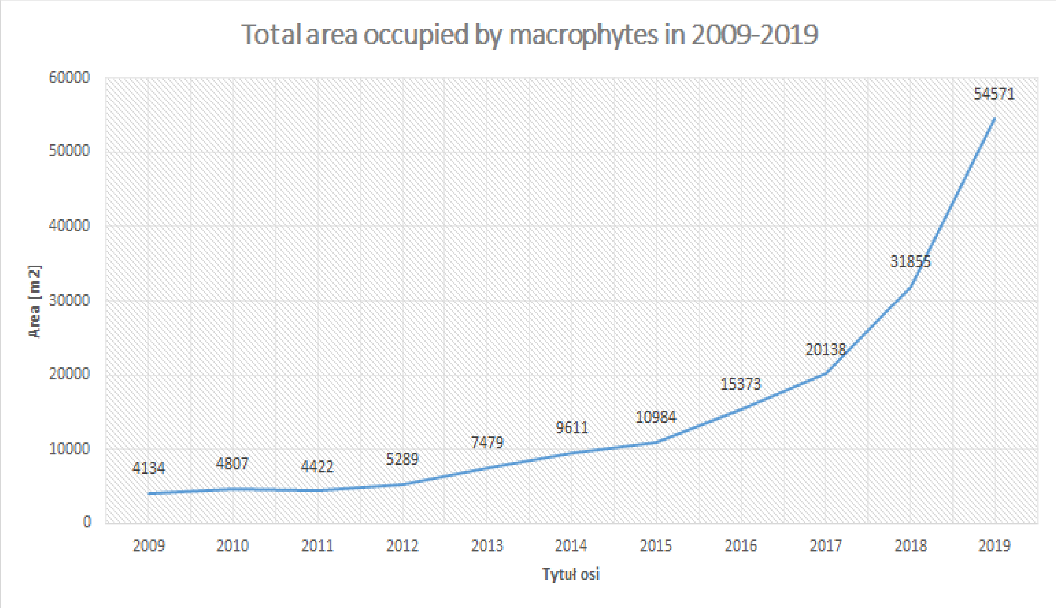

Figure 5: Development of area taken up by submerged plant associations in total from 2009-2019

The most common submerged plant association in this lake was *Fontinaletum antipyreticae* with a surface of 38,945.90 m^2. The second place belongs to *Myriophylletum spicati* with a surface of 10,597.53 m^2, which is still three times less than the first place.

Since its appearance in 2014, *Fontinaletum spicati* has been showing rising tendencies in terms of its surface. In 2019 it dominated all other water plant associations and has increased its surface threefold. *Npharo-nymphaeetum* has also increased its surface, by 700 m^2. Moreover, for the first time *Ceratophylletum demersi* was found in Lake Durowskie, covering 400 m^2. However, despite finding *Charetum tomentosae*, *Charetum contrariae* and *Nitellopsidatum obtusae* last year, they were not present this year. Surface of *Potametum perfoliati* has decreased two-fold in comparison to last year. *Myriophylletum spicati* has also fallen in size, by 5.000 m^2, and *Najadetum marinae* is a species which has decreased in size from 186 m^2 to only about 5 m^2.

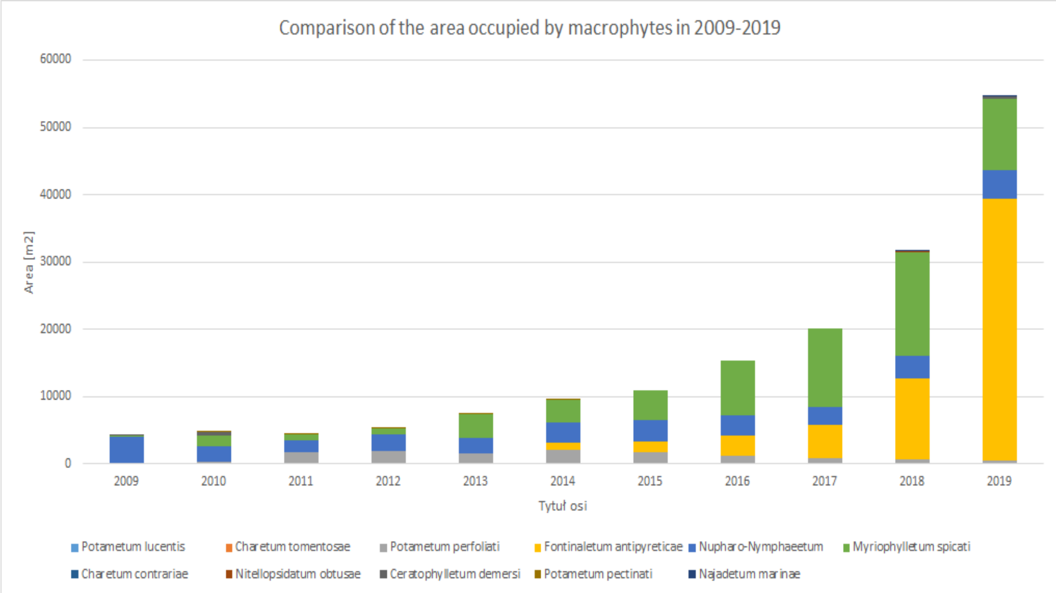

Figure 6: Development of area taken up by submerged plant associations from 2009-2019, listing all present plant associations.

Indices

2019 the ESMI of the Durowskie lake had a value of 0,205 which corresponds with a moderate ecological status of the lake (cf. Table 1) but is at the very threshold to moderate conditions.

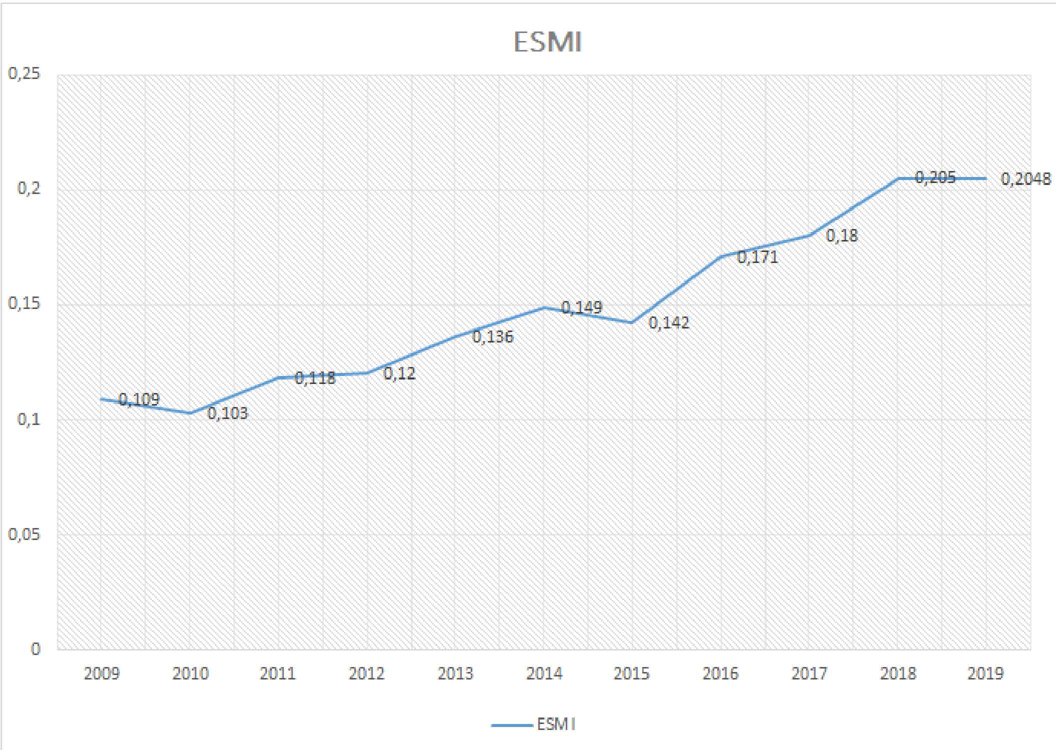

Figure 7: Development of ESMI 2009-2019

Figure 7 displays the development of the ESMI from 2009 till 2019. It started in 2009 with 0,109 in poor ecological conditions and increased with some slight fluctuations to the value of 0,205 in 2018, the threshold value for a moderate ecological status. From 2018 to 2019 the ESMI did not change its value of 0,205 .

The MIR of 2019 had a value of 32,41 which corresponds with a moderate ecological status (cf. table 1).

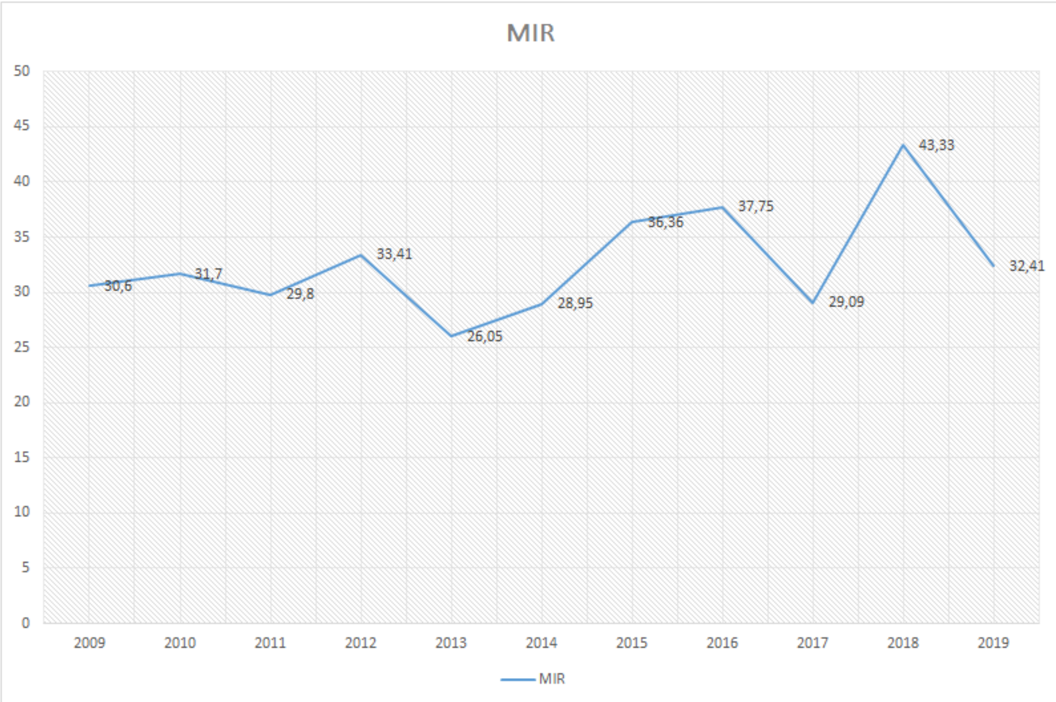

Figure 8: Development of MIR 2009-2019

Figure 8 shows the development of the MIR from 2009 to 2019. It started with a value of 30,6 in 2009 in moderate conditions. Until 2014 it fluctuated in moderate conditions. In 2015 and 2016 it increased to good conditions. After a radical decrease to 29,09 in 2017 it increased again to a peak value of 43,33 in 2018. From 2018 to 2019 it radically decreased again to moderate conditions (32,41).

4. Discussion

Lake Durowskie in comparison to last year has been observed to have two less macrophytes associations present, as there has been only twenty-one. However, the total coverage of macrophytes has increased; the tendencies of macrophytes to increase their coverage has been observed from the very beginning of the research. The more macrophytes in the lake the more significant the barrier against substances that might flow into the lake and disturb its physic-chemical properties. Bigger quantity of macrophytes is also equal to bigger quantity of shelter for zooplankton, invertebrates and fish. However, it is worth noting, that not all macrophytes’ growth suggests good water quality (Thomaz & da Cunha 2010).

The lake within our research has also experienced growth of *Ceratophyllum demersum*. It is an adverse change, signifying hypertrophy of the lake. There has not been enough of specimen of those last year, to claim an association, and this year those associations took around 400 m^2. This species has not been present in this quantity in this lake since 2010, suggesting higher hypertrophic conditions in the northern part of the lake. This is also where single specimen of this species have been found in 2018. Its most likely resulting from new built housing and building might release their nutrient-high sewage into the water triggering this process (Wojciech Pęczuła, 2012).

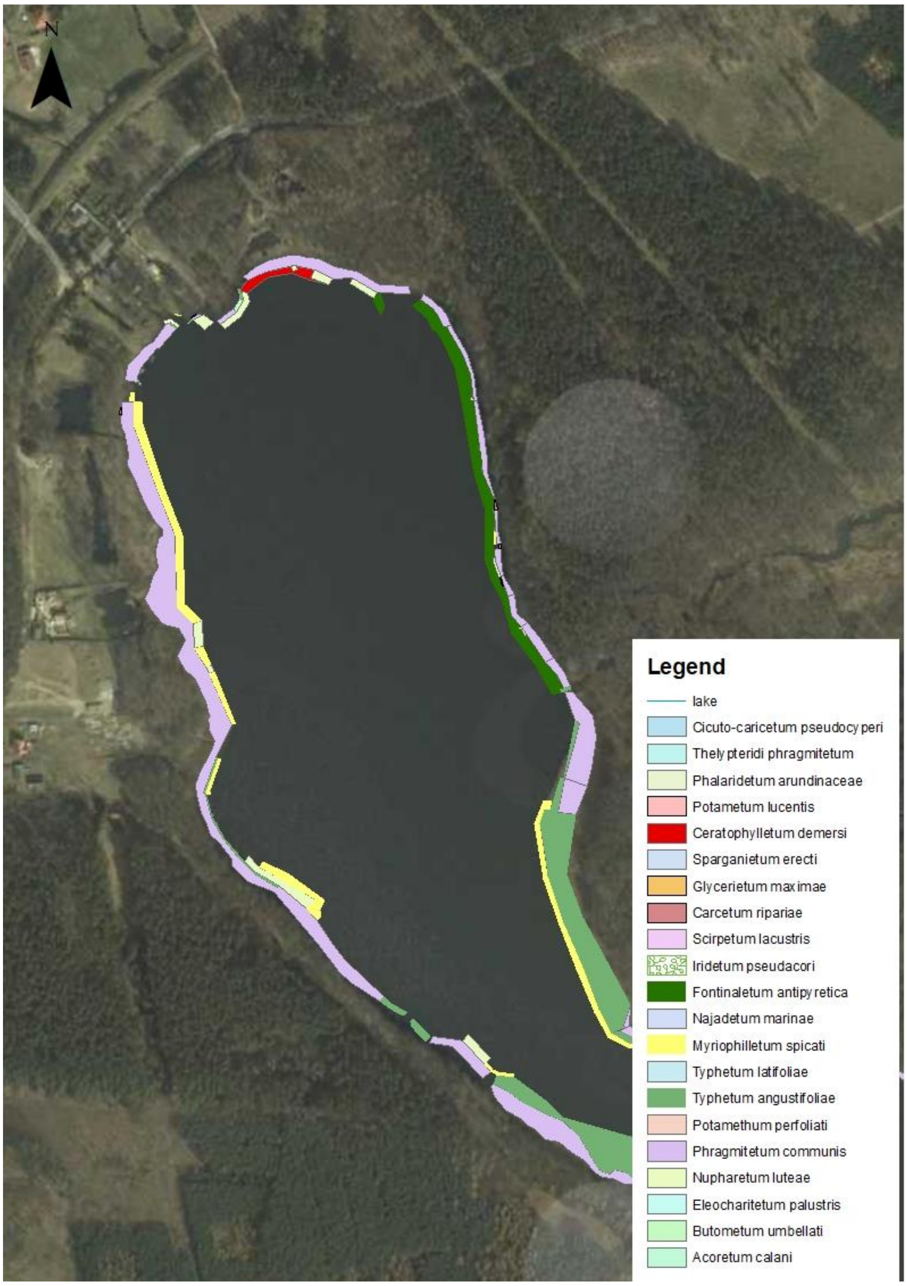

Figure 9: GIS map of Northern Part of Lake Durowskie, with sketched plant associations.

The species preferring eutrophic lakes, being common in large quantities and ascending above water surface are *Phragmitetum communis* and *Typhetum angustifoliae*. *Phragmitetum communis* is not only the most common ascending species but also the most common macrophyte of all. The second species most characteristic for eutrophic lakes and being the third in coverage overall in the studied lake is *Typhetum angustifoliae*. Based upon the previous year record they both decreased in coverage, which might suggest that the conditions for either eutrophic-preferring or ascended plants has decreased[6].

In the surroundings of the lake an association of *Phalaridetum arundinaceae* has once more appeared, a species most common found on humid meadows. There has not been a record of such association in previous year. Its presence suggests more eutrophic conditions in the area of the lake where it has been found. This association has also been noticed in bigger quantities in 2017 (Mieczysław Grzelak, 2013).

One group of the more significant plant species, that impact on improving the quality of the water, decreasing algae blooms and nutrients in water are submerged macrophytes. It is positive for a lake to increase coverage of such species in itself, with the most significant case in view of previous years' records is the sudden development of *Fontinaletum antipyreticae* associations. A fall in coverage of another significant submerged macrophytes species associations, *Myriophylletum spicati*, can also be observed, with it being caused by a change of conditions within the lake, especially less light penetration due to higher turbidity of water (cf. Annex D) , which for *Fontinaletum antipyreticae* is still enough. Moreover, the retraction of *Fontinaletum antipyreticae* has uncovered some of the terrain for *Myriophylletum spicati* to take over (Sangeeta Dhote,2007).

The negative changes of conditions in Durowskie Lake, like the decrease of *Myriophylletum spicati* coverage, a species very significant for the lake restoration, might be triggered by extremely high temperatures during the summer. Hot weather triggers faster and greater algae blooms, greater number of algae impacts the transparency of water, and the fall of transparency limits the amount of light for *Myriophylletum spicati*, which therefore cannot develop.

Apart from the two aforementioned plant associations, four more of this kind had been observed. Due to the role of submerged macrophytes in the lake this is a positive development.

One more association that indicates the improvement of water quality is *Nupharo-nymphaeetum*. The main part of this species is flowing on the water surface. Its coverage has increased by circa 600 m^2. Moreover, this plant is not as dependent on water transparency since its leaves are floating on the surface. It makes it a great indicator not impacted as greatly by water transparency.

A fall in *Najadetum marinae* has also been observed at the lake, from 185 m^2 to only 5 m^2. It is generally perceived as a good effect, as *Najadetum marinae* prefers lakes with worse water quality, and its decrease suggests the improvement of it (Piotr Panek, 2013).

The ESMI index for Durowskie Lake in 2019 is rounded up to 0,205 (the original value is 0,2048). It corresponds with last year value of 0,205 and means that the quality of the lake water is moderate. The change, if it exists at all, is insignificant, since the quality of the lake water is continuously improving since 2009. The minute fall of the ESMI value this year might be caused by this year's extremely high temperatures. Those changes also do not change as abruptly as in rivers, since lake environments are much more stable (Ciecierska i Dynowska, 2013).

The MIR index is worth considering further this year, since its value is 32.4, and last year it was 43.3. The quality of the river has therefore decreased from good to moderate, and it is a significant fall; it is caused by overgrowing of the river by undesired organisms. Radical changes in the river flora are caused by much greater rainfall water inflow into it (Ciecierska i Dynowska, 2013).

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Annex

A **ESMI calculations**

B **Area calculations**

C **MIR calculations**

D **Water turbidity 2018-2019**

Annex A

Name of association	Sum of area	n/N	ln	ln x h	% Area	H max	Z	exp(N/P)	Bracket	ESMI
Phragmitetum communis	64758,93679	0,575638	-0,55228	-0,31791	57,56381					
Myriophylletum spicati	10597,53816	0,094201	-2,36233	-0,22253	9,420086					
Typhetum angustifoliae	11937,48522	0,106112	-2,24326	-0,23804	10,61116					
Fontinaletum antipyreticae	38945,90102	0,346188	-1,06077	-0,36723	34,61877					
Nupharo Nymphaetum	4146,795598	0,036861	-3,30061	-0,12166	3,686061					
Potametum perforiati	462,7842989	0,004114	-5,49344	-0,0226	0,411366					
Caricetum ripariae	379,1170381	0,00337	-5,69286	-0,01918	0,336995					
Acoretum calami	669,3274971	0,00595	-5,12443	-0,03049	0,594961	3,135494	0,536734	1	-0,22927	0,204885
Ceratophylletum demersi	398,95401	0,003546	-5,64186	-0,02001	0,354628					
Najadetum marinae	5,6978729	5,06E-05	-9,89061	-0,0005	0,005065					
Scirpetum lacustris	83,403091	0,000741	-7,20702	-0,00534	0,074136					
Sparganietum erecti	292,7012262	0,002602	-5,95155	-0,01548	0,26018					
Phalaridetum arundinaceae	2,5887001	2,3E-05	-10,6795	-0,00025	0,002301					
Butametum umballatis	45,7972504	0,000407	-7,80648	-0,00318	0,040709					
Thelypteridi phragmitetum	50,0866013	0,000445	-7,71695	-0,00344	0,044522					
Potametum lucentis	14,0286999	0,000125	-8,9896	-0,00112	0,01247					
Glycerietum maximae	80,3652602	0,000714	-7,24412	-0,00517	0,071436					
Eleocharitetum palustris	13,0188968	0,000116	-9,0643	-0,00105	0,011572					
Cicuto Charicetumpseudocyperi	16,63538	0,000148	-8,81917	-0,0013	0,014787					
Tyfetum latifolia	16,5899696	0,000147	-8,8219	-0,0013	0,014747					
Iridetum pseudacori	3	2,67E-05	-10,5321	-0,00028	0,002667					
	132920,7526			-1,39807						
				1,398068						
				H DIVERSITY INDEX is 1.339343						

Annex B

	2017		**2018**		**2019**		**Difference**	
Associations name:	**Total area(m^2)**	**%macrophyte coverage**	**Total area(m^2)**	**%macrophyte coverage**	**Total area(m^2)**	**%macrophyte coverage**	**Total area %**	**% Change.**
Phragmitetum communis (Garms 1927 , Schmale 1931)	62346.3	64.533	65243,1	57.99418	64758,9368	49%	484,163212	-2%
Typhetum angustifoliae (Allorge 1922 , Soo 1927)	12804.6	13.254	13627,85	12.11371	11937,4852	9%	1690,364782	-8%
Myriophylletum spicati (Soo 1927)	11713.3	12.124	15238,48	13.54539	10597,5382	8%	4640,94184	-23%
Nupharo-Nymphaeetum (Tomaszewicz 1977)	2685.9	2.780	3430,567	3.049409	4146,7956	3%	-716,2285982	4%
Fontinaletum antipyreticae (Kaiser 1936)	4855.0	5.025	11929,7	10.60424	38945,901	29%	-27016,20102	132%
Potametum perfoliati (W, Koch 1926)	817.0	0.846	704,3952	0.626133	462,784299	0%	241,6109011	-1%
Acoretum calami (Kobendzz 1948)	368.5	0.381	685,8321	0.609632	669,327497	1%	16,5046029	0%
Caricetum ripariae (Soo 1928)	337.9	0.350	699,4723	0.621757	379,117038	0%	320,3552619	-2%
Charetum tomentosae (Corillion 1957)	43677	0.033	20,7178	0.018416	0	0%	20,7178	0%
Scirpetum lacustris (Allorge 1922 , Chouarge 1924)	136.7	0.141	148,2312	0.131762	83,403091	0%	64,828109	0%

Typhetum latifoliae (Soo 1927)	115.1	0.119	6,51043	0.005787	16,5899696	0%	-10,0795396	0%
Butometum umbelati (Konczak 1968)	64.7	0.067	65,86803	0.05855	45,7972504	0%	20,0707796	0%
Sparganietum erecti (Roll 1938)	82.2	0.085	69,54541	0.061818	292,701226	0%	-223,1558162	1%
Eleocharitetum palustris (Schennikov 1919)	154.5	0.160	20,42395	0.018155	13,0188968	0%	7,4050532	0%
Glycerietum maximae (Hueck 1931)	43576	0.022	21,95682	0.019517	80,3652602	0%	-58,4084402	0%
Thelypteridi-Phragmitetum (Kuiper 1958)	37.9	0.039	37,9	0.026236	50,0866013	0%	-12,1866013	0%
Caricetum acutiformis (Eggler 1933)	43466	0.001	13,21905	0.01175	0	0%	13,21905	0%
Potametum lucentis (Hueck 1931)	36.0	0.037	29,2286	0.025981	14,0286999	0%	15,1999001	0%
Nitellopsidetum obtusae	0.0	0.000	245,638	0.218346	0	0%	245,638	-1%
Phalaridetum arundinaceae	43467	0.002	0	0.000	2,5887001	0%	-2,5887001	0%
Cicuto-Caricetum pseudocyperi (Boer 1942)	0.0	0.000	11,46529	0.010191	16,63538	0%	-5,17009	0%
Charetum contrariae	0	0	69,3662	0.061659	0	0%	69,3662	0%
Najadetum marinae	0	0	186,9287	0.16616	5,6978729	0%	181,2308271	-1%

Iridetum pseudacori (Eggler 1933)	0	0	1,37774	0.001225	3	0%	-1,62226	0%
Ceratophylletum demersi (Soó 1927)	0	0	0	0	398,95401	0%	-398,95401	2%
Total	**96611.8**	**100.0**	**112507,8**	**100.0**	**132521,8**	**100%**	**-20412,97876**	

Annex C

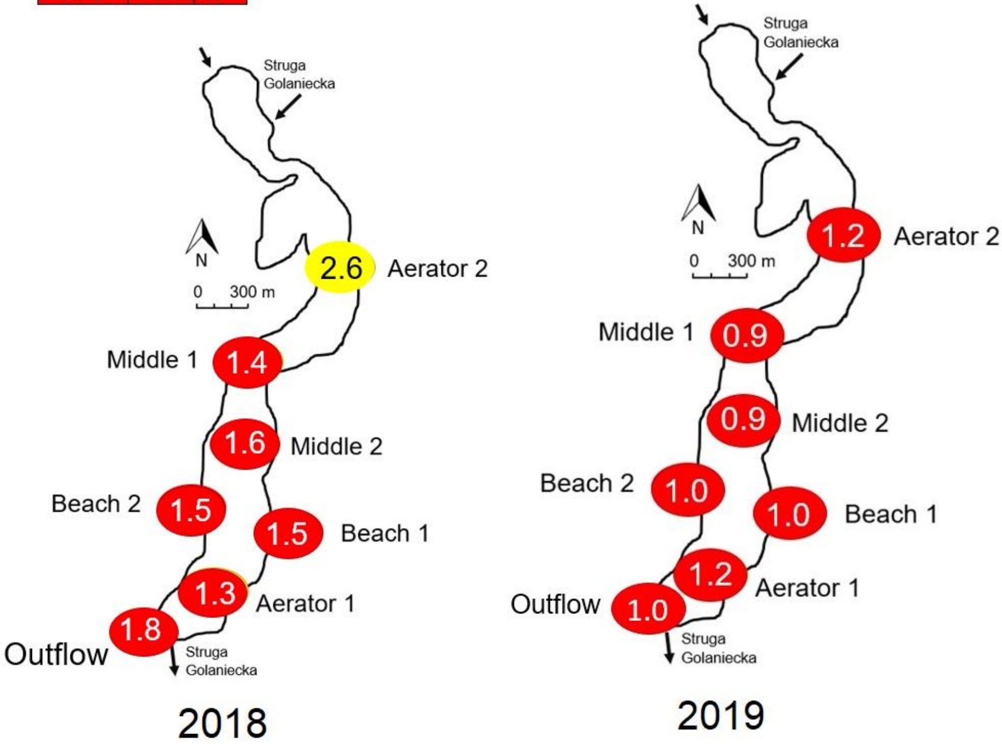
MIR

Species name	L	W	P	l x w x p	w x p
Butomus umbellatus	5	2	6	60	12
Acorus calamus	2	3	4	24	12
Potamogeton pectinatus	1	1	6	6	6
Hildenbrandia rivularis	6	1	6	36	6
Phalaris arundinacea	2	1	2	4	2
Lysimachia thrysiflora	7	3	1	21	3
Cladophora sp.	1	2	6	12	12
Eupatorium cannabinum	-	-	-		
Bidens frondosa	-	-	1		
Calystegia sepium	-	-	2		
Lycopus europaeus	-	-	1		
Ranunculus repens	-	-	1		
Scrophularia alata	4	1	2	8	2
Solanum dulcamara	-	-	2		
Potentilla erecta	-	-	1		
Mantha aquatica	5	1	1	5	1
Fontinalis antipyretica	6	2	1	12	2
Urtica dioica	-	-	1		
Salix fragilis	-	-	2		
Sambucus nigra	-	-	1		
				188	58

Result: 32,4137931

Annex D

SD (m)	Trophic State
4 - >8	Oligotrophic
2 - 4	Mesotrophic
0.5 -2	Eutrophic



Data from Physic-chemical group 2019