International Summer School RESTLAKE

Poznan and Wagrowiec

1st to 15th of July, 2012

Macrophytes as an Indicator for the Ecological State of the Durowskie Lake during Restoration Measures

by:

[1]Aleksandra Bartosiewicz, [2]Anna Elisabeth Lau, [3]Anca-Elena Miron, [1]Natalia Szymkowiak, [2]Sandra Taudt, [3]Andreea-Irina Ursu

[1] Adam Mickiewicz University in Poznan, Wieniawskiego 1, 61-712 Poznan, Poland
[2] Christian-Albrecht University in Kiel, Olshausenstrasse 40, 24118 Kiel, Germany
[3] "Alexandru Ioan Cuza" University of Iasi, BD. Carol I no. 11, 700506 Iasi, Romania

Instructor: Prof. Ryszard Goldyn, Adam Mickiewicz University in Poznan

Poznan, 14th of July 2012

Abstract

Within the fourth RESTLAKE summer school in Wagrowiec/Poznan the macrophyte associations of Lake Durwoskie and their spatial distribution have been investigated in order to assess this year's ecological state. Since the lake is highly eutrophicated several measures to improve the water quality were taken. This study serves to analyze the effect of these measures concerning the macrophytes. Due to the guideline of the European Water Framework Directive the EMSI and MIR index were applied. The four main association appearing at Lake Durowskie are *Phragmitetum communis*, *Typhetum angustifoliae*, *Nupharo- Nymphaeetum albae and Potametum perfoliati*. The MIR index improves in comparison from 30.6 in 2009 up to 33.41 in 2012. The value of ESMI equals 0,120 and is only slightly increasing compared to previous years. Nevertheless the range of calculated index values cannot attain within the Water Framework Directive demanding good ecological state.

Table of Contents

List of Figures **i**

List of Tables **i**

1 Introduction **1**

2 Methods and Materials **2**
2.1 Study area 2
2.2 Data record 2
2.3 Evaluation 2

3 Results **4**
3.1 Types of associations 4
3.2 Distribution of macrophyte associations 5
3.3 Trends of occurrence and abundance 5
3.4 Indices 8

4 Discussion **8**

5 Conclusions **10**

References **10**

A Tables **I**

List of Figures

2.1 Location of Lake Durowskie 3
3.1 Spacial distribution of macrophytes in the year 2012 at Lake Durowskie 6
3.2 Spacial distribution of macrophyte associations at the north and south end of Lake Durowskie 7
3.3 Change of surface area and of areal expansion of main associations from 2009 to 2012 7
3.4 Change of areal expansion of submerged and emerged macrophytes 8

List of Tables

1 Vegetation coverage classes 2
2 ESMI index 4
3 List of associations and their areal extension in m^2 and coverage in % 5

1 Introduction

Lake Durowskie located in the western part of Poland is the attraction of Wagrowiec city serving as an area of water sport activities for the local population and tourists. Due to these impacts and sewage discharges the water quality of the lake suffers. The occurring problem of eutrophication connected with sporadic occurring cyano bacterial blooms leads to a conflict of interests. Improvements of the water quality had to be achieved in order to remain the lake as an attraction for tourists. Additionally the Water Framework Directive of the European Union prescribes, that member states are obliged to assess and report on the ecological state of all lakes exceeding a surface area 0,5 km^2 (Schaumburg et al., 2004).

Since further eutrophication has to be allayed several measures were taken i.e. two aerators were built for the oxygen exchange from the surface to the bottom of the water body to provide the hypolimnion layer with sufficient oxygen during summer time. Furthermore it is tried to manipulate the phytoplankton growth by an artificial increase of pike population. Moreover in year 2009 a restoration program, including student's work during a Summer School, has been founded. The aim of the restoration program is to investigate continuously the ecological state of the Lake Durowskie by examining several indicators such as algaes, macroinvertebrates, macrophytes and physico-chemical parameters.

Especially macrophytes, which are aquatic plants growing in the littoral or sublittoral zone of water bodies can be used as an adequate long-term indicators for the ecological state of a lake (Messyasz et al., 2012). Macrophytes slowly react to changes in nutrient conditions (over years) and successively adapt their distribution to changes of abiotic and biotic factors of the ecosystem (Melzer, 1999). Also the importance of macrophytes serving as land - water ecotone should be considered since they are accumulating litter and sediment and therefore increasing the nutrient concentrations in the littoral zone. Additionally the littoral vegetation provides living conditions for other species such as birds. By balancing the water flow, light availability and temperature macrophytes reduce the extreme habitat conditions, protect the shoreline against erosion, are acting as nutrient filters and their litter forms an important part of the food web for e.g. macroinvertebrates (Water and Rivers Commission, 2011).

In this report for the macrophyte study of the summer school "Ecological state of the lake during restoration measures" aims to address the following questions:

1. What is the present trophic state in the lake and its tributaries?

2. What is the trophic state trend from 2009 to now?

For giving a well founded assessment the results will be compared with the Summer School data from 2009 - 2011. The research work refers to the polish applied guidelines of the European Water Framework Directive. The survey of macrophyte associations includes their abundance, expansion, coverage after the scale of Braun-Blanquet and their distribution. With the help of the implemented Ecological Status Macrophytes Index (ESMI) and the Macrophyte Index for Rivers (MIR) the ecological status of rivers can be estimated (Messyasz et al., 2012).

2 Methods and Materials

During the 2nd and 7th of July data for the associations of macrophytes were recorded at Lake Durowskie, located in the north-eastern Wielkoposlka in Poland. The city Wagrowiec, home of 25 thousand inhabitants and 50 km away from Poznan, adjoins Lake Durowskie's southern part. The location of Lake Durowskie is shown in figure 2.1. Integrated in a chain of lakes along the Golaniecka River Lake Durowskie has a relatively big catchment area of 236,1 km^2. Therefore it is not just influenced by the city and human activities but also by the surrounding types of land uses as well as the comparatively natural vegetation of forests (Miejski, 2012a,b; Messyasz et al., 2012).

Lake Durowskie has a surface of 143,7 ha and a mean depth of 7,9 m. The glacial origin of the lake causes steep shorelines and a fast increase of water depths up to 14,7 m. Embedded into this glacial valley the recent lake has a length of 4 km and a maximal width of approximately 600 m (Wilczyński, 9:00 am, 3rd of July 2012; Messyasz et al., 2012).

2.1 Study area

2.2 Data record

During the examination period the emerged and submerged macrophyte associations along the shoreline of Lake Durowskie were characterized after Podbielkowski and Tomaszewicz (1996); Kłosowski and Kłosowski (2007). Accordingly the most abundant species is defining the type of the association. Besides of the length and width of the vegetation patch the maximal water depth and the coverage of the plants after the scale of Braun-Blanquet (1928) were recorded (see table 1). The submerged macropyhtes were gathered with an anchor to determine the type of association. The beginning and end of the vegetation patches were measured with a GPS tool (Garmin). From the GPS tool the measured points were transferred to the computer and exported into a shape file by using Quantum GIS (version 1.5.0). The shape file was used to digitalize the expansion and location of the macrophyte associations with MapInfo Professional (version 11.0.3). For visualizing the data a map was created by utilizing an areal photograph from the Server WMS (http://geoportal.gov.pl/)

Table 1: *Vegetation coverage classes according to Braun-Blanquet (1928)*

code	coverage %
+	< 1
1	1-10
2	10 - 25
3	25 - 50
4	50 - 75
5	> 75

2.3 Evaluation

To determine the ecological state of Lake Durowskie within the European Water Framework Directive the ESMI index was applied (Ciecierska et al., 2010). The calculation of this index is displayed in equation 1.

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

H	Shannon Wiener index
H_{max}	maximal value of Shannon Wiener index
N	total area covered by plant associations
Z	devision of total area covered by plant associations (N) and area with a maximal depth of 2,5 m (isob 2,5m = 20,96 ha)
P	total area of lake (143,7 ha)

Table 2 displays the classification of the ecological state of deep stratified lakes to the

(a) Areal photograph including isobaths

(b) View from the south east shoreline

(c) Location of Wagrowiec, Miejski (2012a)

Figure 2.1: *Location of Lake Durowskie*

value of the ESMI index. Additionally to classify the ecological state of the outflow of Lake Durowskie the MIR index was calculated witch is shown in equation 2 (Gołdyn et al., 2009). Its classification is also shown in table 2.

$$MIR = \frac{\sum L_i \cdot W_i \cdot P_i}{\sum W_i \cdot P_i} \cdot 10 \qquad (2)$$

L indicator value for each association
P coverage for each species
W weight factor

Table 2: *Classification of the ecological state by ESMI and MIR index.*

State	ESMI index	MIR index
very good	0,680 - 1,000	$\leq$ 44,5
good	0,340 - 0,679	44,5 - 35,0
moderate	0,170 - 0,339	35,0 - 25,4
poor	0,090 - 0,169	25,4 - 15,8
bad	$<$ 0,090	$<$ 15,8

3 Results

3.1 Types of associations

In this study 16 different macrophyte associations were declared at Lake Durowskie. Thereof two new associations *Phalaridetum asundinaceae* and *Thelypteridi - Phragmitetum* were recorded. *Caricetum acutiformis* was not detected this year. All associations and their areal expansion as well as their share of the total area are displayed in table 3.

The four main association appearing at Lake Durowskie are *Phragmitetum communis* (67,7 % of surface covered by macrophytes), *Typhetum angustifoliae* (21,35 %), *Nupharo-Nymphaeetum albae* (3,7 %) and *Potametum perfoliati* (2,7 %).

The association of *Phragmetitum communis* with the most abundant spieces *Phragmites communis* is growing dense, close to the shoreline (max. 2,5 m water depth) and can reach highs of several meters. The community occurs at eutrophic to mesotrophic conditions with mineral soils in artificial or natural water bodies and is widely distributed (Podbielkowski and Tomaszewicz, 1996).

Typhetum angustifoliae is an association mostly occurring at eutrophic water conditions. The most abundant species is *Typha angstfolia*. The community is not growing as dense as *Phragmetitum communis* and is mostly present in deeper waters (around 2 meters). Often it is found together with other association such as *Phragmetitum communis* (Podbielkowski and Tomaszewicz, 1996).

Nupharo-Nymphaeetum albae with either *Nuphar luteum* or *Nymphaea alba* as the dominant species is an association with floating macrophytes occurring in water depth less than 2 meters. This community can be found in shallow lakes with high amounts of organic sediments, rivers and oxbows. *Nupharo-Nymphaeetum albae* is growing in eutrophic and rather in mesotrophic condotions and is often building a complex with *Phragmetitum communis* or other associations (Podbielkowski and Tomaszewicz, 1996).

These three associations are known for their ability to cover big areas, forming a lot of biomass and their importance for the natural aggradation of lakes. In contrast to these emerged associations the forth most abundant community of *Potametum perfoliati* with the most dominating specie *Potamogeton perfoliatus* is growing submerged and in eutrophic and mesotrophic conditions. The association *Potametum perfoliati* is not covering large areas but

Table 3: *List of associations and their areal extension in m^2 and coverage in %*

Assosciation	Area (m^2)	Coverage (%)
Acoretum calami (Kobendzz 1948)	862	1,25
Butometum umbellati (Konczak 1968)	107	0,15
Caricetum ripariae (Soo 1928)	997	1,44
Elecaritetum palustrae (Schennikov 1919)	124	0,18
Glicerietum maximae (Hueck 1931)	7	0,01
Myriophylletum spicati (Soo 1927)	850	1,23
Nupharo - Nymphaeetum albae (Tomaszewicz 1977)	2540	3,68
Phalaridetum asudinaceae (Libb. 1931)	23	0,03
Phragmitetum communis (Garms 1927 , Schmale 1931)	46745	67,70
Potametum pectinati (Carstensen 1955)	17	0,02
Potametum perfoliati (W. Koch 1926)	1882	2,73
Scirpetum lacustris (Allorge 1922 , Chouarge 1924)	48	0,07
Sparganietum erecti (Roll 1938)	58	0,08
Thelypteridi - Phragmitetum (Kuiper 1957)	35	0,05
Typhetum angustifoliae (Allorge 1922 , Soo 1927)	14743	21,35
Typhetum latifoliae (Soo 1927)	10	0,01

is still forming dense vegetation in standing or floating waters. For optimal growth mineral soils with little organic content and water depth up to 5 meters are needed (Podbielkowski and Tomaszewicz, 1996).

The remaining associations recorded during the sample period cover an area less than 5 %. Each of them not reaching a percentage of more 1,5 %.

3.2 Distribution of macrophyte associations

In figure 3.1 the spatial distribution of macrophytes occurring at Lake Durowskie is displayed. In the northern part of the lake a higher abundance and expansion of the macrophyte associations can be recognized. In comparison the southern part exhibits a more fragmented and a minor enlarged macrophyte vegetation.

As shown in figure 3.2 (a) in the north of the lake *Phragmitetum communis* is the most dominant species. Together with *Typhetum angustifoliae* they form large vegetation belts along the shoreline. Sporadically also *Numpharo - Nympharetum albae* appears. In the south sector also *Phragmitetum communis* is most abundant but increased occurrence of *Acoretum calami* can be observed.

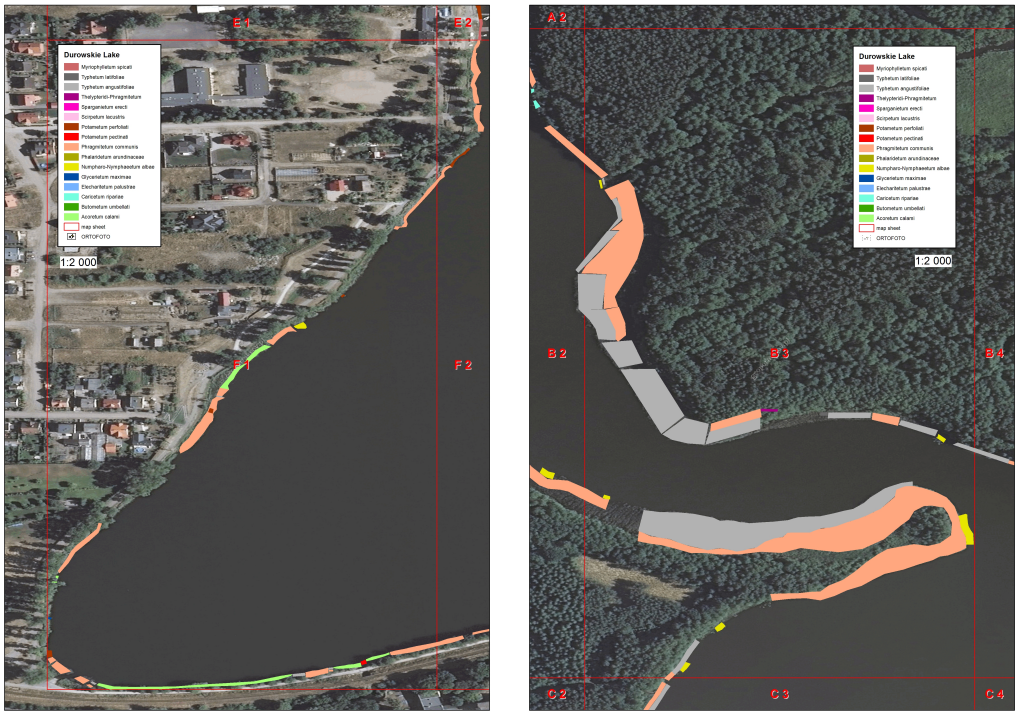
3.3 Trends of occurrence and abundance

In order to imbed the results of this study into a context, the recorded data is compared to the findings of the summer schools from 2009 to 2011. A detailed table with the collections of the data from the last years can be found in annex A.

Considering the total surface covered by the macrophytes in the lake (see figure 3.3 (a)) an increase from 2011 (67322 m^2) to 2012 (69048 m^2) is documented. Nevertheless the total surface area still has a lower value than the first recorded total area form 2009 (89925 m^2).

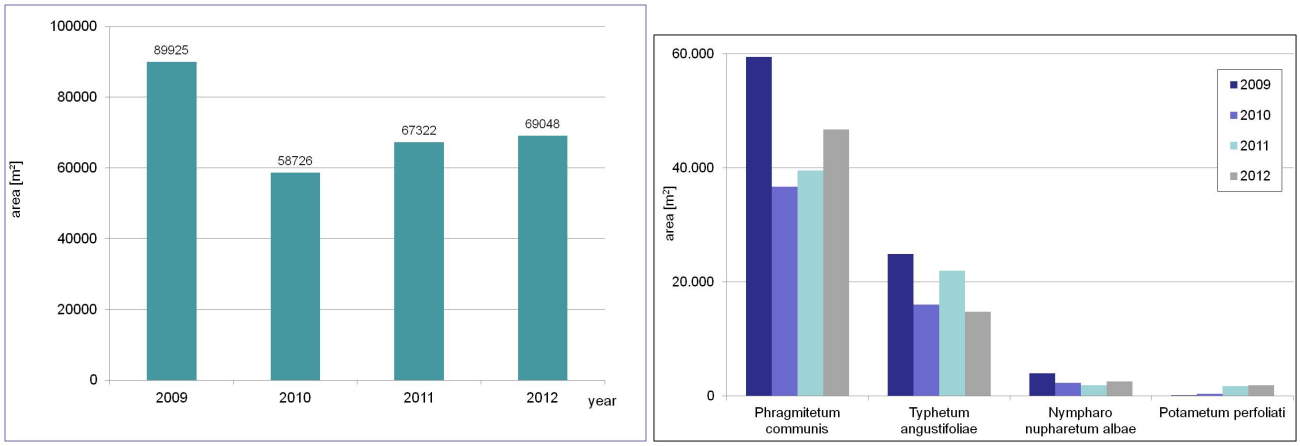
In figure 3.3 (b) the change of the occurrence of the four most abundant species from year 2009 to 2012 is displayed. *Phragmitetum*

Figure 3.1: *Spacial distribution of macrophytes in the year 2012 at Lake Durowskis*



(a) (b)

Figure 3.2: *Spacial distribution of macrophyte associations at the north and south end of Lake Durowskie*



(a) (b)

Figure 3.3: *Change of surface area (a) and of areal expansion of main associations (b) from 2009 to 2012*

communis covers the largest area which is reincreasing since 2010. Whereas areal distribution of *Typhetum angustifoliae* denotes a downwards trend over the last four years. The expansion of association *Numpharo - Nympharetum albae* maintains stable. *Potametum perfoliati* underlies an obvious rising tendency from 26 m^2 in 2009 to 1882 m^2 in 2012.

Furthermore the areal share of the submerged compared to the emerged associations was calculated. The share of the submerged aquatic vegetation increased from 2009 to 2010 from 0,2% to 4% and remains since then on the same level. Additionally as shown in figure 3.4 the composition of the dominant submerged associations was investigated. From 2010 to 2012 the total area of *Myriophylletum spicati* is decreasing whereas the total area of *Potametum perfoliati* is increasing.

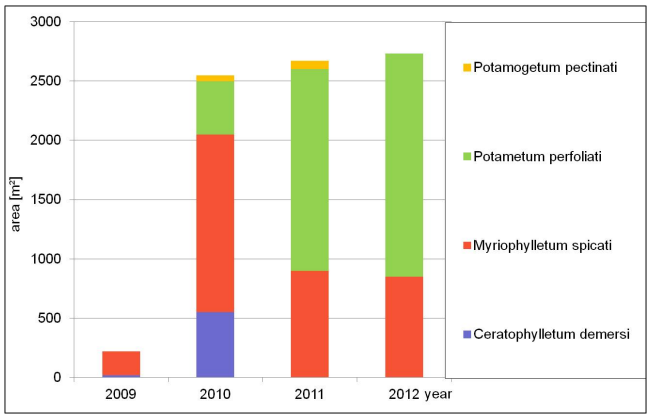


Figure 3.4: *Change of areal expansion of submerged and emerged macrophytes*

3.4 Indices

For the assessment of the ecological state of Lake Durowskie and its outflow region the ESMI and MIR indeces were calculated. For calculating the MIR index the associations *Phragmitetum communis*, *Typhetum angustifoliae*, *Nupharo-Nymphaeetum albae* and *Scirpetum lacustris* are taken into account. The index improves in comparison from 30.6 in 2009 up to 33.41 in 2012. The value of ESMI equals 0,120 and is only slightly increasing compared to the years 2011 (0,103) and 2010 (0,118).

4 Discussion

In the following the pattern of occurrence, structure and abundance of macrophyte associations detected at Lake Durowskie from the 2nd to the 7th of July 2012 is discussed. Furthermore the development from the past years is taken into account.

The maximal growing depth of macrophytes is strongly related to the transparency of the water. Especially in the time of germination a higher depth of transparency is needed leading to an occurrence of macrophytes in deeper areas. For example *Potametum perfoliati* can be found up to a depth of five meters (Podbielkowski and Tomaszewicz, 1996). Since the measured water depth of macrophytes in the littoral zone of Lake Durowskie ranged from 0,2 m to 2,7 m, it can be assumed that the water transparency was not optimal in the spring time. The average Secchi depth recorded during the sample period with 0,88 m supports this thesis.

The distribution of macrophytes displayed in figure 3.1 leads to the conclusion that the occurrence of certain associations in the north of the lake is affected by the shallow shoreline and the surrounding forest vegetation. As a result large and aligned macrophyte bands of *Phragmitetum communis* (orange patches), *Typhetum angustifoliae* (grey patches) and *Nympharo nupharetum albae* (yellow patches) developed. In figure 3.2 (b) the typical complex of the associations *Phragmitetum communis* next

to the shoreline and *Typhetum angustifoliae* towards the lakefront can be recognized. *Nympharo nupharetum albae* was mainly recorded in the north, because this association grows up to a water depth of 2 m (Podbielkowski and Tomaszewicz,1996).

The fast increasing isobaths in the south of the lake leads to steep slopes which obviously influences the narrow macrophyte patches i.e. *Phragmitetum communis*. Moreover a strong disrupting effect on the macrophyte habitats due to the connection to Wagrowiec city is supposed. Although the aquatic plant belt is more fragmented, a positive growing potential for submerged macrophytes i.e. *Potametum pectinati*, *Potametum perfoliati* is conceivably. These areas meet the demand of those with shallow water and good light availability for expansion of the submerged associations.

In the south the more nutrient rich outflow of the Lake Durowskie is located. Large occurrence of *Acoretum calami* (green patches) can be investigated. This association can sustain hypertrophic water (Prof. Goldyn, 2012).

Considering figure 3.3 a strong decrease in the extent of the total surface area covered by macrophytes between 2009 and 2010 due to bad winterly climate conditions occurred. Since 2010 the total surface area recovers, based on a successive increase up to 2012. The increase of the total surface area covered by macrophytes shows a moderate reaction. Here the function of macrophytes as long-term indicators can be exemplary experienced (Melzer, 1999).

Regarding the change in the surface area covered by the four most abundant associations it can be observed that the coverage of *Typhetum angustifoliae* decreases. For growing this association requires a rich organic material accumulation on the lake bottom. Therefore it is assumed that the organic matter degrades to a certain degree. At the same time embedded in the context of competition an increase of *Phragmitetum communis* since 2010 can be considered. In conclusion this development indicates a shift of the lake towards a more mesotrophic state. Also the slightly rise of surface coverage of *Nupharo - Nymphaeetum albae* in 2012 substantiates this assumption. Moreover during sampling new developed small patches of *Nupharo - Nymphaeetum albae* were considered. This determines a positive trend to an increasing water quality (Prof. Goldyn, 2012).

The share of submerged macrophytes is displayed in figure 3.4 remains stable on a level of 4% since 2010. As a conclusion it could be assumed that the water transparency connected with more light availability for the plants in the lake is not enhancing. The disappearance of the hypertrophic association *Ceratophylletum demersi* in 2011/2012 also alludes to an improvement of water quality. Nowadays *Ceratophylletum demersi* occurs only in some patches as single species close to the beaches. *Potametum pectinati* is presumably outcompeted by the increased growth of *Potametum perfoliati* (Prof. Goldyn, 2012).

The ESMI index is calculated to classify the ecological state of the lake and the MIR index ranks the state of the river outflow. For the MIR index an obvious increase is illustrated but the ecological state of the river outflow is still on a “moderate” level. The ESMI index also rises slightly higher than in the previous year from 0.109 in 2009 to 0.120 in 2012. In spite of this positive trend the ecological state of the lake maintains in a “poor” range.

In order to analyze the ecological state of Lake Durowskie the used macrophyte indication method is assessed as suitable. It has

to be considered that the values calculated for the areas of the associations are not as exact as they seem since there might be some difficulties identifying the association types and observing the occurrence, coverage and distribution of plant communities (Kunii and Minamoto, 2003). Anyhow total phytolittoral mapping was executed in July 2012 by boat while using a GPS –Tool as it is proposed e.g. by Ciecierska (2004); Kolada et al. (2009).

5 Conclusions

The association composition of Lake Durowskie in 2012 remains stable since monitoring has started in 2009. The most abundant associations show a sustained eutrophic state. 16 macrophyte communities were observed, whereby two new associations occurred and one disappeared.

Moreover the mentioned human impact influences obviously the development of the macrophyte associations along the shoreline. The different habitat conditions in the north and south of the lake leading to opposing structures, occurrence and abundance of macrophyte patches. The recognized slight increase of the ESMI index can be treated as an improvement of the ecological lake conditions. The restoration measurements show progressively success concerning the macrophyte associations. Nevertheless the range of calculated index value cannot attain within the Water Framework Directive demanding good ecological state. A further improvement of water quality connected with better light availability could lead to a higher abundance of submerged and emerged macrophytes.

For the future we would recommend further long-term monitoring of macrophytes to collect more data and knowledge about their distribution. Continued monitoring of the aquatic plants will have to prove whether the observed change was transient or permanent (Kunii and Minamoto, 2003). Moreover it is important to create a gapless databank. Methods and recorded data comparability should be made possible. As a first step the protocol created by the Macrophyte group in the Summer School 2010 could be used.

The positive trend of the ecological state of the macrophytes should elate to further measures, which will reinforce the development. For that reason the motorboat traffic on the lake should be localized on the already human moulded south of the lake. Additionally the fisher jetties could be transferred in front of the macrophyte belt to increase their potential growing habitat. Furthermore the swimming areas of the lake should be assigned to avoid destruction of macrophytes. Besides more macrophytes could be planted at fragmented shoreline areas to improve the erosion protection and the nutrient sink capacity of the macrophytes.

Acknowledgements

The authors of this report would like to thank everyone involved organizing this wonderful summer school. For all of us it was a great experience, especially getting a first insight into measuring and recording all parameters that were observed on Lake Durowskie and learning in an international framework. We would warmly like to thank Prof. Beata Messyasz for her enthusiastic commitment to this course. Furthermore we would like to thank Prof. Ryszard Goldyn for his assistance and guidance completing this report.

References

Braun-Blanquet, J., 1928. Pflanzensoziologische Grundzüge der Vegetationskunde. Springer Verlag, Berlin, Germany.

Ciecierska, H., 2004. Ecological state of reference lakes of the European Intercalibration Network, located in the Masurian Landscape Park (NE Poland). Limnological Review , 45 – 50.

Ciecierska, H., Kolada, A., Soszka, H., Golub, M., 2010. A Method for Macrophyte-Based Assessment of the Ecological Status of Lakes, Developed and Implemented for the Purpose of Environmental Protection in Poland. BALWOIS , 1 – 25.

Gołdyn, H., Arczyńska-Chudy, E., Pińskwar, P., Jezierska-Madziar, M., 2009. Transformation of flora versus the ecological status of the wyskoć watercourse in the last thirty years. Botanika - Steciana , 103 – 108.

Kłosowski, S., Kłosowski, G., 2007. Rośliny wodne i bagienne. Multico Ofic. Wydaw , 336.

Kolada, A., Hellsten, S., Kanninen, A., Sondergaard, M., Dudley, B., Noges, P., Ott, I., Ecke, F., Mjelde, M., Bertrin, V., Davidson, T., Duel, H., 2009. Overview and comparison of macrophyte survey methods used in european countries and a proposal of harmonized common sampling protocol to be used for wiser uncertainty exercise including a relevant common species list. WISER , 1 – 31.

Kunii, H., Minamoto, K., 2003. Temporal and spatial variation in the macrophyte distribution in coastal lagoon Lake Nakaumi and its neighboring waters. Marine Systems , 223 – 231.

Melzer, A., 1999. Aquatic macrophytes as tools for lake management. Hydrobiologia , 181–190.

Messyasz, B., Pikosz, M., Szendzina, L., 2012. MATERIALS FOR PARTICIPANTS OF SUMMER SCHOOL. International Summer School RESTLAKE of Lake Durowskie .

Miejski, U., 2012a. Location. Last checked: 10.07.2012. `http://www.wagrowiec.eu/en/polozenie/opis/`.

Miejski, U., 2012b. Tourism. Last checked: 10.07.2012. `http://www.wagrowiec.eu/en/rekreacja/`.

Podbielkowski, Z., Tomaszewicz, H., 1996. Zarys hydrobotaniki. Wydawnictwo Naukowe PWN, Warszawa, Poland.

Prof. Goldyn, R., 2012. Conversation about the results of the macrophyte study. oral. July 13th, 11:00 am.

Schaumburg, J., Schranz, C., Hofmann, G., Stelzer, D., Schneider, S., Schmedtje, U., 2004. Macrophytes and phytobenthos as indicators of ecological status in german lakes - a contribution to the implementation of the water framework directive. Limnologica , 302 – 314.

Water and Rivers Commission, 2011. Water quality and macroinvertebrates. Water facts 2.

Wilczyński, S., 9:00 am, 3rd of July 2012. Welcome meeting with the maior of Wangrowiec for Summer School 2012. oral.

A Tables

Table A.4: *List of associations found from 2009 to 2012 on Lake Durowskie, their areal extension in m^2 and coverage in %.*

Assosciation	**Surface (m^2)**				**Coverage (%)**			
	2009	**2010**	**2011**	**2012**	**2009**	**2010**	**2011**	**2012**
Acoretum calami (Kobendzz 1948)	528	871	651	862	0,59	1,5	1	1,25
Butometum umbellati (Konczak 1968)		24	67,5	107		0	0,1	0,15
Caricetum acutiformis(Sauer 1937)	94	38	58		0,1	0,1	0,1	0,00
Caricetum ripariae (Soo 1928)	92	27	191,5	997	0,1	0	0,3	1,44
Ceratophylletum demersi (Hild 1965)	15	570			0,02	1		0,00
Elecaritetum palustrae (Schennikov 1919)	84	70	34	124	0,09	0,1	0,1	0,18
Glicerietum maximae (Hueck 1931)	55	35,5	2	7	0,06	0,1	0	0,01
Myriophylletum spicati (Soo 1927)	124	1520	833	850	0,14	2,6	1,2	1,23
Najadetum marinae	20				0,02			0,00
Nupharo - Nymphaeetum albae (Tomaszewicz 1977)	3969	2300	1872	2540	4,41	3,9	2,8	3,68
Phalaridetum asudinaceae (Libb. 1931)				23				0,03
Phragmitetum communis (Garms 1927, Schmale 1931)	59448	36691	39504	46745	66,11	62,5	58,8	67,70
Polygonetum natantis (Soó 1927)		1				0		0,00
Potametum pectinati (Carstensen 1955)		30	49	17		0,1	0,1	0,02
Potametum perfoliati (W. Koch 1926)	26	387	1667,5	1882	0,03	0,7	2,5	2,73
Scirpetum lacustris (Allorge 1922, Chouarge 1924)	92	54	57	48	0,1	0,1	0,1	0,07
Sparganietum erecti (Roll 1938)	460	102	228	58	0,51	0,2	0,3	0,08
Thelypteridi - Phragmitetum (Kuiper 1957)				35				0,05
Typhetum angustifoliae (Allorge 1922, Soo 1927)	24910	16001	21987	14743	27,7	27,2	32,7	21,35
Typhetum latifoliae (Soo 1927)	8	4	120	10	0,01	0	0	0,01
Total	**89925**	**58725,5**	**67321,5**	**69048**	**99,99**	**100,1**	**100,1**	**100**