Water Quality of Lake Durowskie 2012

Poland Fieldtrip

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1. Introduction

Lake Durowskie in Wagrowiec, Poland is one major pot for leisure activities, but it is threatened by eutrophication due to the lack of wastewater treatment plants and intensive agricultural land use on the surroundings. In order to achieve and preserve a good quality of the lake, there have been made several improvements to the lake such as establishments of two aerators and installations of phosphorus traps. Consequently, this work deals with following questions:

a. The interactions between water parameters and the water quality according to the Water Framework Directive
b. Trophic state of the lake according to the Carlson's Trophic State Index (TSI)
c. Development of the lake over years
d. Possible management and improvements of the lake

1.1. Field area

Lake Durowskie is a typical post-glacial through flow lake, characteristic for the area of Central Poland. The shape of the lake is elongated in north-south direction. On the southern edge of the lake, there is the town of Wągrowiec. This town is the capital of the commune and district with 25000 citizens.

The catchment of lake Durowskie is located in mostly agricultural region. The amount of area covered with forest in the Wągrowiec district is only 19%, although the lake itself, apart from most southern and most northern parts, is surrounded by forest (usually more than 1 km from the lake shore). The flow of lake water is from north to south.

Wągrowiec community has its own sewage treatment plant that purifies averagely 800000 m^3 of waste per year (in scale of whole district 87,3% of waste is properly treated).

In former times large loads of nutrients were supplied to this lake, both from towns, when there was no sewage treatment plant and from the agriculture in catchment area (especially in time of communist systems, because during this time fertilizers were founded from national budget, instead of being bought by farmers, hence they used to fertilize fields much more than now, when they have to buy fertilizers on their own).

In Wągrowiec, there are many tourist facilities, especially beaches, hotels, restaurants, kayak and boat renting points, sport facilities, and also one Aquapark and rehabilitation center. There are also many fishing points at the lake, which concludes in a whole that fishing is very popular in this area. In every five years, the lake is being monitored by Voivodeship Inspectorate of Environmental Protection.

2. Methods

The following chapter will describe the methods of the fieldwork, its purpose and importance in the ecology, the analysis in the laboratory and the digital analysis.

2.1. Fieldwork

Figure 1. Sampling Points at Lake Durowskie

During the first week of July (02.07 - 07.07.2012) the water samples as well as local measurements have been taken. Daily weather has been also noticed down. The following six points were sampled each day: Middle I, Middle II, Aerator I, Aerator II, Beach I, Beach II. Field parameters were determined by multi parameter-measuring device. Each parameter was examined in every meter, starting at water surface and climbing down one meter at the time from above to the bottom lake.

Aerator Rotations

There are two aerators in the lake Durowskie. One is in the north and one in the south of the lake. The aerators are supposed to generate O_2 into the lake, which leads to chemical reactions like oxidation of reduced compounds and/or to keep oxidizing conditions in the hypolimnion area to create an aerobic condition in order for the biomass to grow and utilize oxygen. For each day the number of aerator rotations has been also noted down, in which a higher number of rotations means a higher pumping of O_2 into the water bodies.

Dissolved oxygen

The O_2 content of a lake is measured in mg/l and states the amount of solved oxygen in the water. It is an important ecological measure, because heterotrophic microorganisms need O_2 to work their organisms. The amount is dependant of air pressure, amount of other solved ions and temperature. With a higher temperature there will be less O_2 in the water (Frede. 1999)

Temperature

The temperature of the lake is important for biological activities and chemical reactions (Van't Hoff's rule). Between different zones of a lake (*epilimnion*, *metalimnion*, *hyperlimnion*) there are different temperatures and therefore different organisms.

pH value

The pH value is a measure for acidity or alkalinity of an aqueous solution. It is measured in mol/l and divided in a range from 1 to 12. The pH value is not only important for the habitat of every living organism, but also plays a role in chemical reactions. pH value will also indicate the living organisms inside the water bodies.

Electrical conductivity

The electrical conductivity determines all dissolved ions in the water. Therefore it can be an indicator for solved salts and nutrients like chlorides and sulfates since pure water does not contain high water conductivity. Electrical conductivity is measured in µS/cm.

Total dissolved solids

TDS is a measure of the combined content of all - inorganic and organic substances (minerals, salts and metals) contained in a liquid and give an idea of how many anions and cations are in the water. TDS is measured in mg/l and directly related to the purity of water and the quality of water purification systems. The TDS is based on the electrical conductivity of water. Pure H_2O has no conductivity.

Secchi depth

Water transparency, nutrient concentration, and phytoplankton biomass are good indicators for trophic state of water, because they can show primary production in the lakes. A low clarity of water can be interpreted as high amount of suspended materials, including phytoplankton or zooplankton and other substances. With Secchi discs measurements it is possible to calculate the trophic state indices (TSI) and therefore becoming one way to examine ecological conditions and water qualities. (Elster. 1962)

At each day Secchi discs being used to measure water transparency at each sampling point. At Middle I, Middle II, Aerator I and Aerator II samples of water have been taken for laboratory analysis of chlorophyll ‘a’. To determine chlorophyll ‘a’ concentration, the water samples that have been taken were filtered (1000 ml) and the filter was brought to the laboratory.

2.2. Laboratory analysis

The method of determination of concentration of chlorophyll ‘a’ is based on the condense seston on the filter (made of fiberglass) and the known volume of water.

The filter with seston is getting pulped in a mortal, and filled with acetone in a test tube (approximately 10ml). The sample is getting centrifuged and put into a refrigerator (4℃) for 24 hours. During the storage of the sample the extraction occurs. At the next day the measurements take place. Each sample is filled into a *cuvette* and measured at a photometer with wavelength of 663nm and 750nm. 0,1ml of HCL was added to the samples immediately after measurement and measured again after 10 minutes (665nm and 750 nm). The content of chlorophyll ‘a’ is calculated with following formula:

$$X = 26,73 \, [\, (A663b - A750b) - (A665a - A750a)] * VE/VW * I$$

where,

A663b, A750b: marked absorption of the extract before adding the acid

A665a, A750a: marked absorption of the extract after adding the acid

VE: volume of the prepared extract

2.3. Digital Analysis

Graphs and figures have been produced using Microsoft Excel application. For each station the average value of every 5 days has been taken.

The calculation of the trophic state index (TSI) has been produced with the following formulas that were assessed by Carlson's Trophic State Index (TSI) equations. (Carlson. 1996)

TSI for Secchi depth

$$TSI_{(SD)} = 10(6 - \ln SD / \ln 2)$$

TSI for Chlorophyll 'a'

$$TSI_{(CHL)} = 10(6 - (2.04 - 0.68 \ln CHL / \ln 2))$$

The quantities of nitrogen, phosphorus, and other biologically useful nutrients are the primary determinants of a lake's Trophic State Index (TSI). Nutrients such as nitrogen and phosphorus tend to be limiting resources in standing water bodies, so increased concentration tend to result in increased plant growth, followed by corollary increases in subsequent trophic levels. Consequently, a lake's trophic index may sometimes be used to make a rough estimate of its biological conditions. But due to the lacking data of phosphorus and nitrogen during the samplings, and that the samplings were taking place during summer, the results therefore only calculate TSI using chlorophyll 'a' and Secci Depth.

During this research, the TSI Chlorophyll 'a' was used to determine the trophic state since chlorophyll 'a' is possibly being the most accurate compared to Secci Depth.

3. Results

3.1. Results of the local measurements

All figures representing locally data are shown with the depth on the y-axis and the value of the parameter on the x-axis. For the parameters there is always the average measurement of all days used.

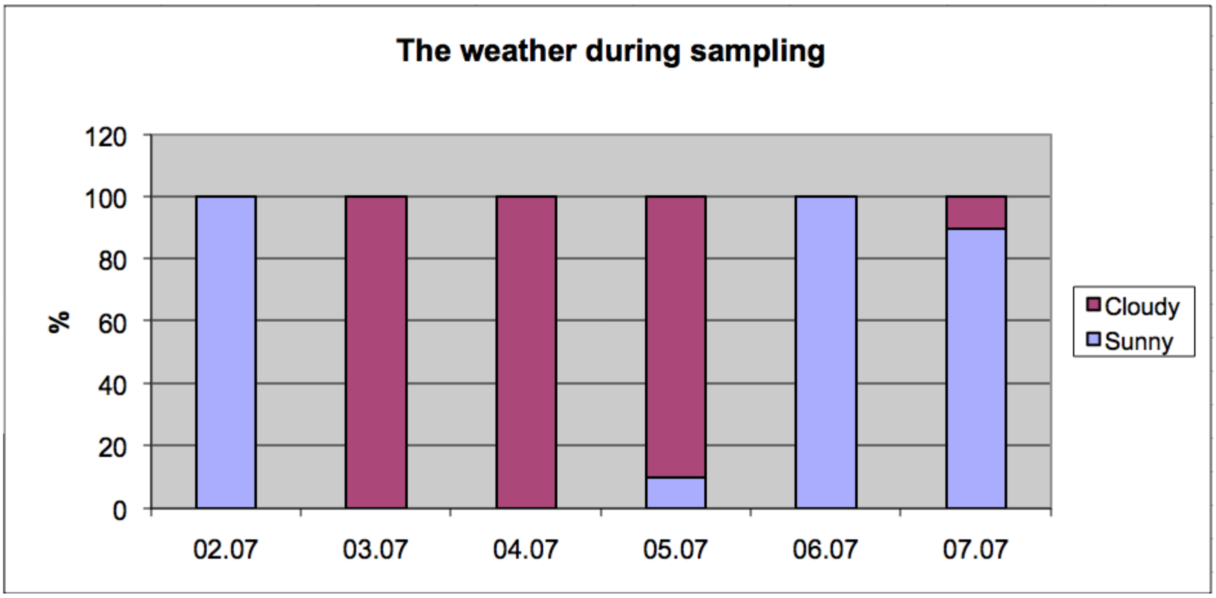

Figure 2. Daily weather of the week (02.07 - 07.07.12)

The following figure shows the average rotations of aerator 1 and aerator 2 for the whole week

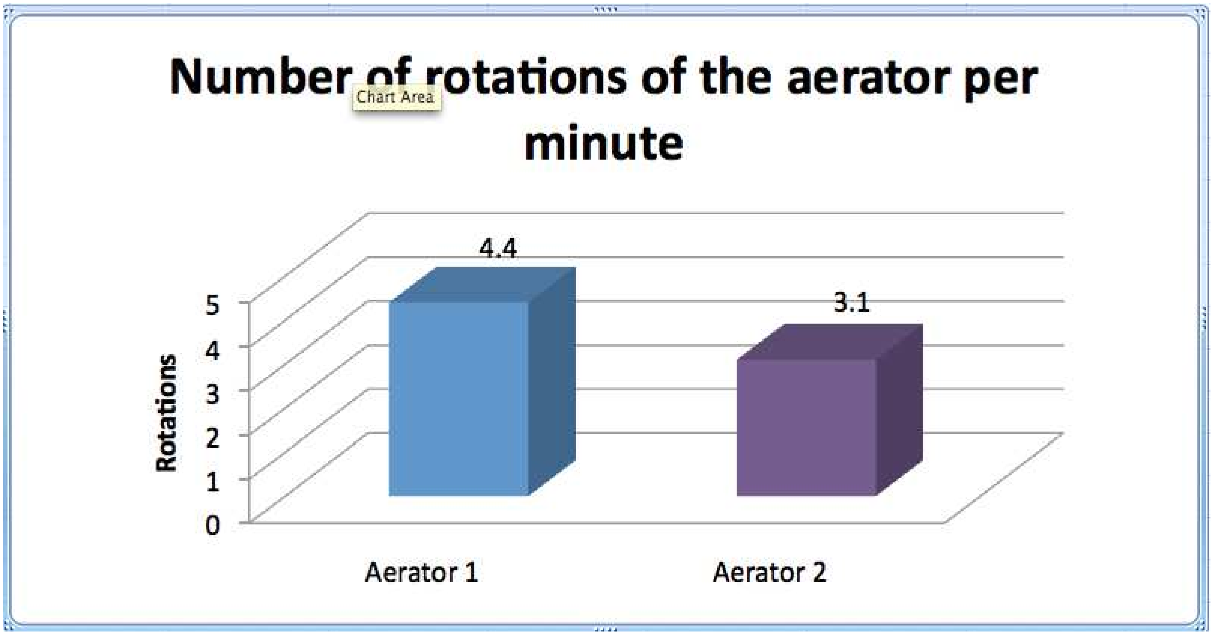

Figure 3. Average Rotations of The Aerators per Minute

Dissolved oxygen varies between 0.11 mg/l and 16.721 mg/l. The highest amount of oxygen is at the Middle 2 on the surface. Noticeable is that there is a massive decrease of dissolved oxygen between 3 m and 4 m at all sampling sites.

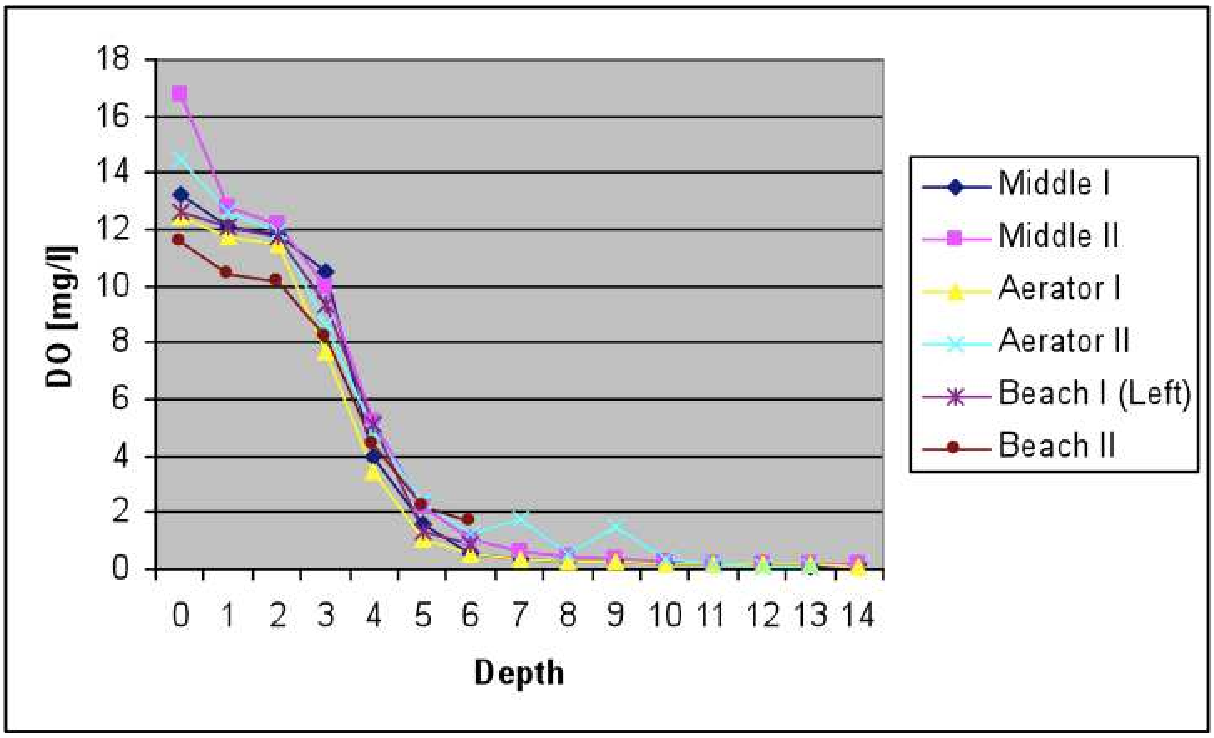

Figure 4. Average Values of Dissolved Oxygen

The water temperature varies between 7.13 ℃ and 24 .32 ℃. The different sampling sites only vary a little from each other. It only shows a big decline in temperature from 5 m to 4 m in common. The deeper it gets, the more decreasing the temperature is.

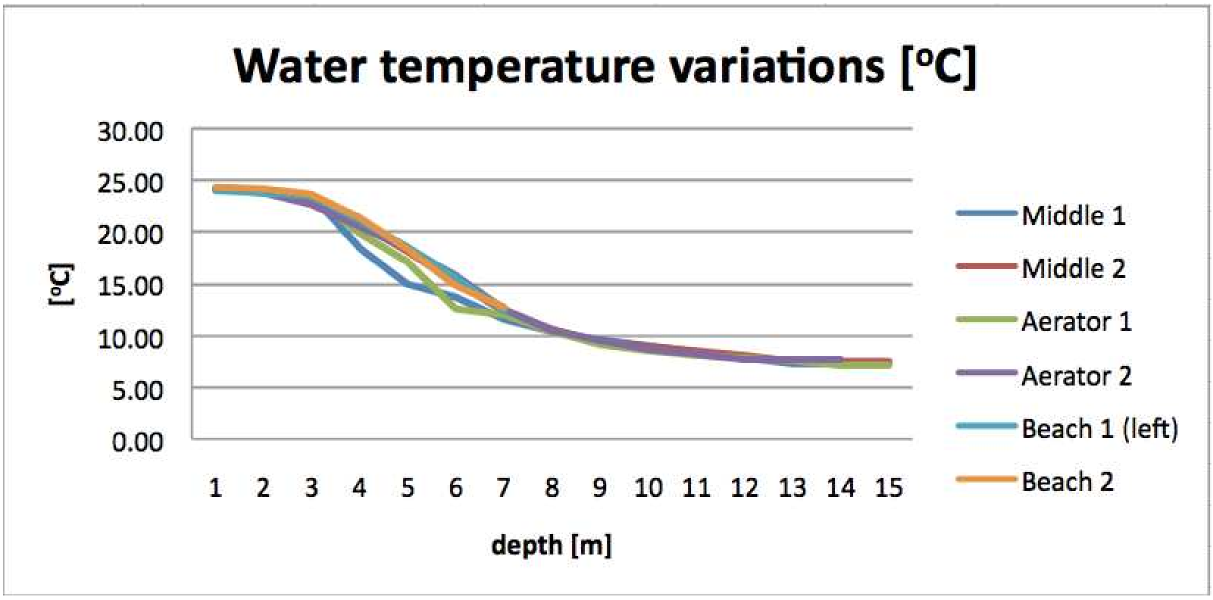

Figure 5. Average Values of Water Temperature

During the field measurements there were definitely no such huge variations of pH values between one to another both depth and location-wise. The lowest pH measured was 8,02 and the highest was due 9,89. However, due to equipment failure during measurements, several pH values were measured separately using the tube and pH meter. It is thereby lies a difference values between the charts and the results collected.

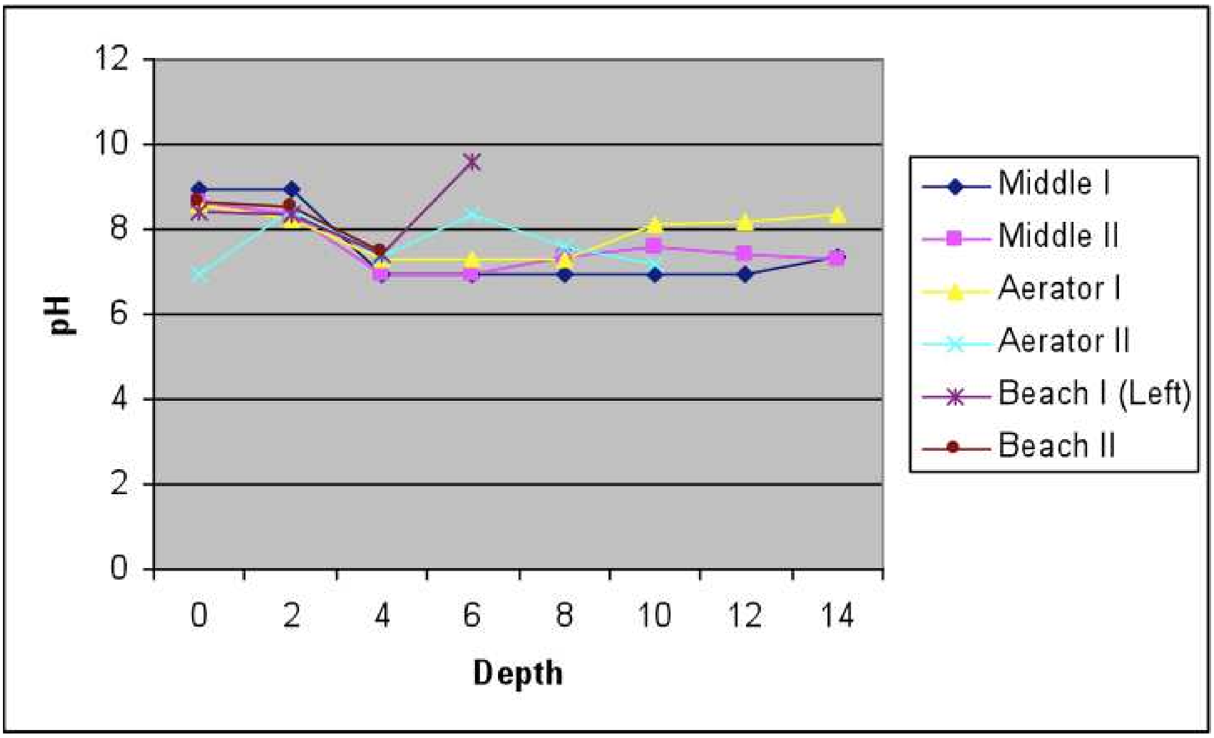

Figure 6. Average pH Values

Figure 7 shows the conductivity of the different sampling sites. It ranges from 570 µS/cm to 741.334 µS/cm. Near to the water surface the conductivity is the lowest. It tends to get higher from 3 m to the bottom of the lake.

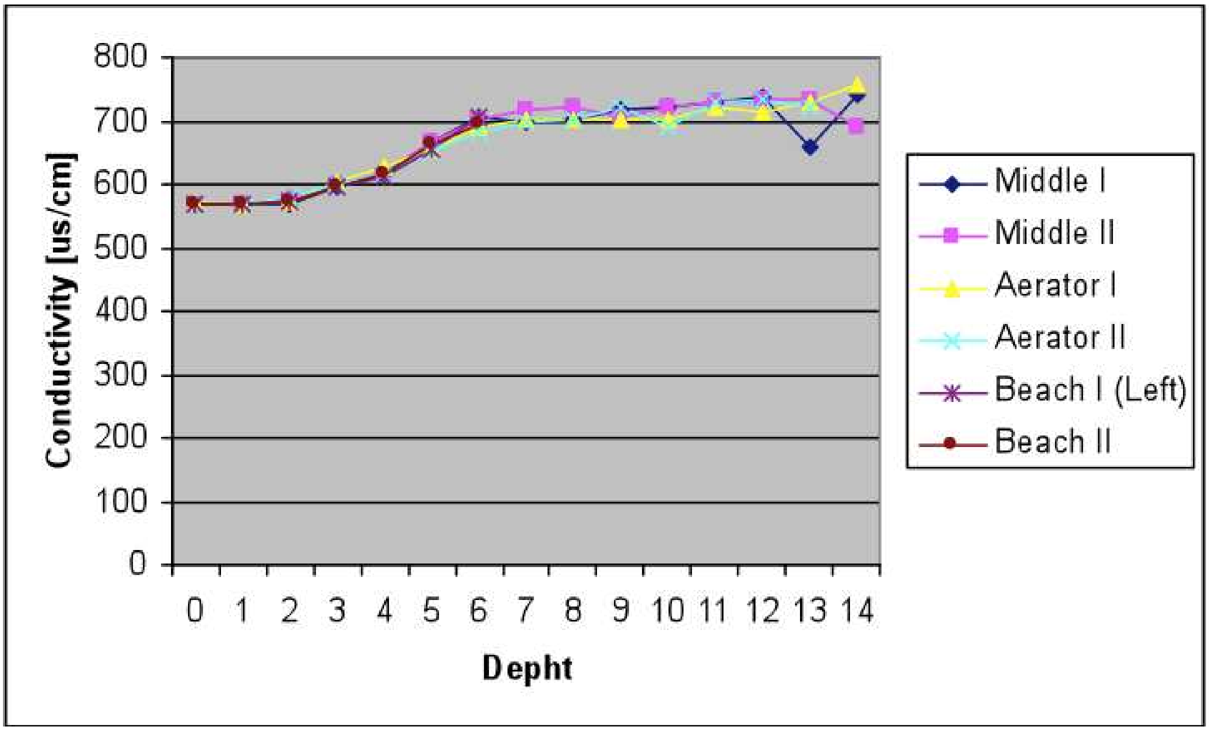

Figure 7. Average Conductivity Values

The TDS is showing a decreasing sign along with increasing depth. It ranges from 444.5 g/l and 683 g/l. Between 3m and the water surface the content tends to increase rapidly. Aerator 2 shows such oscillating values.

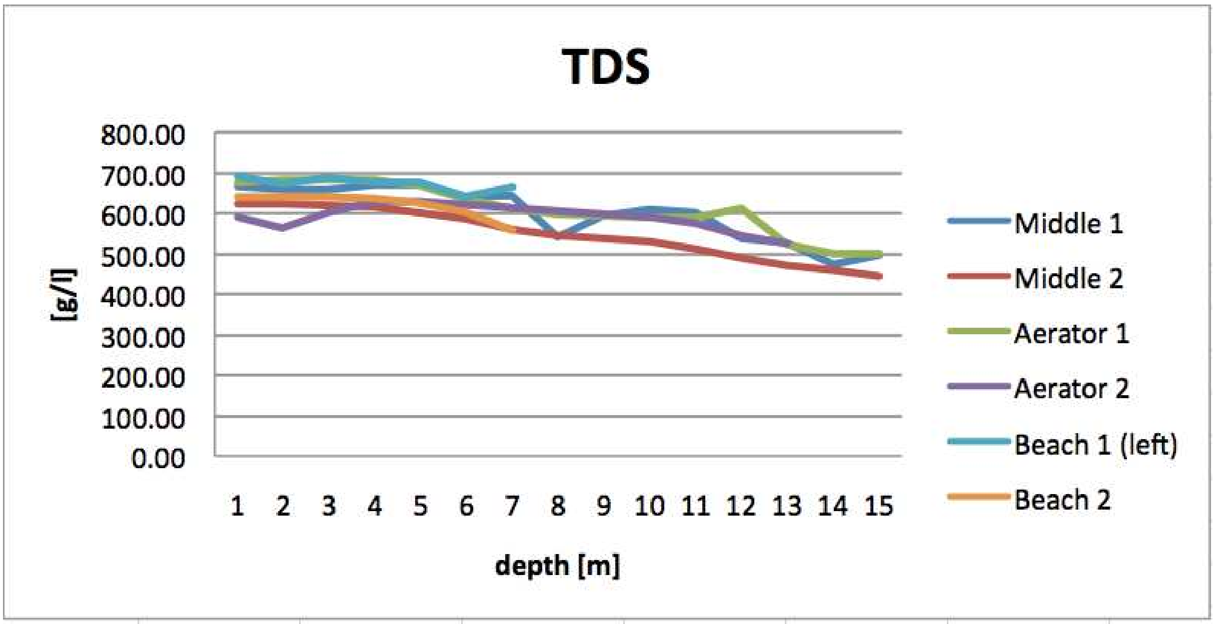

Figure 8. Average Total Dissolved Solid (TDS) Values

The following figure will show the water transparency that being measured daily. On average value, water transparency during measurements was not more than 1 meter.

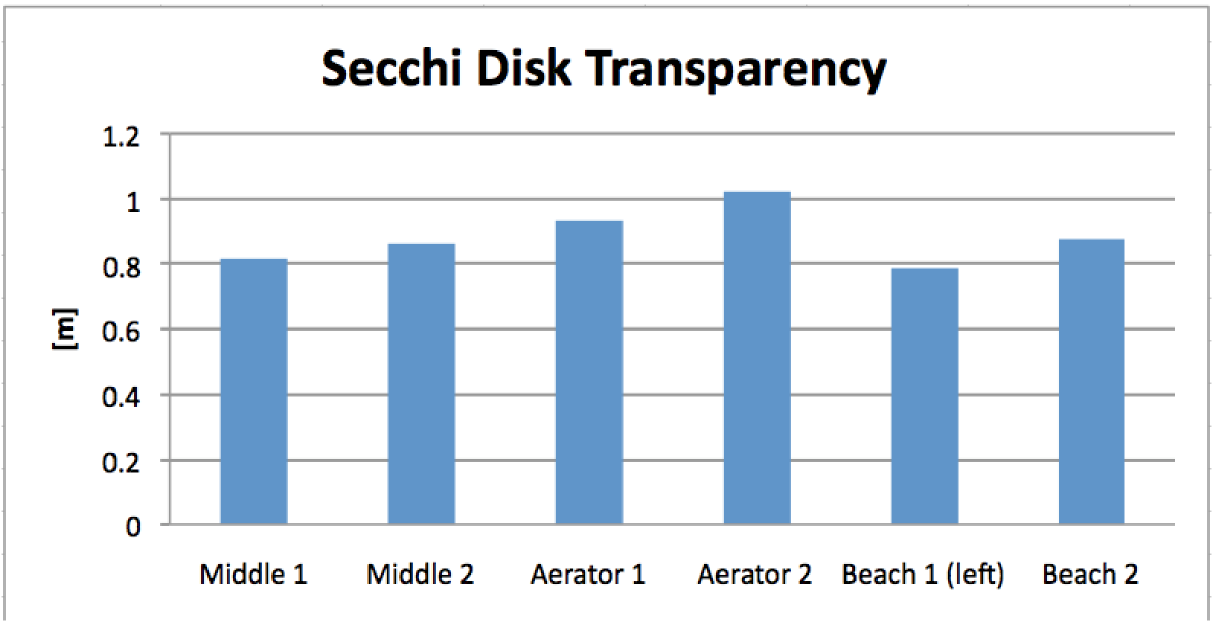

Figure 9. Average Water Transparency Values

3.2. Results of chlorophyll 'a'

The chlorophyll 'a' concentration is showing a steep drop at all sampling sites. It varies between 1.4 µg/l and roughly 3 µg/l in average. The sampling sites differ from each other. The chart shows that Aerator 1, Middle 1, and Middle 2 have a very increasing number of concentrations of chlorophyll 'a' on 6th of July. It is possible due to a very clear and sunny weather within the day. However, two days earlier, Middle 2 also shows a prominent number of 5.71 µg/l despite of the cloudy weather whole day.

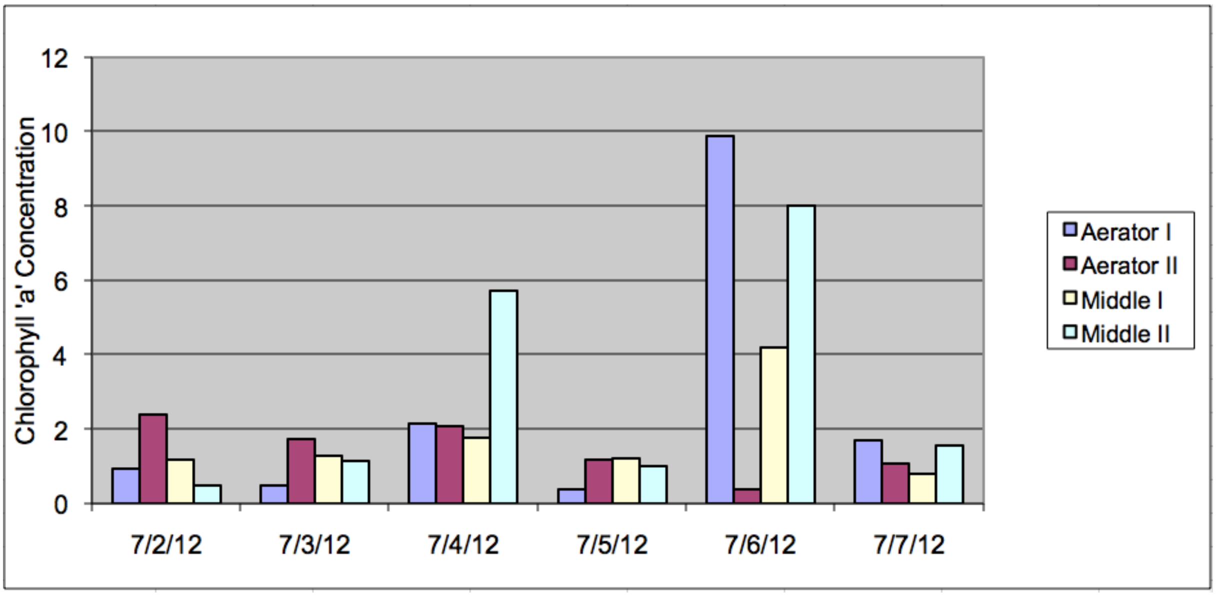

Figure 10. Chlorophyll 'a' Concentration

The average concentrations of chlorophyll are listed in the table below. The highest chlorophyll value is measured at Middle 2 with 2.99 µg/L while the lowest has been measured at Aerator 2 with 1.473 µg/L.

Sites	Chlorophyll ‘a’ concentration (µg/L)
Aerator 1	2.593
Aerator 2	1.473
Middle 1	1.749
Middle 2	2.99

Table 1: Chlorophyll ‘a’ Concentration

3.3. Results of TSI calculations

The following table shows the results of the TSI calculations. The TSI according to the Secchi Depth is in average 61.84 and the average TSI of the chlorophyll is 45.05.

	Middle I	Middle II	Aerator I	Aerator II	Beach I	Beach II
TSI SD	49.6	50.1	51	48.75	50.5	49.85
TSI Chlorophyll ‘a’	48.47	38.44	41.25	52.04		

Table 2: Carlson’s Trophic State Index

3.4. Sources of Error
3.4.1. Possible Sources

There are several sources of possible error during the research and therefore the results of this work must be treated carefully. There are three main sources of error: Selection of sampling sites error, errors during samples taking, and errors during laboratory work.

3.4.2. Selection of Sites

The sampling sites of aerator 1, 2, and the sites of Beach 1 and 2 were always the same place (knotted boat to pillar), whereas the sampling sites of Middle 1 and Middle 2 differed every day slightly, because there were no precise orientation points.

3.4.3 Errors During Measurements

Sources of error are:

a. Measurements not in the right depth.
b. Possible higher O_2 content because of the coincidental aeration by water bikes and any other passer by's that generating oxygen.
c. Less time being spent while the value measured by multi-parameter display is still fluctuating.
d. Group changed every day therefore slightly deviations in methods could be possible due to uncontrolled measuring.
e. At some points and occasions, multi-parameter display failed to indicate the pH values which resulted to the manual measurement using tube and pH meter.
f. Some missing data also occurred during the measurements due to uncontrolled measurements by other groups that may be encountering first time experience measuring data.

3.4.4. Errors During Laboratory Works

Students are coming from multi - discipline of educational backgrounds. It is therefore possible that some students may experience laboratory work for the first time. Some slight error might occur during the process of laboratory works.

4. Discussion

4.1. Interaction of The Parameters and Water Quality According to Water Framework Directive

The weather during the measuring period was interrupted with three different storms during the night. The weather was sunny in the first and fifth day with a slight cloudy condition in the sixth day. However, despite of the weather condition, the measurements showing that the temperatures of the water were slightly oscillating and maintained well between 23 and 24 ºC on daily basis. First it decreases slightly and then very fast from 4 m to 6 m. This temperature change indicates the different zones in a lake (epilimnion, metalimnion, hypolimnion). At the surface there is the epilimnion with relatively high and constant temperatures and then there is the metalimnion with a fast decrease in temperature. In the hypolimnion (7 m to bottom) there is almost no change in temperature anymore. (Walter. 2002)

Along with the increase of depth and the dropping temperature, the amount of dissolved oxygen, and TDS are also decreasing. However, the opposite values are shown by water conductivity. Dissolved oxygen is higher at the surface out of different reasons. First here it is possible to increase the DO by weather changes. Wind, waves, rain, or any other cause of turbulence activity such as motor boats for instance. Second, the epilimnion is where most algae grow. Algae need lights, nutrients and warm temperature (SEIP. 1990). Dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5 mg/l, aquatic life is put under stress condition. The lower the concentration becomes, the grater the stress will be.

Middle 2 shows one peak in the DO graph on the water surface. A normal indicator whereas surface of water is the most part that receives better light and often aerated better.
The electrical conductivity and the TDS are indicators for nutrients. The electrical conductivity shows that the nutrients are increasing with increasing depth within the measurement week. This condition is due to heavy storms that occur during the measurement week, which therefore influences the turbidity of the water bodies, which caused by heavy inflows from the runoff of surroundings and also from the inflow of lake Kobyleckie. But an overload of nutrients is also a stress factor for most aquatic ecosystems involving mixed fish fauna. The TDS of the lake is decreasing with increasing depth. Reason for that is the sediment and the fact that the sediment load which leads into the lake sinks down along with the time (retention time).

These sediments are main source of nutrients in lake currently. Nutrients are taken off from sediments not only during spring and autumn destratification and mixing of water, but also during summer stagnation. When the bottom of the lake is suffering from lack of oxygen, phosphates (PO_4^{3-}) are migrating from the sediments into the water. This is because phosphates in sediments are usually found in form of iron (III) phosphate that is almost insoluble in water. When water of the hypolimnion is out of oxygen, the iron (III) phosphate is reduced into iron (II) phosphate, which dissolves much easier in water.
The presence of algae in the upper parts of a lake is one reason for the increased pH values near to the water surface. Usually a water body is more acid because of the carbon dioxide in the water. Algae use this carbon dioxide for their metabolism and therefore the pH is getting lower.

All parameters describe the very low amount of chlorophyll ‘a’. Supposedly algae will grow better during summer and especially with the beginning of the warm weather the algae had better living circumstances and could grow a lot. However, due to a very late summer and heavy storms it is possible that the water body is disrupted and causing fewer algae to produce more biomass. Also, there had been prominent availability amount of *Bacillariophyceae* that been founded during the measurement week.

Better condition of weather system on the 6th of July has increased the growth of algae temporarily, gases at the bottom of the lake are forced to go up and bring algae in lower layers to the surface. With less amount of chlorophyll ‘a’ and with a continuous inflows coming after storm, the transparency of the water measured by Secchi Disc decreased. Following table determines the classes after the Water Framework Directive (values especially for Poland). For Secchi depth, dissolved O_2 in hypolimnion and electrical conductivity there is no specification in classes, but in “good” and “bad”.

Parameters	**Class of Water**				
	I (Good)	II (Good)	III (Bad)	III (Bad)	III (Bad)
Chlorophyll ‘a’ (µg/L)	< 7.0	7.0 – 13.0	13.0 - 21.0	21.0 - 33.0	> 33.0
Secchi Depth (m)	> 1.7		< 1.7		
Dissolved O_2 in hypolimnion (mg/L)	> 4		< 4		
Conductivity (µS/cm)	< 600		> 600		

Table 3. Water Classification in Accordance to Water Framework Directive

Consequently, we have following classes for Lake Durowskie this year

Parameters	Value	Classification
Chlorophyll ‘a’ (µg/L)	2.2	1 (Good)
Secchi Depth (m)	0.88	Beyond 2nd Class (Bad)
Dissolved O_2 in hypolimnion (mg/L)	0.27	Beyond 2nd Class (Bad)
Conductivity (µS/cm)	648.2	Beyond 2nd Class (Bad)

Table 4: Classification of lake Durowskie According to Water Framework Directive

Chlorophyll ‘a’ is with a value of 2.2 µg/l is suitable with the required value and therefore classed as Class 1. The dissolved oxygen is too less and is evaluated as ‘bad’ according to the Water Framework Directive. Transparency and water conductivity are evaluated as ‘bad’ as well.

4.2. Trophic State of The Lake According to The Carlson’s Trophic State Index (TSI)

The Carlson’s TSI according to the Secchi disc is in average 61.84 and the average TSI of the chlorophyll ‘a’ is 45.05. These values are indicators for highly mesotrophic lakes, which suitable with the following index table. The preferred used of the TSI is TSI Chlorophyll ‘a’ due to the least accurate of TSI SD used to assess TSI.

TSI Value	Status
< 40	Oligotrophic
40 - 50	Mesotrophic
50 - 70	Eutrophic
> 70	Hypertrophic

Table 5. Carlson's Trophic State Index (TSI)

4.3. Development of The Lake Over Years

The following figures show the changes of the TSI's of the year 2011 and 2012 and the conductivity of the year 2008 - 2010, and 2011. The chlorophyll 'a' falling down at all sampling points. Reason for this could be the weather of this year and a specific disrupted weather during the whole week. The turbidity of the water caused by the storm led to the decreasing transparency and therefore made the production of the biomass becomes less. This also could be an indicator for higher nutrient load into the lake. According to this year's TSI of chlorophyll 'a', the lake is mesotrophic.

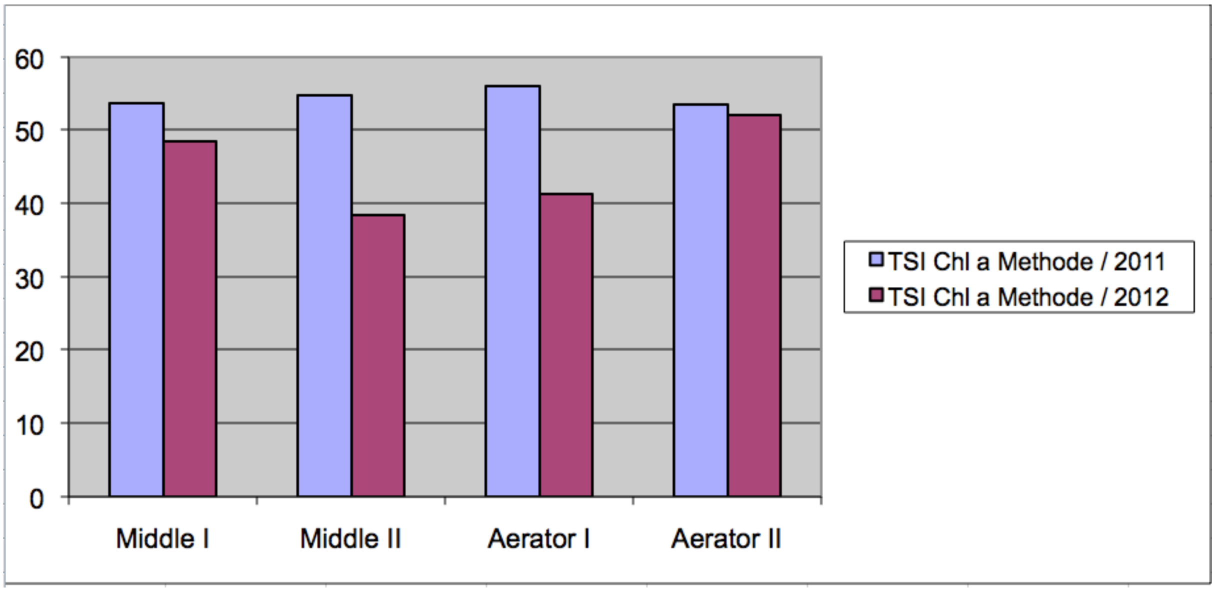

Figure 11. Comparison of TSI Chlorophyll 'a' 2011 – 2012

The TSI SD shows a significant decline compared to last year's TSI

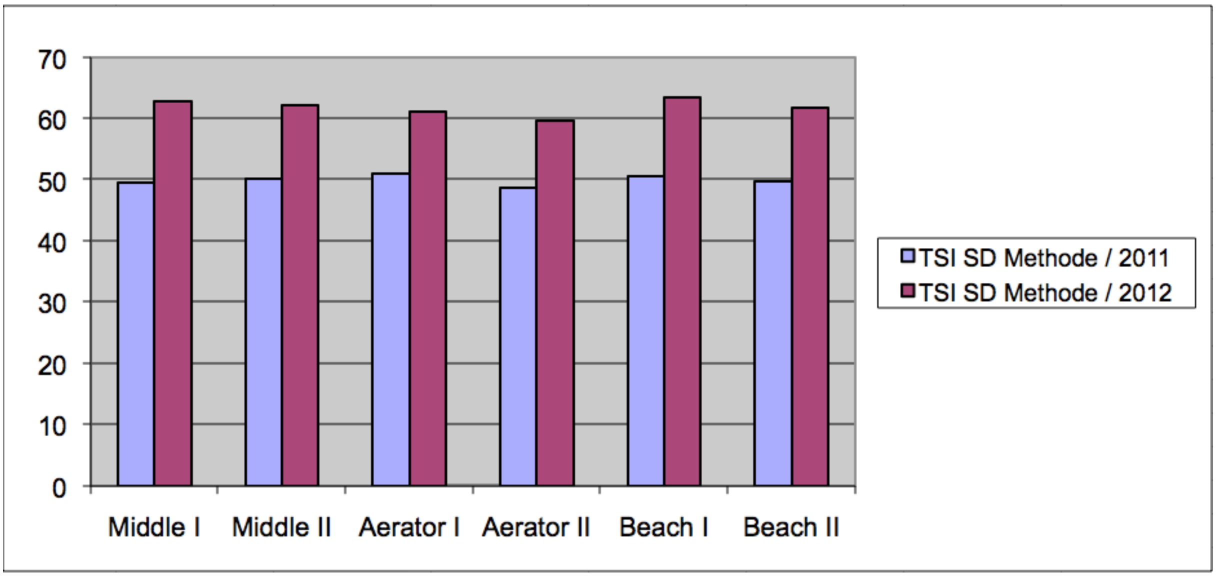

Figure 12. Comparison of TSI SD 2011 - 2012

The conductivity has been changing many times during the years. In 2008 there was in high increase of conductivity with increasing depth. In 2009 the increase of conductivity was less and in 2011 there is a slightly decrease of conductivity with increasing depth. In 2012 conductivity raises along with the depth, which is a vivid different situation. The conductivity is much higher (between 570 µS/cm - 742 µS/cm) and there is a decrease of conductivity with increasing depth. This development shows that there are fewer nutrients at the bottom, which are getting released.

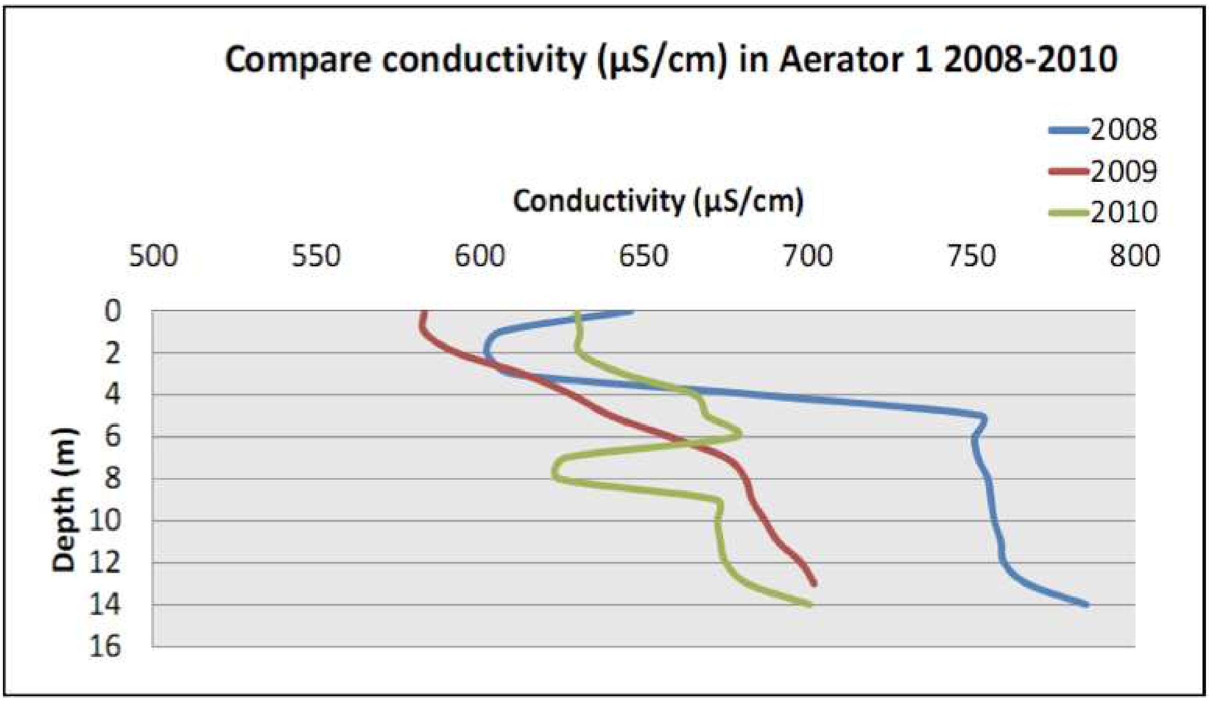

Figure 13. Comparison of Conductivity from 2008 to 2010

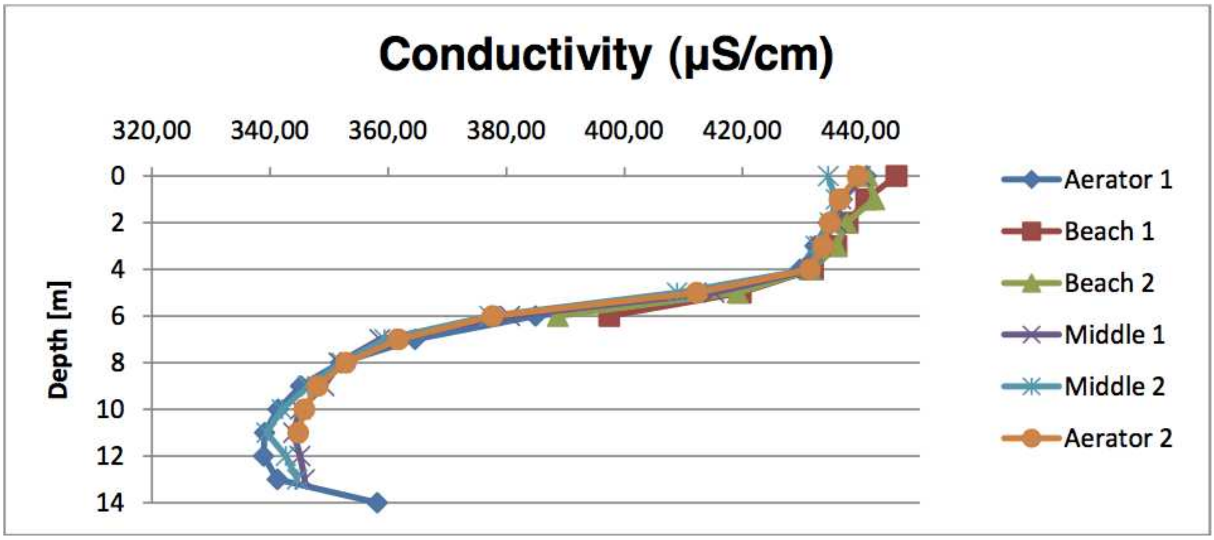

Figure 14. Conductivity in 2011

4.4. Possible Management and Improvements of The Lake

The management of the lake Durowskie is a difficult task and there is no guideline to manage the lake in the right way. The efforts of building the aerators and having a phosphorous trap seem to show no high/fast efficiency in gaining a good water quality. One way to avoid any more loads is not to treat the consequences, but the source. There are several households, which are still not connected to waste water plants. Improving the ability to have access to water plants could therefore improve the lakes quality in a long - term sight.

Improvements of the current aerator might be necessary and to measure and calculate efficiency of the aerator located. Aeration runs better when it is placed deeper in the water body, and since it is necessary to improve dissolved oxygen in the *hypolimnion*. Another important thing is the increase of agriculture and population growth. In the near future precise development would have to meet the ecological requisites. The changes of the weather in particular needed to be properly addressed. If the trend of the heavy storm will continue in the upcoming years, then particular improvements to handle post-storm effect is necessary.

The lake is monitored every five years by Voivodeship Inspectorate of Environmental Protection. This monitoring should be continued and even improved in order to reach a better water quality and therefore securing tourism at lake Durowskie.

5. Conclusion

a. This work concludes that the water quality of Lake Durowskie currently satisfies the demands of the Water Framework Directive.
b. The classification of the water class is based on chlorophyll ‘a’ measurements and gives a classification of I. However, chlorophyll ‘a’ can fluctuate rapidly and shows only the current state of the water and no long-term developments.

c. Apart from the chlorophyll ‘a’, the quality of the lake according to dissolved O_2 in the *hypolimnion* must be evaluated as “bad”. Secchi depth and conductivity also do not show any good class but possibly due to the weather disturbances.
d. In the comparison with former years, there seems to be an improvement in the lakes quality.
e. In 2012 the conductivity is decreasing with decreasing depth. However, the trophic state indexes of the lake give the result that the lake is mesotrophic.

To sum up, it can be stated that Lake Durowskie is in a good direction, but necessary improvements should be considered in order to suit Water Framework Directive.

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Appendix

Water temperature [°C]

DEPTH	Middle 1	Middle 2	Aerator 1	Aerator 2	Beach 1 (left)	Beach 2
0	24,24	24,22	23,98	24,22	24,04	24,32
1	24,06	24,06	23,94	23,79	23,74	24,07
2	23,48	23,11	23,28	22,62	23,46	23,49
3	18,41	20,69	19,82	20,42	20,92	21,27
4	14,94	18,07	17,13	18,29	18,44	18,21
5	13,68	15,11	12,55	15,76	15,40	14,67
6	11,54	12,22	12,02	12,53	12,35	12,71
7	10,42	10,50	10,37	10,57		
8	9,49	9,29	9,10	9,46		
9	9,04	8,85	8,63	8,74		
10	8,39	8,40	8,21	8,23		
11	7,84	8,03	7,92	7,90		
12	7,58	7,73	7,57	7,68		
13	7,28	7,64	7,31	7,71		
14	7,39	7,51	7,13			

Dissolved oxygen [mg/l]

Depth	Middle I	Middle II	Aerator I	Aerator II	Beach I (Left)	Beach II
0	13,22	16,72	12,43	14,44	12,62	11,57
1	12,09	12,83	11,76	12,58	12,10	10,39
2	11,85	12,16	11,48	11,87	11,72	10,18
3	22,20	9,94	7,67	8,67	9,36	10,14
4	3,94	5,19	3,46	4,84	5,13	4,42
5	1,56	2,16	1,05	2,37	1,36	2,25
6	0,51	1,02	0,50	1,20	0,89	1,68
7	0,37	0,65	0,39	1,74		
8	0,26	0,46	0,31	0,51		
9	0,24	0,32	0,25	1,52		
10	0,21	0,23	0,21	0,33		
11	0,19	0,16	0,16	0,21		
12	0,15	0,17	0,16	0,11		
13	0,13	0,21	0,14	0,11		
14	0,14	0,18	0,12			

Oxygen [%]

Depth	Middle 1	Middle 2	Aerator 1	Aerator 2	Beach 1 (left)	Beach 2
0	153,52	173,60	145,62	149,30	147,70	152,52
1	137,73	152,53	139,40	148,67	142,80	145,55
2	128,72	140,30	132,72	135,40	137,60	141,00
3	89,03	102,66	79,58	92,50	100,06	111,35
4	38,55	51,62	34,25	48,90	51,75	58,53
5	12,37	20,03	8,80	22,13	12,70	16,93
6	4,75	9,35	4,17	10,38	7,50	6,58
7	3,47	5,50	3,37	6,35		
8	2,35	3,97	2,52	4,14		
9	2,14	2,85	2,03	2,95		
10	1,84	1,83	1,57	2,65		
11	1,56	1,38	1,28	1,73		
12	1,33	1,32	1,27	0,95		
13	1,20	1,72	1,15	0,90		
14	1,17	1,50	1,00			

pH

Depth	Middle I	Middle II	Aerator I	Aerator II	Beach I (Left)	Beach II
0	8,84	9,01	8,84	8,81	8,77	8,99
1	8,91	8,99	8,71	9,16	8,87	9,11
2	8,55	9,05	8,89	9,08	8,85	9,00
3	8,70	9,33	8,77	9,18	8,80	9,25
4	8,52	9,05	8,71	8,96	8,56	9,04
5	8,69	9,51	8,79	9,41	9,06	9,47
6	8,66	9,24	8,93	9,46	8,78	9,67
7	9,13	9,89	8,95	9,60		
8	9,06	9,80	8,92	9,55		
9	9,27	10,25	8,67	9,43		
10	9,18	9,97	8,97	9,40		
11	9,26	10,38	9,68	8,17		
12	9,18	9,94	9,64	8,98		
13	8,02	9,87	9,98	9,13		
14	8,31	8,60	9,81			

TDS (g/L)

Depth	Middle 1	Middle 2	Aerator 1	Aerator 2	Beach 1 (left)	Beach 2
0	665,22	623,13	674,26	588,02	691,55	640,38
1	655,03	619,47	679,76	563,18	669,62	640,10
2	655,88	618,05	682,77	599,82	685,13	638,78
3	669,68	613,70	680,28	628,54	673,17	633,28
4	666,00	599,37	665,68	626,80	673,13	624,90
5	636,72	583,90	632,23	617,48	641,22	601,60
6	642,22	557,14	608,88	610,58	661,70	557,63
7	538,36	542,82	595,78	603,88		
8	593,22	534,68	591,05	595,45		
9	606,88	528,04	588,18	590,63		
10	599,95	507,00	585,39	573,73		
11	535,65	485,66	607,83	543,20		
12	524,70	465,23	518,93	525,10		
13	473,48	454,70	500,00			
14	495,25	444,50	502,78			

Conductivity [µS/cm]

Depth	Middle I	Middle II	Aerator I	Aerator II	Beach I (Left)	Beach II
0	570,00	570,33	572,00	569,17	567,17	569,00
1	569,33	570,00	570,17	569,33	569,33	569,00
2	570,20	576,00	573,17	579,00	572,17	573,33
3	596,50	598,17	602,00	599,83	597,67	595,33
4	615,83	615,50	629,33	616,83	611,83	614,67
5	666,17	666,50	655,50	652,50	654,40	661,67
6	704,50	700,83	691,33	682,50	704,50	694,20
7	699,33	716,67	700,33	699,83		
8	702,00	720,17	702,67	703,33		
9	719,40	704,67	702,83	722,83		
10	723,20	723,17	703,83	692,00		
11	730,40	727,60	722,50	730,83		
12	735,60	735,00	714,67	733,50		
13	657,38	733,50	727,67	723,00		
14	741,33	689,50	756,00			