Water quality of Lake Durowskie

2011

Fieldtrip to Poland

By

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1. Introduction

Two thirds of the earth's surface is covered by water, only 2,75 % of this water is fresh water whereas 2,15 % is still bound in polar ices (WRI, 2008). Water has become a scarce source within the last decades and a major subject in economic and environmental aspects. Therefore it has become of great interest to manage water in a sustainable, thoughtful and controllable way.

With the introduction of the Water Framework Directive 2000, it has become of major interest to improve and keep good water qualities within the European Union.

Lake Durowskie in Wagrowiec, Poland is one major spot for tourism, but it is threatened by eutrophication due to the lack of waste water plants and intensive agricultural land use in the surroundings. In order to get and keep a good quality of the lake there have been made several improvements to the lake such as buildings of two aerators and installations of phosphorus traps.

Therefore this work deals with following questions:

a) How do the parameters interact with each other and what is the water quality according to the Water Framework Directive?
b) What is the trophic state of the lake according to the trophic state index (TSI)?
c) How did the lake develop in the last year?
d) What are possible management improvements for the lake?

1.1. Field area

Lake Durowskie is a typical post-glacial troughflow 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 commune 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 in this time fertilizers were founded from national budget, not bought by farmers, so 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; fishing is very popular in this area.

The lake is monitored every five years by Voivodeship Inspectorate of Environmental Protection. Last time it was monitored in 2006, so the next monitoring will take place this year.

2. Methods

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

2.1. Field work

During the first week of July (04.07.-09.07.2011) the water samples as well as locally measurements have been taken. Every day the weather was written down. The following six points were sampled each morning (Middle I, Middle II, Aerator I, Aerator II, Beach I, Beach II) by water bikes.

Figure 1: Sampling points at Lake Durowskie

Following field parameters were determined by a multiparameter measuring device. Each parameter was examined every meter, starting at water surface and going down to one meter above the lake bottom.

<u>Aerator turnings</u>

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 pump H_2O into the lake which leads to chemical reactions like oxidation of reduced compounds and/or to keep oxidizing conditions in the hypolimnion water to protect the lake from emissions of phosphates from sediments.
For each day the number of aerator turnings has been written down, in which a higher number of countings a higher pumping of O_2 into the sediment means.

<u>Dissolved oxygen</u>

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)

<u>Temperature</u>

The temperature of a 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.

<u>pH-value</u>

The pH value is a measure for acidity or basicity 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, for example:

$$NH_3 + H_3O^+ \leftrightarrow NH_4^+ + H_2O$$

<u>Electrical conductivity</u>

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. Electrical conductivity is measured in µS/cm.

<u>Total dissolved solids</u>

TDS is a measure of the combined content of all inorganic and organic substances (minerals, salts and metals) contained in a liquid and gives 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.

<u>Secchi depth</u>

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 indexes (TSI) and therefore it is one way to examine ecological conditions and water qualities (ELSTER 1962).
At each day secchi discs measurements have been taken at each sampling point.

At Middle I, Middle II, Aerator I and Aerator II there have been taken water samples for laboratory analysis of chlorophyll a. To determine chlorophyll a the water samples which have been taken were filtered (1000ml) 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 (app. 10ml). The sample is getting centrifuged and put into a fridge (4℃) for app. 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. After this measurements 0,1ml of HCL are added to the samples and measured again after 10 minutes (665nm and 750 nm).

The content of chlorophyll a is calculated with following formula:

$$X=26{,}73\,[\,(A_{663b}-A_{750b})-(A_{665a}-A_{750a})]*V_E/V_W*l$$

where:

A_{663b} , A_{750b}: marked absorption of the extract before adding the acid
A_{665a} , A_{750a}: marked absorption of the extract after adding the acid
V_E: volume of the prepared extract

V_W: volume of the filtered water sample
l: thickness of absorption in the cuvette [cm]
26,73: conversion factor

2.3. Digital Analysis

Graphs and figures have been produced in Excel 2010. 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 which were assessed by Carlson's Trophic State Index (TSI) equations (CARLSON, 1996).

<u>TSI for Secchi depth</u>

$$TSI_{(SD)} = 10\left(6 - \frac{\ln SD}{\ln 2}\right)$$

<u>TSI for chlorophyll a</u>

$$TSI_{(CHL)} = 10\left(6 - \frac{2{,}04 - 0{,}68 \ln CHL}{\ln 2}\right)$$

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 condition.

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.

Fig. 2 shows the weather during the week (04.-09.07.11). The weather was mainly sunny. At the 5^{th} and 8^{th} of July clouds were dominating.

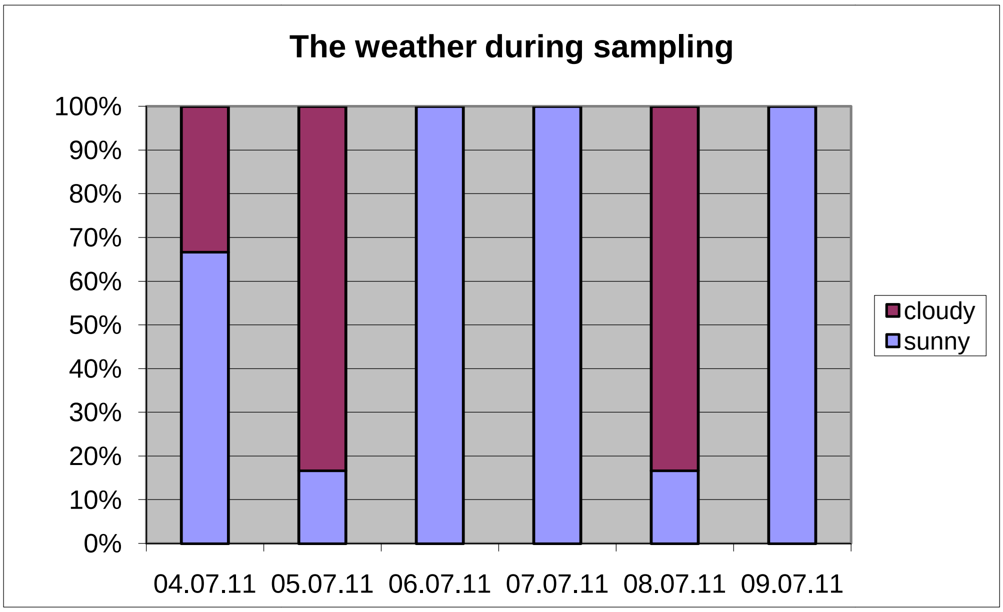

Figure 2: weather during sampling week

The following figure shows the average turnings of the aerators counted in one minute. The average of aerator 1 and aerator 2 only differ slightly in the average display. Looking at the data it becomes conspicuous that during the first two days average turnings of app. 10 have been reached, which was much higher than at the end of the week.

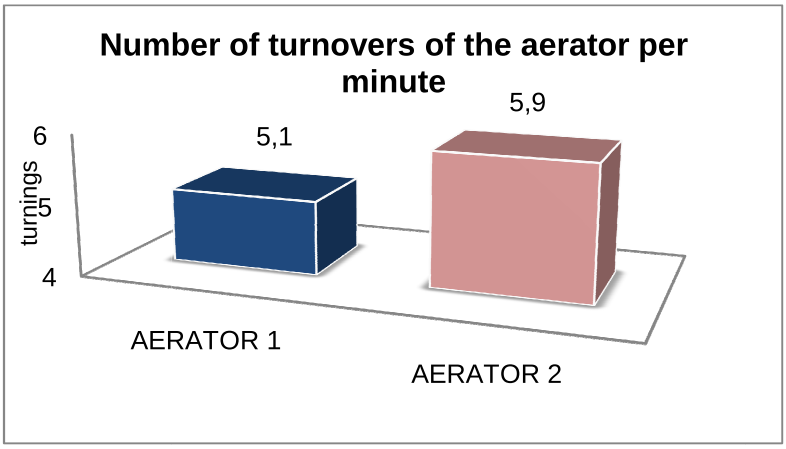

Figure 3: Number of turnigs per minute

Dissolved oxygen varies between 0,01 mg/l and 11,58 mg/l. The highest amount of oxygen has beach 1 at a depth of 2m. Noticeable is that there is a massive decrease of dissolved oxygen between 4m and 6 m at all sampling sites. All measurements with a depth deeper than 6 m show very low contents (<0,5), but Aerator 1, which has a peak at 9 m with an oxygen content of 1.

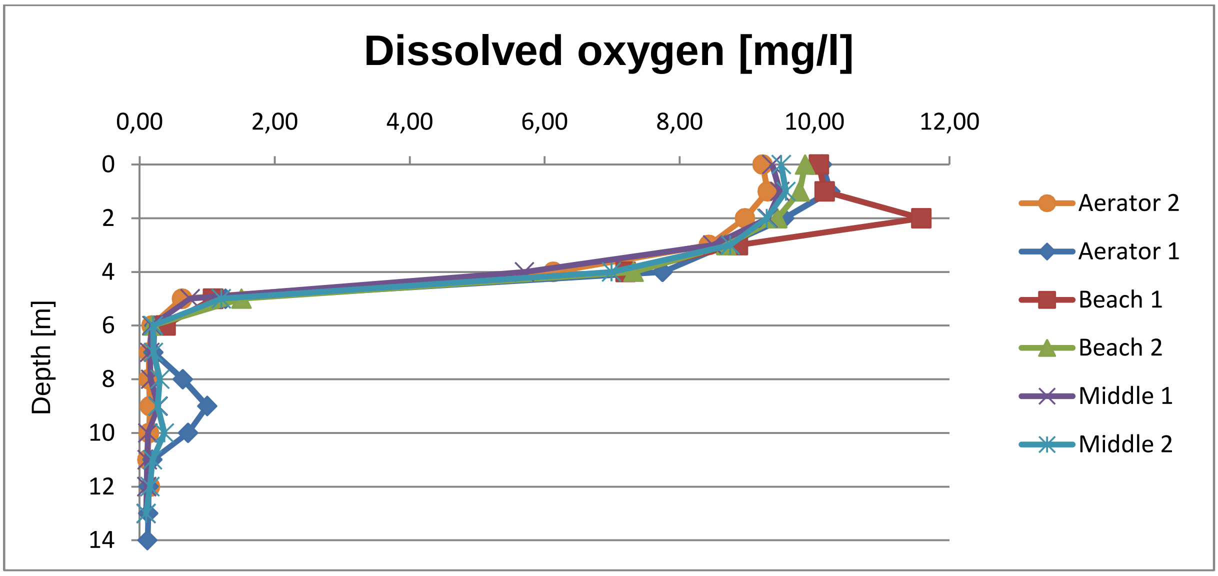

Figure 4: Content of dissolved oxygen at different sampling stations

The water temperature varies between 6,1℃ and 21,8 ℃. The different sampling sites only vary a little from each other. They have a big decline in temperature between 4m and 6m in common. With the deepness the temperature is decreasing.

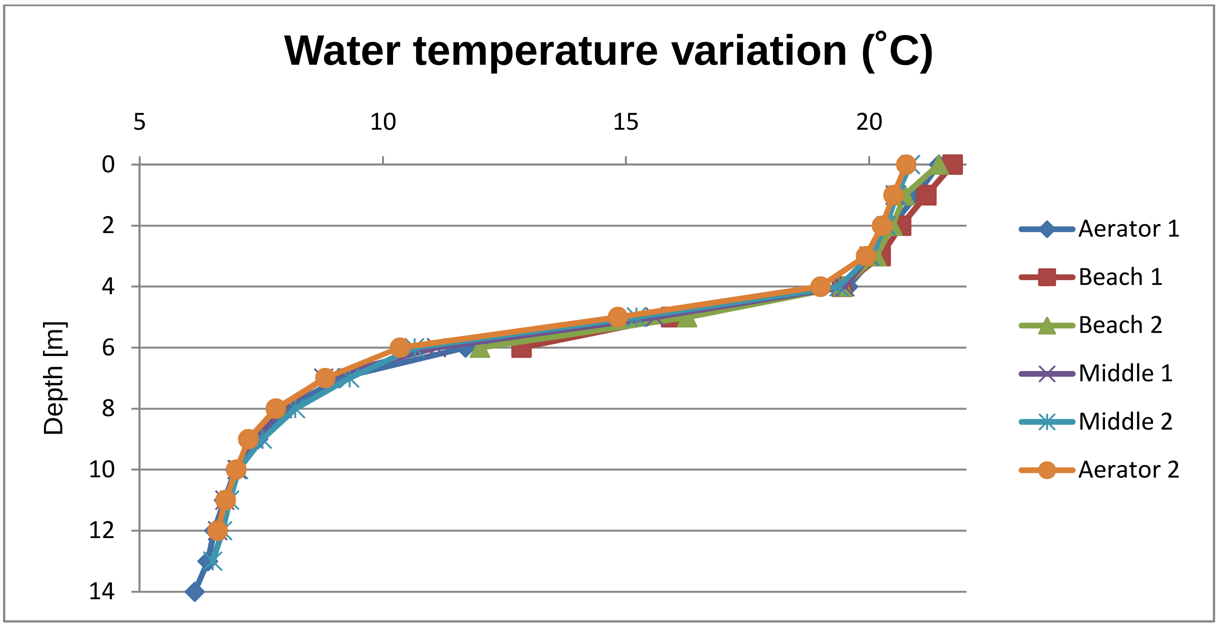

Figure 5: Water temperature at different sampling points

The pH-value varies between 7,5 and 8,8. The different sites vary only a little. With increasing depth there is a decrease in pH. Between the 3rd and 8th meter there is a drastic decrease. Reaching the 8m depth the pH-value only decreases barely.

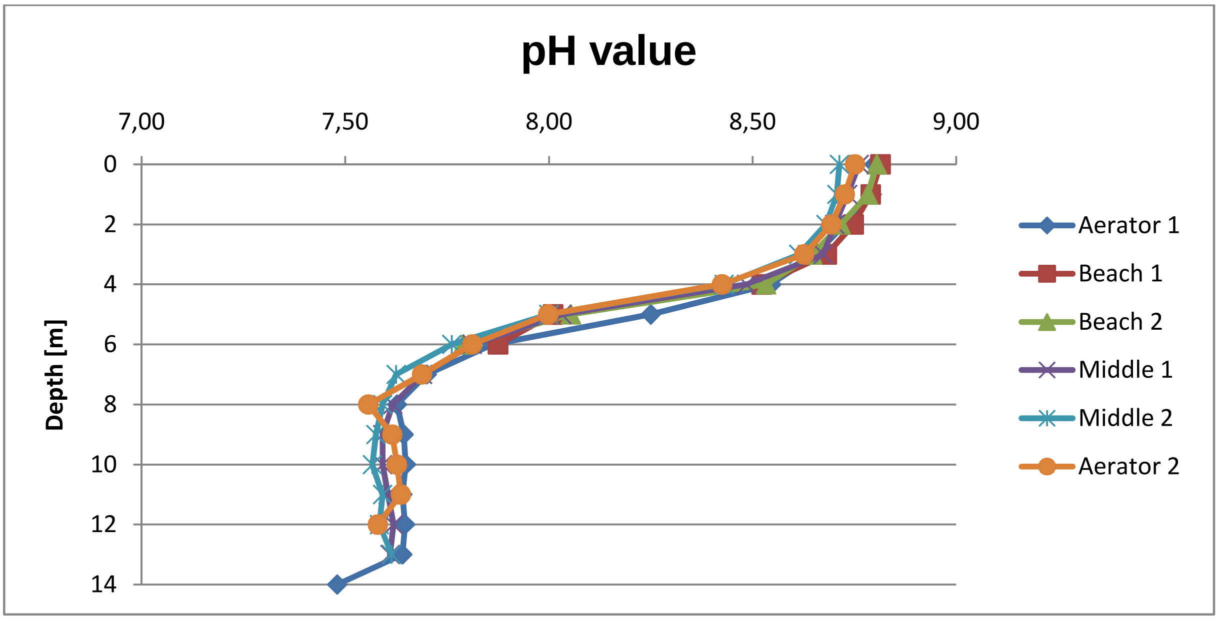

Figure 6: pH value at different sampling points

Figure 7 shows the conductivity of the different samplings sites. It ranges between 446µS/cm and 338 µS/cm. Near to the water surface the conductivity is the highest. Between 4m and 11m the conductivity is decreasing and afterwards it is increasing slightly.

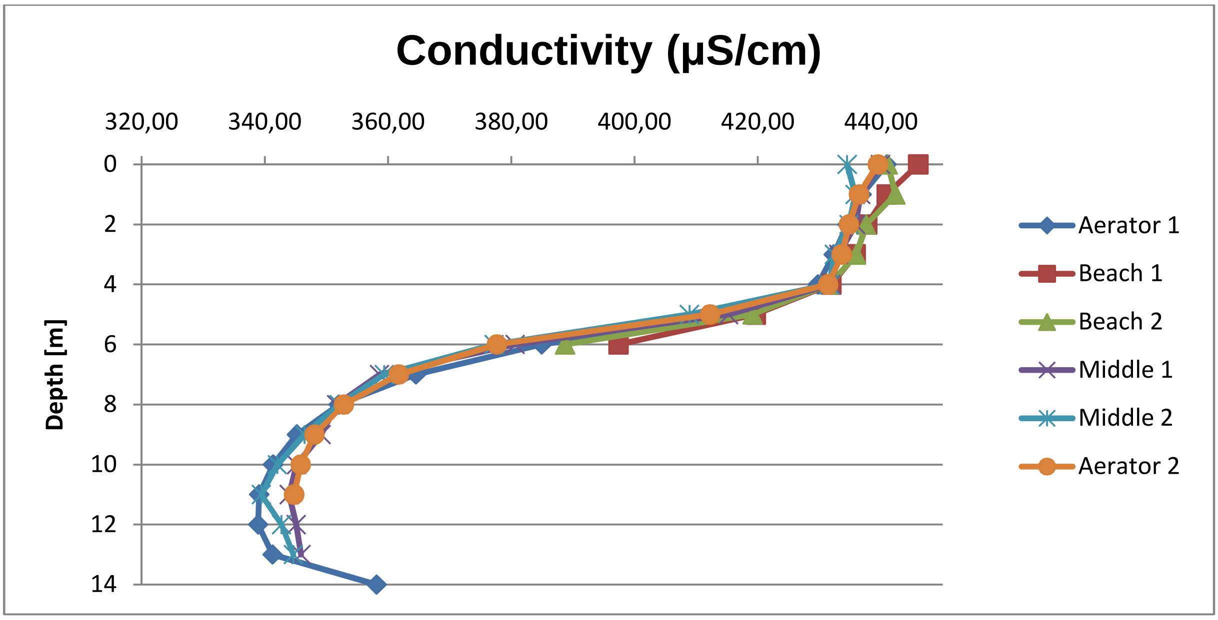

Figure 7: Conductivity of different sampling sites

The TDS is increasing with increasing depth. It ranges between 308 g/l and 355 g/l. Between 4m and 6m the content is increasing rapidly. Aerator 2 shows a decrease of TDS between 11m and 12 m.

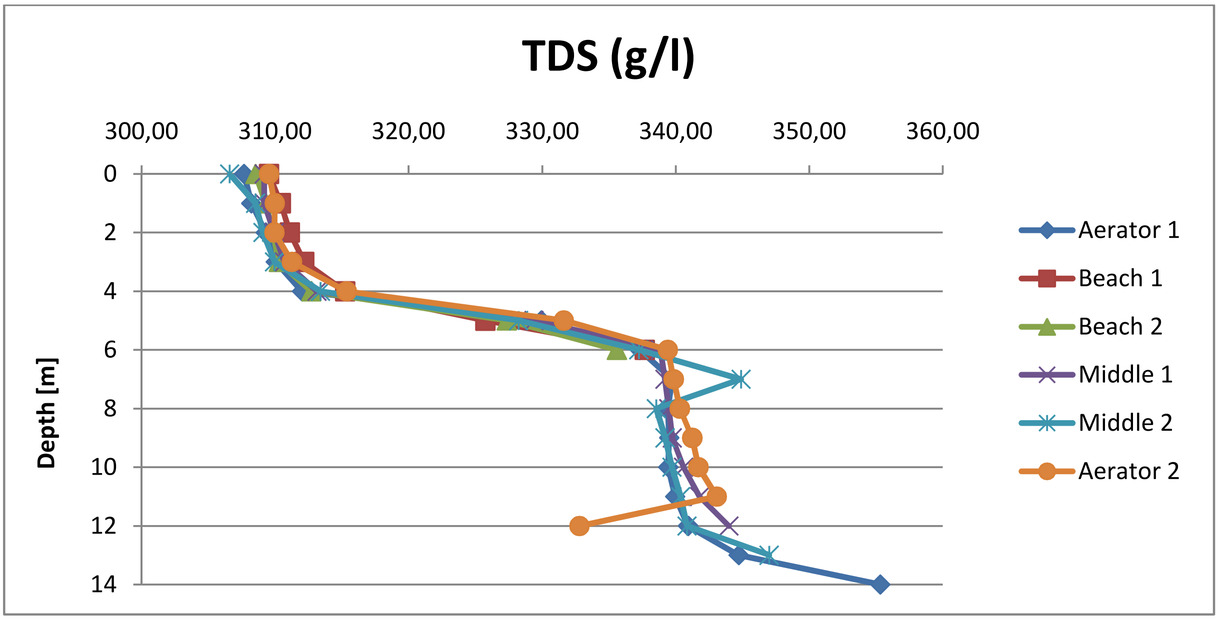

Figure 8: TDS of different sampling points

The secchi disc transparency is decreasing within the five days at all sampling points. At the beginning of the week the secchi disc transparency was at beach 2 the highest with 2,9m. The transparency of middle 1 increases at the second day but then decreases again. At the end of the week the secchi disc transparency differs between 1,9m and 1,7m.

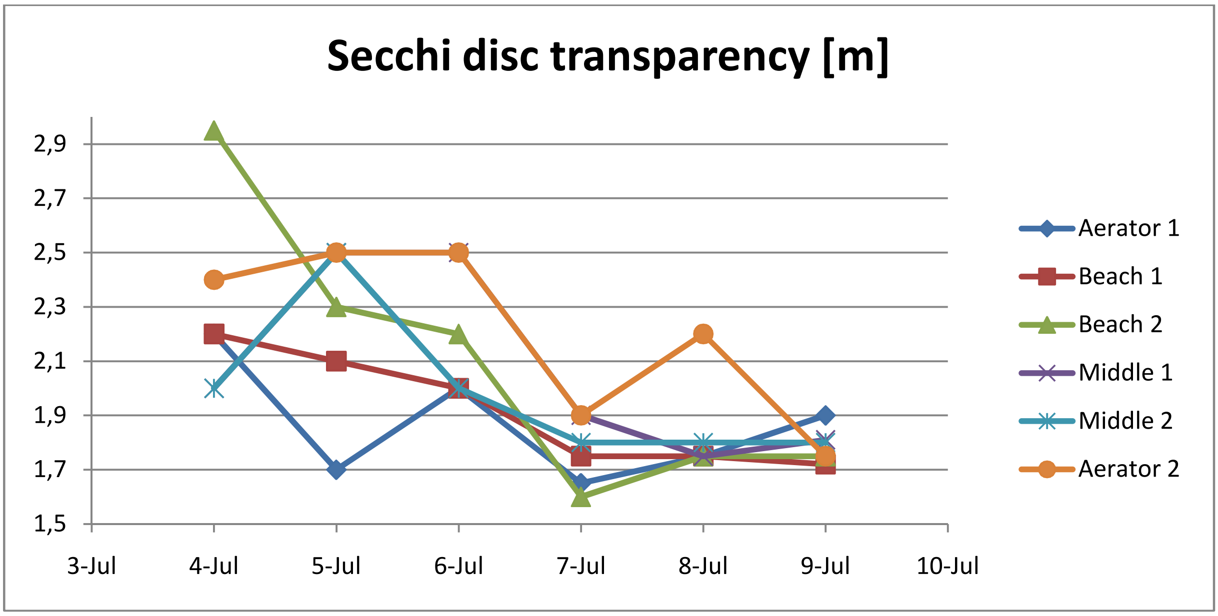

Figure 9: Secchi disc transparency of the different sampling points at different days

3.2. Results of chlorophyll a

The chlorophyll a concentration is increasing at all samplings sites. It varies between 2,5 µg/l and 42µg/l. The sampling sites differ from each other. Aerator 2 which had 2,5 µg/l at the 4th, had the highest amount at the 9th of July. Middle 2 only varies a little in the first 3 days (app. 7µg/l), but then increases in the next 4 days. Middle 2 is similar to Middle 2 but with a smaller increase between the 7th and 8th. The chlorophyll a concentration at Aerator 1 increases at the 5th to 15 µg/L, decreases again to 10µg/L and increases betweens the 7th and 9th of July.

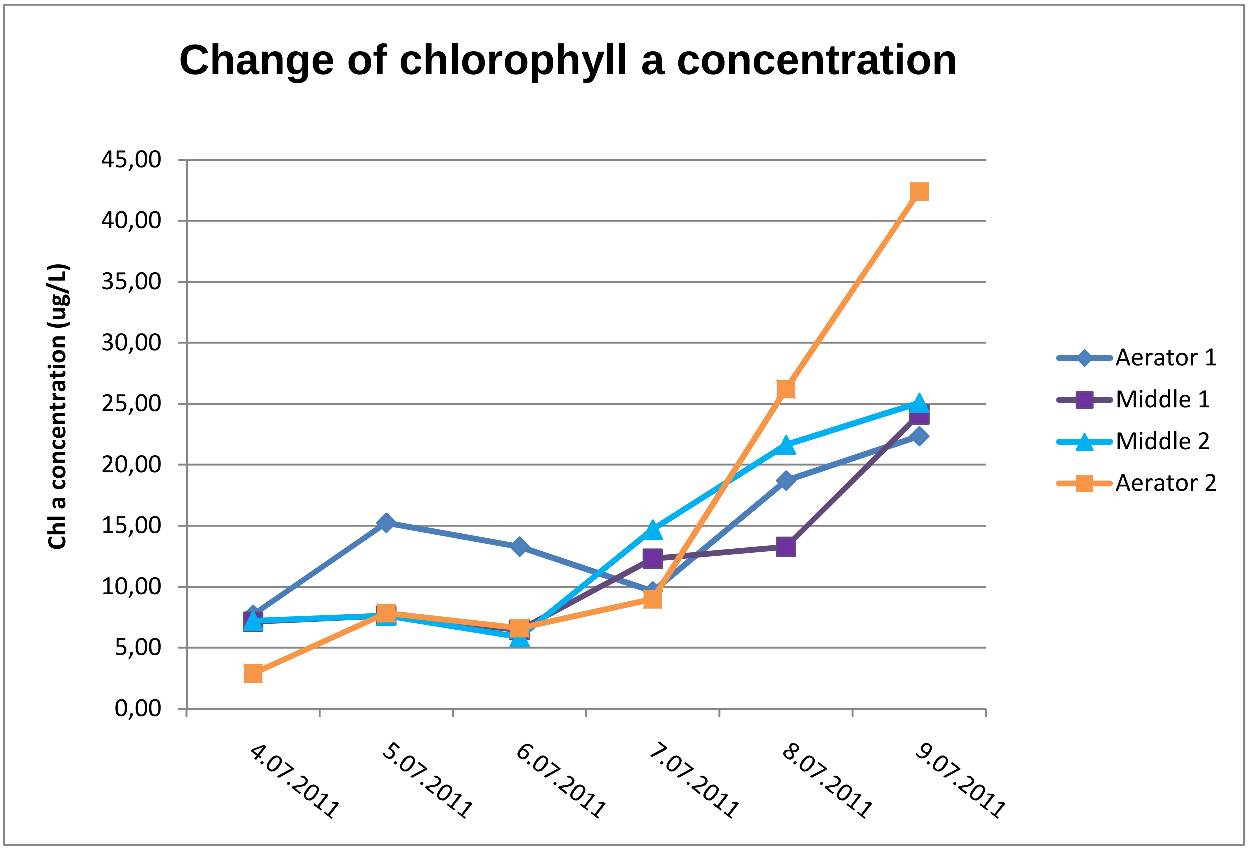

Figure 10: Chlorophyll a concentration of the different sampling sites.

The average concentrations of chlorophyll are listed in the table below.
The highest chlorophyll values are measured at aerator 2 with 15,82 µg/L, the lowest has been measured at middle 1 with 13.69 µg/L.

Table 1: Chlorophyll a concentration

Chl a concentration	[µg/L]
Aerator 1	14.48
Aerator 2	15.82
Middle 1	11.81
Middle 2	13.69

3.3. Results of TSI calculations

The following table shows the results of the TSI calculations and the average deviation from the mean. The TSI according to the Secchi disc is in average 49,9 with an average deviation of 2,48 and the average TSI of the chlorophyll is 54,59 with an average deviation of 3,42.

Table 2: Trophic state index (SD= Secchi disc, Chl a= Chlorophyll a)

TSI	SD method	Chl a method
Aerator 1	51.07	56.16
Aerator 2	48.7	53.81
Middle 1	49.61	53.69
Middle 2	50.22	54.71
Beach 1	50.54	no data
Beach 2	49.68	no data
Whole lake	**49,97±2,48**	**54,59±3,42**

3.4. Sources of error

There are several sources of error and therefore the results of this work must be treated carefully.

In common there are three main sources of error:

1. Selection of sampling sites;
2. Errors by taking the samples;
3. Errors occurring in the laboratory.

1) The sampling sites of aerator I, II and the sites of beach I and II were always the same place (knotted boat to pillar), whereas the sampling sites of middle I and middle II differed every day slightly, because there weren't effective orientation points.

2) Sources of error are:

- Measurement not in the right depth.
- Higher O_2-content because of the water bikes.
- Not long enough waiting before reading of multiparameter display.
- Group changed every day therefore slightly deviations in methods could be possible.

3) Sources of error are:

- Inexperience of group members in the laboratory and therefore unclean work

4. Discussion

In the following chapter the questions of chapter one will be discussed.

4.1. How do the parameters interact with each other and what is the water quality according to the Water Framework Directive?

The weather during the measuring period was almost always sunny with only a few clouds. With the sun, the temperature of the lakes surface water is over 20℃. The sampling points show no significant variation, because they all get the same amount of sun during the morning. With increasing depth, the temperature is decreasing. First it decreases slightly and then very fast from 4m to 6m. This temperature change indicates the different zones in a lake (epilimnion, metalimnion, hyperlimnion). 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 hyperlimnion (7m to bottom) there is almost no change in temperature anymore (WALTER 2002).

With the increase of depth it is not only getting colder, but also the amount of dissolved oxygen, the pH-value and electrical conductivity are decreasing.

Dissolved oxygen is higher at the surface out of different reasons. First here it is possible to increase the DO by weather changes, e.g.: wind, waves, rain etc. and the epilimnion is affected by turbulences of for example boats. Second, the epilimnion is where most algae grow. Algae need light, nutrients and a 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 aerobe life forms. As dissolved oxygen levels in water drop below 5,0 mg/l, aquatic life is put under stress. The lower the concentration, the grater the stress.

Aerator 1 shows one peak in the DO graph at 9m. Reason for this peak could be the air pumping into the water. It means that oxygen pumped by aerators is being used to oxidize reduced compounds and/or to keep oxidizing conditions in the hypolimnion to protect the lake from emissions of phosphates.

The electrical conductivity as well as the TDS are indicators for nutrients. The electrical conductivity shows that the nutrients are decreasing with increasing depth. Therefore the epilimnion offers the best circumstances to live. But an overload of nutrients is also a stress factor for most aquatic ecosystems involving mixed fish fauna.

The TDS of the lake is increasing with increasing depth. Reason for that is the sediment and the fact that the sediment load which leads into the lake sinks down during time.

These sediments are main source of nutrients in lake now. Nutrients are taken off from sediments not only during spring and autumn destratifications and mixing of water, but also during summer stagnation. If at the bottom of the lake is a 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 insolubly 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 carbondioxid in the water. Algae use this carbondioxid for their metabolism and therefore the pH is getting more basic.

All parameter explain the high amount of chlorophyll a. The week before the 4th of July was very rainy and cloudy; therefore there was not a big algae growth. With the beginning of the warm weather the algae had better living circumstances and could grow a lot.

The low pressure system on the 5th of July increased the growth of algae even more; gases at the bottom of the lake are forced to go up and bring algae in lower layers to the surface. With a higher amount of chlorophyll a and therefore algae in the water, the transparency of the secchi disc decreased.

Following table determines the classes after the Water Framework Directive (values especially for Poland). For Secchi depth, dissolved O2 in hypolimnion and el. Conductivity there is no specification in classes, but in “good” and “bad”.

Table 3: Classes of Water Framework Directive

	Ecological state of water	Good			Bad	
Parameter	Class of water	I	II	III	IV	V
Chlorophyll a	(ug/L)	<7,0	7,0-13,0	13,0-21,0	21,0-33,0	>33,0
Secchi	(m)	>1,7			<1,7	
Dissolved O_2 in hypolimnion	(mg/L)	>4			<4	
Conductivity	(µS/cm)	<600			>600	

Therefore we get following classes for Lake Durowskie

Table 4: Evaluation of lake Duroskie according to Water Framework Directive

Parameter	**Value**	**Class**
Chlorophyll a	13,7 µg/l	III
Secchi disk	2,02 m	good

Dissolved O_2 in hypolimnion	0,23 mg/l	bad
El. Conductivity	395µS/cm	good

Chlorophyll a is with a value of 13,7 µg/l too high and in class III. The dissolved O_2 is too less and is evaluated as “bad” according to the water framework directive. Transparency and el. Conductivity are evaluated as good.

4.2. What is the trophic state of the lake according to the trophic state index (TSI)?

The TSI according to the Secchi disc is in average 49,9 and the average TSI of the chlorophyll is 54,59. These values are indicators for highly mesotrophic and/or eutrophic lakes. This result agrees with the results of question 1.

Table 5: TSI index

TSI index table:	
<40	oligothrophic
40-50	mesothrophic
50-70	euthrophic
>70	hyperthrophic

4.3. How did the lake develop in the last year?

The following figures show the changes of the TSI’s of the year 2010 and 2011 and the conductivity of 2008-2011. The chlorophyll a increased at all sampling points. Reason for this can be the weather of this year. The low temperature in the week before and then the warm weather with one low pressure system has led to huge algae growth. 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 eutrophic.

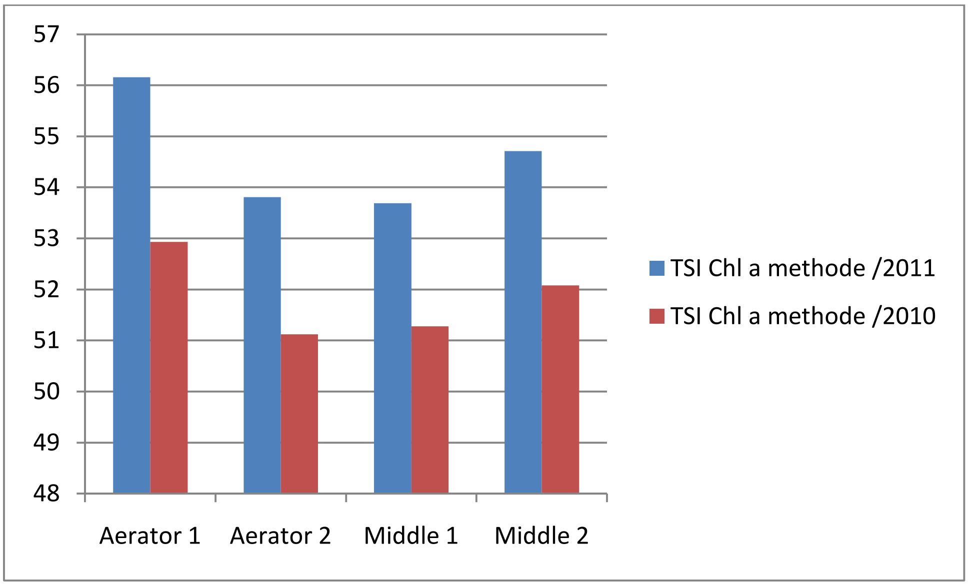

Figure 11: Comparison of the trophic state index (Chl a) between 2011 and 2010

The trophic state index based on SD measurements shows an improvement. In the year before transparency is much less than this year.

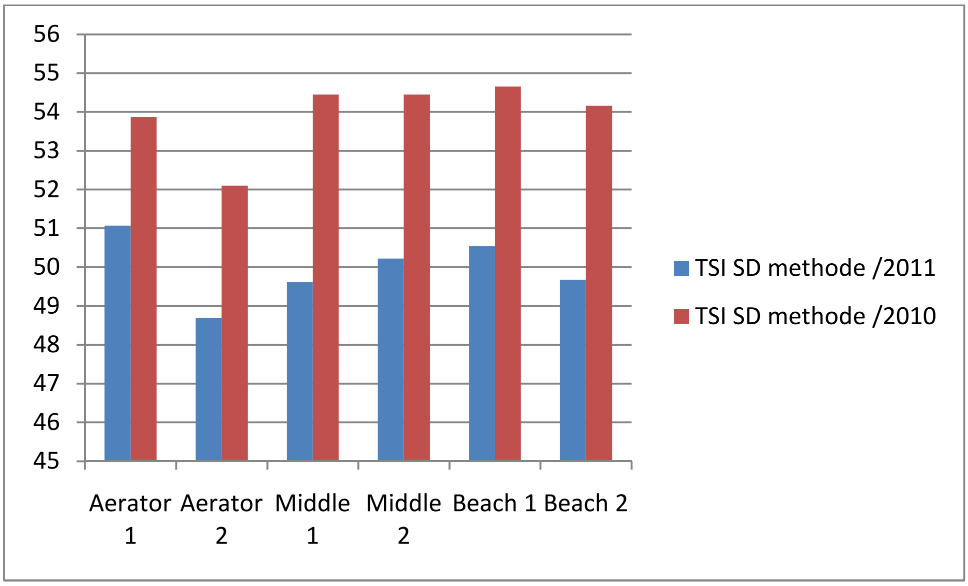

Figure 12: Comparison of the trophic state index (SD) between 2011 and 2010

The conductivity changed a lot during the years. In 2008 there was in high increase of conductivity with increasing depth. In 2009 the increase of conductivity got less and in 2011 there is a slightly decrease of conductivity with increasing depth. The results of 2011 show a different situation. The conductivity is much lower (between 338µS/cm- 442338µS/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.

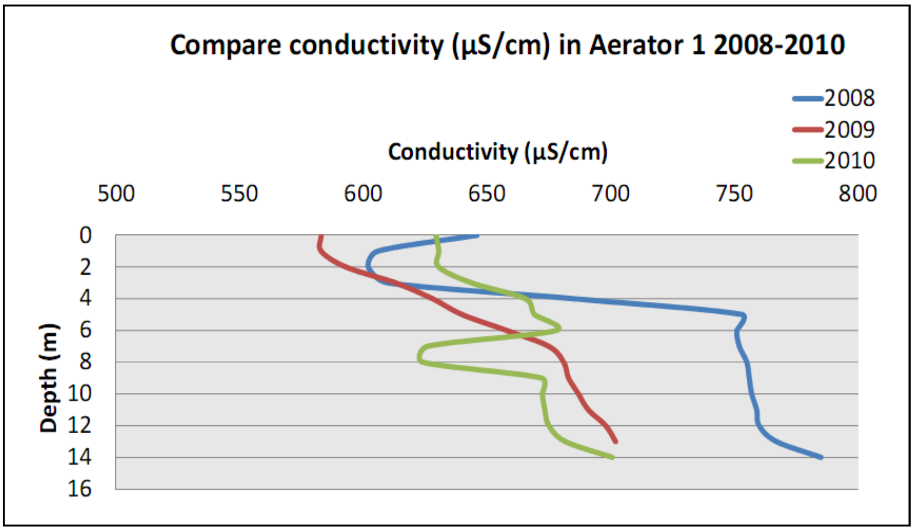

Figure 13: Conductivity of Aerator of 2008- 2010

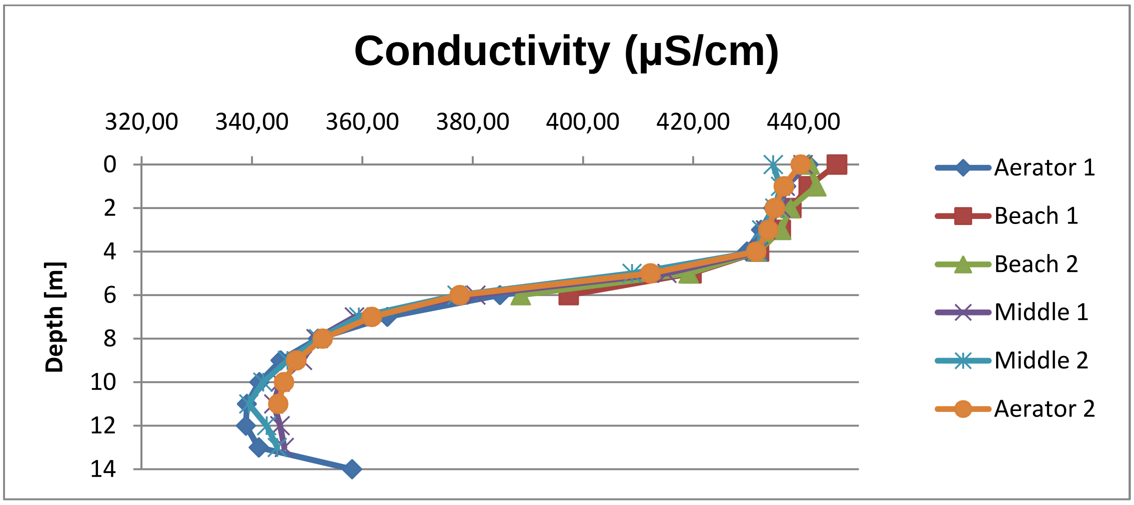

Figure 14: Conductivity of different sampling sites

Table 6 shows the improvements and degradation of year 2011 in comparison to 2010.

Table 6: Comparison of data between 2010 and 2011

Year	2010	2011
Chlorophyll „a"	≈ 9 µg/L	≈ 14 µg/L
Conductivity	≈ 650 µS/cm	≈ 400 µS/cm
pH on surface	≈ 8	≈ 8,7
Transparency	≈ 1,5 m	≈ 2 m
TDS (surface)	0,41 g/L	0,31 g/L
Diss. oxygen	10 mg/L (surface)	10 mg/L (surface)

4.4. What are possible management improvements for 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 not a 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.

Another important thing is the increase of agriculture and population growth. In the future there has to be paid attention to an economic but ecological growth.

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

5. Conclusion

This work concludes that the water quality of Lake Durowskie does not satisfy the demands of the Water Framework Directive of class II.

The classification of the water class is based on chlorophyll a measurements and gives a classification of III. However, chlorophyll a can fluctuate rapidly and shows only the current state of the water and no long term developments.

The quality of the lake according to dissolved O_2 in the hyperlimnion must be evaluated as "bad" But still, figure 4 shows an increase of O_2 at the aerator I, even in deeper water layers. This increase and the results of the secchi measurements are major hints that the water quality of Lake Durowskie is on its way of improvement.

In the comparison with former years, there seems to be an improvement in the lakes quality. In 2011 the el. conductivity is decreasing with increasing depth, which indicates that the nutrients at the lakes bottom are not getting released anymore.

However, the trophic state indexes of the lake give the result that the lake is still mainly eutrophic and that attempts like the aerators and the phosphorous traps show positive results, but only over a long time period.

In summarizing it can be stated that Lake Durowskie is on a good way, but still needs further improvements and a longer time period in order to fit the European water framework directive.

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7. Appenix

temperature						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	21.43333	21.72	21.43	20.85	20.85	20.76667
1	20.98333	21.18	20.73	20.53	20.56667	20.5
2	20.46667	20.66	20.48	20.35	20.35	20.26667
3	20.11667	20.24	20.15	20.00	20.01667	19.93333
4	19.56667	19.44	19.47	19.50	19.38333	19
5	15.83333	15.925	16.26	15.60	15.21667	14.83333
6	11.7	12.85	12.00	11.10	10.65	10.35
7	9.1			8.78	9.316667	8.816667
8	8.033333			7.93	8.2	7.8
9	7.433333			7.35	7.516667	7.233333
10	6.966667			7.00	7.033333	6.983333
11	6.733333			6.75	6.85	6.766667
12	6.533333			6.60	6.7	6.6
13	6.4			6.47	6.5	
14	6.133333					
Dissolved oxygen						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	10.11	10.06	9.86	9.37	9.506667	9.23
1	10.235	10.15	9.78	9.49	9.576667	9.31
2	9.553333	11.58	9.45	9.31	9.293333	8.97
3	8.681667	8.86	8.69	8.49	8.75	8.43
4	7.748333	7.20	7.32	5.70	6.991667	6.13
5	1.27	1.09	1.506	0.745	1.206667	0.63
6	0.215	0.38	0.18	0.18	0.2	0.18
7	0.203333			0.15	0.203333	0.14
8	0.638333			0.16	0.296667	0.13
9	1.001667			0.27	0.263333	0.15
10	0.716667			0.12	0.361667	0.14
11	0.186667			0.11	0.188333	0.11
12	0.131667			0.10	0.15	0.15
13	0.125			0.09	0.093333	
14	0.115					

oxygen						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	114.68	114.36	112.00	104.98	106.15	104.63
1	111.10	114.04	108.95	104.88	106.3667	103.75
2	113.22	113.28	103.58	102.20	102.5167	98.95
3	95.00	97.22	95.28	93.15	95.28333	91.20
4	83.63	74.56	78.53	75.82	73.35	65.85
5	11.57	10.50	16.74	7.216667	10.66667	7.10
6	1.95	2.40	1.63	1.62	1.75	1.57
7	1.75			1.32	1.816667	1.17
8	6.32			1.40	2.55	1.10
9	8.60			2.30	1.883333	1.17
10	5.60			1.00	3.033333	1.12
11	1.42			0.92	1.633333	1.02
12	1.03			0.84	1	1.20
13	1.00			0.77	0.7	
14	0.87					
pH						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	8.80	8.81	8.81	8.76	8.713333	8.75
1	8.79	8.79	8.78	8.73	8.706667	8.73
2	8.73	8.75	8.72	8.70	8.68	8.69
3	8.66	8.68	8.65	8.67	8.613333	8.63
4	8.55	8.52	8.53	8.49	8.43	8.43
5	8.25	8.01	8.05	8.031667	8	8.00
6	7.86	7.88	7.79	7.81	7.761667	7.81
7	7.70			7.69	7.625	7.69
8	7.63			7.62	7.591667	7.56
9	7.64			7.59	7.575	7.62
10	7.65			7.59	7.566667	7.63
11	7.64			7.61	7.591667	7.64
12	7.65			7.62	7.584	7.58
13	7.64			7.61	7.613333	
14	7.48					
tds						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	307.67	309.53	308.53	309.18	306.58	309.53
1	308.21	310.43	309.29	309.18	308.53	309.97
2	309.29	311.09	309.85	309.94	309.08	309.95
3	310.05	312.18	310.27	310.70	309.94	311.25
4	312.00	315.25	312.71	313.13	313.39	315.35
5	329.93	325.74	327.34	329.3833	328.24	331.63
6	337.30	337.68	335.59	338.86	337.24	339.41
7	339.73			339.20	344.90	339.85
8	339.41			339.48	338.54	340.31
9	339.52			339.74	339.21	341.24

10	339.44			340.59	339.72	341.70
11	339.96			341.79	340.38	343.08
12	340.93			343.98	340.85	332.80
13	344.72			344.07	347.00	
14	355.32					
conductivity						
Depth	Aerator 1	Beach 1	Beach 2	Middle 1	Middle 2	Aerator 2
0	440.90	446.04	441.10	439.90	434.50	439.48
1	436.85	440.94	442.32	436.68	435.80	436.42
2	434.52	437.76	437.58	435.88	434.80	434.80
3	432.28	435.86	435.96	433.12	432.42	433.62
4	429.73	431.94	431.65	431.85	431.60	431.40
5	418.92	419.68	419.15	415.24	408.90	412.24
6	384.93	397.40	388.70	380.60	377.18	377.66
7	364.52			358.58	359.36	361.72
8	351.97			351.62	352.06	352.82
9	345.18			349.14	346.42	348.04
10	341.32			345.12	342.00	345.80
11	339.07			343.96	339.42	344.74
12	338.90			345.08	342.68	
13	341.23			345.85	344.60	
14	358.13					