Available online at www.ilcpa.pl

International Letters of Chemistry, Physics and Astronomy

5 (2013) 86-96 ISSN 2299-3843

Evaluation of chemical and physico-chemical indicators of water and bottom macrofauna the Resko Lake on the basis of the European Union Water Framework Directive

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ABSTRACT

Have studied lake close to neutral pH – 7.67 to 7.73. All lakes in accordance with the classification of the European Union Water Framework Directive have been included in the first class. The concentration in the surface layer of P_{tot}. Lake is little differentiated, is at level II quality class according to the classification of the European Union Water Framework Directive. Tested water lakes were changing the concentration of the $PO_4^{3-}{}_{diss}$ - these concentrations correspond to water quality from III. The increase of the concentrations of phosphorus in the Lake may indicate a decrease in the amount of oxygen in the waters of the shallow and changes their status to release phosphorus compounds accumulated redox in sediment bottom. In the case of nitrogen-compounds nitrates and nitrites values for these indicators were at level I and II class in all the surveyed lakes in accordance with the classification of the European Union Water Framework Directive. Indicator, which indicates the high productivity of Lake is the biochemical oxygen demand (BOD_5). The level of this indicator values on the studied Lake was on level III class. In the remaining Lake oxygen concentration was similar (continued in I class). Fauna of the Resko Lake bottom during summer stagnation was poor in terms of quality, which proves its considerable biological degradation. In terms of the concentration in the test macrozoobenthos Lake dominated, and Oligochaeta, Diptera larvae.

Keywords: water, lake, chemical and physico-chemical indicators, macrozoobenthos, European Union Water Framework Directive

1. INTRODUCTION

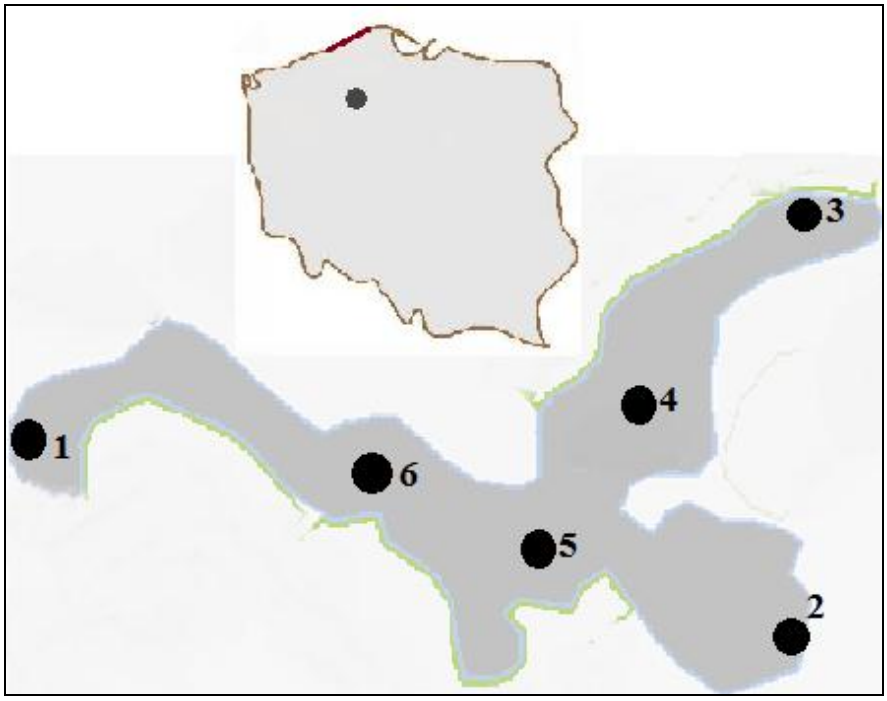
To address the increasing degradation of the surface waters in the European Union, changed the approach to the evaluation and protection of water resources [7-15, 20-29, 32, 35, 37-48, 51, 56-58]. This approach was formulated in the European Union Water Framework Directive (2000/60/EC), which requires the protection of water and ecological and

comprehensive approach to its assessment [5-18, 21-24, 27, 29, 32-47, 50-62]. Ecological status of surface water and groundwater is assessed on the basis of the ecological potential of the biological and physico-chemical and hydromorphological [5-10, 12, 14, 18, 23, 24, 27, 29, 32-47, 50-58]. The work shows the evaluation of physico-chemical parameters of water and bottom macrofauna Resko Lake, based on the European Union Water Framework Directive.

2. EXPERIMENTAL

Lake Resko (Upper Resko) is located on the territory of Drawsko Lake District [35]. The Resko lake is characterized by the following indicators of morphometric [35]:

- latitude N-53° 40.7 ',
- longitude E-15° 57.9 ',
- the catchment area – 197,2 km^2,
- the water catchment area – Rega,
- the surface of the water mirror is 50.7 hectares,
- height – 145,4 m above sea-level,
- the capacity of 1358,4. m^3,
- the maximum depth – 5.0 m,
- the average depth is 2,7 m,
- maximum length – 1610 m,
- maximum width – 1200 m,
- the length of the shoreline – 7200 m,
- development of the shoreline – 2.85,
- unveiling of the indicator – 18.8.



Map 1. Location of the measuring point in Resko lake. *Source: Google maps 2012/develop your own*

At the place of sampling were numbered pH. Trying to test water were taken by Polish Standards. Collected water samples were fixed in accordance with the recommendations in the Polish Standards [7-12, 14, 16, 19-22]. Other indicators for the quality of the waters have been tagged within 24 hours from the moment of download attempts.

Determination of dissolved organic matter oxidation was vulnerable as COD-Mn in accordance with Polish Standards [7-12, 14, 16]. Dissolved oxygen has been marked in accordance with the methodology described by Winkler in the work of Daniszewski [7-12, 14, 16-21]. The degree of oxygenation of water specified by arrays in the work Nemerowa [44].
this work marked concentration of General Suspension, BOD_5, NH_4^+, NO_2^-, NO_3^-, $PO_4^{3-}{}_{diss,}$ and $P_{tot.}$ - in accordance with the methodology described in the work of Daniszewski [7-12, 14, 16].

The quality objectives was evaluated according to the criteria recommended to evaluate inland surface waters as set out in the European Union Water Framework Directive (2000/60/EC) [24].

The material from the bottom of the settlement along with fauna a groundswell of obtained using gripper Ekmana (225 cm^2). After extraction of the gripper has a kind of sediments and the depth of bottom (Table 3). Macrozoobenthos collected from 6 posts spread over 4 transverse profiles (Table 3). At each collected sedimented sample from the bottom (sample 2). “Flushed” material collected on the sieve mesh diameter 0.5 mm and maintained in 4% formalin solution.

Segregate animals on individual taxa macroscopically and binocular Magnifier (PZO), and their density compared to 1 m^2. Taxa of benthic fauna, derived from positions weigh to the nearest 0,01 g, after drying on the filter paper. Biomass of fauna depicted in g wet weight per 1 m^2.

Measurement of the length of the larvae were predominant at the basic slide graduated Chironomidae (to the nearest 0,5 mm). Frequencies (F) design calculated: n/n × 100% where: n-number of posts on the where he performed the taxon N-number of test posts. Indicator of dominance (D) calculated from the formula: D = S (a)/S (x)·100%, where S is the sum of (a) animals belonging to the taxon "and", and S is the total biomass of macrozoobenthos in all attempts.

The interpretation of the indicator values obtained dominance and turnout has been made in accordance with the criteria given by Kasprzak and Careless (1981).
There is also an indicator of biodiversity PIE, using the formula:

$$PIE = \frac{N}{N+1}(1-\sum p_i^2) \qquad p_i = \frac{n_i}{N}$$

where N - total number of individuals; p_i - part of the species and in the total number of individuals.

3. RESULTS AND DISCUSSION

The results of the Resko Lake are presented in Table 1 - 5.

Table 1. Results of the quality of surface water of Resko Lake (2008 year) along with the classification values of indicators according to the criteria of the European Union Water Framework Directive (2000/60/EC).

Resko Lake			
2008 year			
No	**Water quality indices**	**Units**	**Average (Spring, Summer, Autumn)**
1.	Total suspended solids	mg $\cdot dm^{-3}$	19,6 (II)
2.	pH	-	7,67 (I)
3.	COD-Mn	mg $O_2 \cdot dm^{-3}$	8,3 (III)
4.	BOD_5	mg $O_2 \cdot dm^{-3}$	4,27 (III)
5.	$O_{2\ diss.}$	mg $O_2 \cdot dm^{-3}$	7,57 (I)
6.	NO_3^-	mg $N \cdot dm^{-3}$	0,23 (I)
7.	NO_2^-	mg $N \cdot dm^{-3}$	0,034 (II)
8.	NH_4^+	mg $N \cdot dm^{-3}$	1,25 (III)
9.	$PO_4^{3-}{}_{diss.}$	mg $PO_4 \cdot dm^{-3}$	0,64 (III)
10.	$P_{tot.}$	mg $P \cdot dm^{-3}$	0,25 (II)

Explanation: I, II, III - classification of values of examined indicators in accordance with the European Union Water Framework Directive (2000/60/EC).

Table 2. Results of the quality of surface water of Resko Lake (2009 year) along with the classification values of indicators according to the criteria of the European Union Water Framework Directive (2000/60/EC).

Resko Lake			
2009 year			
No	**Water quality indices**	**Units**	**Average (Spring, Summer, Autumn)**
1.	Total suspended solids	mg $\cdot dm^{-3}$	21,7 (II)
2.	pH	-	7,73 (I)
3.	COD-Mn	mg $O_2 \cdot dm^{-3}$	8,1 (III)
4.	BOD_5	mg $O_2 \cdot dm^{-3}$	4,5 (III)
5.	$O_{2\ diss.}$	mg $O_2 \cdot dm^{-3}$	7,6 (I)
6.	NO_3^-	mg $N \cdot dm^{-3}$	0,38 (I)
7.	NO_2^-	mg $N \cdot dm^{-3}$	0,036 (II)
8.	NH_4^+	mg $N \cdot dm^{-3}$	1,18 (III)
9.	$PO_4^{3-}{}_{diss.}$	mg $PO_4 \cdot dm^{-3}$	0,72 (III)
10.	$P_{tot.}$	mg $P \cdot dm^{-3}$	0,26 (II)

Explanation: I, II, III - classification of values of examined indicators in accordance with the European Union Water Framework Directive (2000/60/EC).

Table 3. Type of bottom deposits, depth and pH of interstitial waters in measurement points Resko Lake (July, 2008, 2009).

Sampling site no.	**Type of bottom deposits**	**Depth [m]**	**pH of intersitial waters**
1	Fine sand, autochthonous detritus, the remains of shells, leftover cane	1,5	7,45
2	Fine sand, autochthonous detritus, the remains of shells	1,8	7,19
3	Hamlets tanatocenozowy, seashell scrap (Dreissena), , leftover cane	2,4	7,57
4	Hamlets tanatocenozowy, seashell scrap (Dreissena)	3,5	6,59
5	Hamlets tanatocenozowy, seashell scrap (Dreissena), silt, detritus, gravel	3,8	7,27
6	Black silt, detritus, gravel	4,7	7,04

Table 4. Macrozoobenthos condensing in summer of Resko Lake.

Lp.	**Taxa**	**Density of macrozoobenthos (indiv.·m^{-2})**		
		2008	2009	Average
1.	Oligochaeta	745	803	774
2.	Hirudinea	101	220	161
3.	Isopoda – *Asellus aquaticus* Racov.	12	6	9
4.	Ephemeroptera larvae	18	12	15
5.	Trichoptera larvae	20	22	21
6.	Diptera larvae	396	479	438
7.	Bivalvia – *Dreissena polymorpha* Pall.	25	27	26
8.	Megaloptera larvae – *Sialis lutaria* L.	54	79	67
Σ		1371	1648	1510
Biodiversity index PIE		0,767	0,783	0,775

Table 5. Comparison of macrozoobenthos condensing in summer in some lakes of Western and Northern Polish.

Taxa	**Density of macrozoobenthos (indiv.·m^{-2})**				
	Lake				
	Jamno (Piór--Zasada 1997)	Gardno (Piór--Zasada 1997)	Krzynia (Gostomczyk 2005)	Lubowidzkie (Obolewski, Gąska 2006)	Resko (by author)
Oligochaeta	272	1669	666	979	774
Hirudinea	0	11	48	99	161
Crustacea	0	0	146	2	0
Ephemeroptera larvae	0	2	22	4	15
Megaloptera *Sialis lutaria*	0	0	28	6	67
Trichoptera larvae	0	0	53	12	21
Diptera larvae	487	2427	674	276	438
Caretopogonidae	0	2	0	0	0
Gastropoda	0	0	7	0	
Bivalvia – Dreissena polymorpha	0	0	123	4	26
Σ	759	4111	1767	1382	0
Numer of taxa	2	5	9	8	7
Biodiversity index PIE	0,920	0,973	1,990	0,940	0,807

The pH of the water pH in Lakes influenced by physico-chemical and biotic interactions of environmental factors [1, 4, 21, 26, 28, 32]. The degree of acidity affects directly the life processes occurring in ecosystems, among others. It is responsible for the correct download of nutrients by organisms. High alkalinity beneficial for assimilation, and the same use, located in water, nitrogen and phosphorus compounds are much more accessible than in an acid medium. Like high acidity, also clearly detrimental impact on organisms has excessive alkalinity of natural waters - pH above 9.0 [2, 25-28, 37]. Have studied lake close to neutral pH – 7.67 to 7.73. All lakes in accordance with the classification of the European Union Water Framework Directive have been included in the first class.

In aquatic ecosystems of lakes have experienced loss of ignition loss and not the value of the COD-Mn according to estimates, which were made on the basis of the indications of "dry residues" and "residue after ignition" in accordance with the methodology set out by Macioszczyk [42] and on the basis of the results of COD-Mn, which always values match III class water quality-tested water lakes have shown continuing in all seasons of the year quite a significant content of organic substances, including substances of a gear. The cause of this

condition should be found also in the bottom of the Lakes, which is at opulent fabric of organic. The most important elements involved in primary production are phosphorus and nitrogen. The presence of these substances determines the productivity of the water body, and the same for their quality. Biogen significantly affecting the quality of water included phosphorus [1, 4, 7-12, 31-37]. This is the primary factor constraining the development of phytoplankton. And thus affect the massive algal blooms. This element occurs in the waters the form of inorganic phosphorus and dissolved organic forms [1, 2, 24,25]. The mineral phosphorus, phosphates are best absorbed by organisms, which play a huge role in primary production. It is included in the circulation of matter, where content in the waters are not big get on minimum. So you should pay attention to phosphorus compounds in the demersal zone.

The forms which occur and concentrated in the water depth of the Lake and are dependent from all types to use in catchment area. Nitrogen occurs in the form of gas dissolved in the water, ammonium ions, nitrate and nitrite. In Lakes is the main factor limiting the growth of organisms [1, 2, 19, 22, 23, 25, 27, 29, 35, 40, 41].

The concentration in the surface layer of P_{tot}. Lake is little differentiated, is at level II quality class according to the classification of the European Union Water Framework Directive. Tested water lakes were changing the concentration of the $PO_4^{3-}{}_{diss}$ - these concentrations correspond to water quality from III. The increase of the concentrations of phosphorus in the Lake may indicate a decrease in the amount of oxygen in the waters of the shallow and changes their status to release phosphorus compounds accumulated redox in sediment bottom [7, 8, 10, 12-15]. In the case of nitrogen-compounds nitrates and nitrites values for these indicators were at level I and II class in all the surveyed lakes in accordance with the classification of the European Union Water Framework Directive. Indicator, which indicates the high productivity of Lake is the biochemical oxygen demand (BOD_5). The level of this indicator values on the studied Lake was on level III class. In the remaining Lake oxygen concentration was similar (continued in I class).

During the macrozoobenthos Resko Lake there are among the collected of organisms with eight clusters: Oligochaeta, Hirudinea, Crustacea, Insecta and Bivalvia. The most represented in terms of species was represented in August which featured Insecta cluster larvae with four rows: Ephemeroptera (*Leptophlebia* sp., *Ephemera* sp., *Caenis macrura* (Stephens)), Trichoptera (Limnephilidae, Leptoceridae, *Cyrnus* sp.) Diptera i Megaloptera (*Sialis lutaria* L.), (Tab. 4).

The average concentration of total benthic fauna in the Resko Lake in the summer of 2008 745 (indiv.·m^{-2}) (table 4). The Greatest the importance of littoral Oligochaeta and Hirudinea, took in the larvae of Chironomidae, that accounted for 95% of the density of benthic fauna. The average concentration of total benthic fauna in the Resko Lake in the summer of 2009 803 (indiv.·m^{-2}) (Table 4). The Greatest the importance of littoral Oligochaeta and Hirudinea, took in the larvae of Chironomidae, that accounted for 92% of the density of benthic fauna. In 2008 attendance related macrofauna test bed showed that the most common they were mud-eating and larvae chironomids, oligochaeta (F = 100%), which consisted of Tischlera classification of the species is absolutely solid. Among larvae of Chironomidae the species is absolutely integral were *Chironomus f. l. plumosus* (F = 100%).

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by high density macrozoobenthos, because the higher values were found only in Lakes (*Gostomczyk 2005, Piór-Zasada 1997*). In comparison with other lakes in the Resko Lake is a large number of taxa, however, as a result of the distribution of non-harmonic doesn't translate to the indicator value of biodiversity PIE.

4. CONCLUSION

Have studied lake close to neutral pH - 7.67 to 7.73. All lakes in accordance with the classification of the European Union Water Framework Directive have been included in the first class. The concentration in the surface layer of P_{tot}. Lake is little differentiated, is at level II quality class according to the classification of the European Union Water Framework Directive. Tested water lakes were changing the concentration of the $PO_4^{3-}{}_{diss}$ - these concentrations correspond to water quality from III. The increase of the concentrations of phosphorus in the Lake may indicate a decrease in the amount of oxygen in the waters of the shallow and changes their status to release phosphorus compounds accumulated redox in sediment bottom. In the case of nitrogen-compounds nitrates and nitrites values for these indicators were at level I and II class in all the surveyed lakes in accordance with the classification of the European Union Water Framework Directive. Indicator, which indicates the high productivity of Lake is the biochemical oxygen demand (BOD_5). The level of this indicator values on the studied Lake was on level III class. In the remaining Lake oxygen concentration was similar (continued in I class). Fauna of the Resko Lake bottom during summer stagnation was poor in terms of quality, which proves its considerable biological degradation. In terms of the concentration in the test macrozoobenthos Lake dominated, and Oligochaeta, Diptera larvae.

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