

# Total alkaline phosphatase activity in water of Szmardgowe lake in the city of Szczecin in Poland

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## ABSTRACT

The progress of civilisations causes changes in the water catchment areas lakes. aquatic waters are order - phosphorus and nitrogen compounds. Level of activity alkaline phosphatase (APA) has an important impact on the chemical and biological processes taking place in the aquatic environment. APA belongs to a group of indicators, who tells us about the extent limitations to development of biomass in the tank water. Water of Szmardgowe lake were the subjects of 2008-2012 (July – September). Total alkaline phosphatase activity was determined seven times a year in these environments. A study of seasonal fluctuations showed that a maximum total alkaline phosphatase activity, both in the water and in the bottom sediment, occurred in spring (May) and summer (July, August). The results presented in in tables 1 to 5 demonstrate that total alkaline phosphatase activity in the waters of Szmardgowe lake over the five-year period of study oscillated between 242,3 to 642,1  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ . The oscillation range in both zones of the analyzed water body was similar. In the littoral it ranged from 312,3 to 642,1  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ , and in sublittoral from 242,3 to 536,9  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ .

**Keywords:** total alkaline phosphatase activity; water; Szmardgowe lake

## 1. INTRODUCTION

Urbanization is the cause of many changes which is taking place in the environment, including those found in the catchment [3-7,11-13,21-25].

With this in mind, an important issue is the proper protection of water reservoirs and also taking action to counter the adverse effects of human activities on the natural environment, including water tanks [4-7,9-13,21-25].

Phosphorous plays a key role in biological production and thereby in the eutrophication of the water environment [4-7,11-13,21-25]. One of the important processes impacting on the level of available mineral phosphorous is enzymatic hydrolysis of organic bonds of this element [11-13,19,22-25]. A majority of previous studies shows that alkaline phosphatase is chiefly responsible for the rate of organic phosphorous mineralization, both in the pelagic zone and in the bottom sediment of water bodies with  $\text{pH} > 7$  [1-9,11-15,20,23]. However, some authors report, e.g. Yiyong [15], that abiotic factors can also play a part in the process. Jones [16] suggests that the level of phosphatase activity in the water is linked to the degree of

lake trophicity. Whereas phosphatase activity in bottom sediment, according to Kobari and Taga [17], can indicate their enzymatic potential [13,15].

The assumption for this cycle of study was also to demonstrate the usefulness of the applied enzymatic test as a biological indicator of the degree of lake trophicity and possibly of progressing eutrophication of the analyzed water bodies.

## 2. EXPERIMENTAL

Szczecin is situated in North-Western Poland, in the western part of West Pomeranian Voivodeship in the Polish-German border [26]. Szmaragdowe Lake - the origin of the artificial in the Beech Forest, formed 26 July 1925 as a result of the flooding of the mine's existing before the war. Explore color water owes its name (the effect of the content of calcium carbonate) [26]. Lake morphometric data: area - 4.5 ha, average depth - 8.2 m, maximum depth - 15.8 m [26].



**Map 1.** Location of the measuring point in Szmaragdowe lake.  
53°22'16,7"N 14°37'28,6"E

Samples of littoral and sublittoral water were taken with a Ruttner sampler with a capacity of 2 dm<sup>3</sup>. Water and sediments were stored for 24 hours at 4 °C.

After that time total alkaline phosphatase activity in water was determined with the use of Jones's method [17], which involves detecting coloured p-nitrophenol formed from p-nitrophenol phosphate dissolved in a buffered solution (0.1 M Tris-HCl of pH 8.5). Activity of that enzyme in bottom sediments was established in accordance with Tabatabai and Bremmer [24], using the aforementioned buffer solution. The study was conducted during 2008-2012.

The analyses were carried out 7 times a year (April, May, June, July, August, September and October), in three repetitions.

### 3. RESULTS AND DISCUSSION

Results of the General activity of the alkaline phosphatase in the Deep waters of the Lake in Szmardgowe are presented in Tables 1 to 5.

**Table 1.** The total alkaline phosphatase activity in water ( $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ ) in 2008.

| No            | Analysis terming | Litoral | Sublitoral |
|---------------|------------------|---------|------------|
| 2008          |                  | 1 m     | 4 m        |
| 1.            | April            | 331,8   | 242,3      |
| 2.            | May              | 419,3   | 381,5      |
| 3.            | June             | 462,8   | 412,5      |
| 4.            | July             | 571,8   | 532,6      |
| 5.            | August           | 579,2   | 446,9      |
| 6.            | September        | 472,6   | 441,3      |
| 7.            | November         | 354,2   | 322,1      |
| Average value |                  | 455,9   | 397,0      |

**Table 2.** The total alkaline phosphatase activity in water ( $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ ) in 2009.

| No            | Analysis terming | Litoral | Sublitoral |
|---------------|------------------|---------|------------|
| 2009          |                  | 1 m     | 4 m        |
| 1.            | April            | 351,8   | 274,2      |
| 2.            | May              | 403,6   | 347,9      |
| 3.            | June             | 452,2   | 416,4      |
| 4.            | July             | 619,5   | 524,7      |
| 5.            | August           | 532,8   | 439,1      |
| 6.            | September        | 463,2   | 442,9      |
| 7.            | November         | 335,8   | 329,3      |
| Average value |                  | 451,3   | 396,4      |

**Table 3.** The total alkaline phosphatase activity in water ( $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ ) in 2010.

| No            | Analysis terming | Litoral | Sublitoral |
|---------------|------------------|---------|------------|
| 2010          |                  | 1 m     | 4 m        |
| 1.            | April            | 357,0   | 281,2      |
| 2.            | May              | 439,7   | 327,9      |
| 3.            | June             | 526,2   | 412,5      |
| 4.            | July             | 642,1   | 536,9      |
| 5.            | August           | 514,6   | 421,4      |
| 6.            | September        | 553,1   | 483,2      |
| 7.            | November         | 431,9   | 363,9      |
| Average value |                  | 494,9   | 403,85     |

**Table 4.** The total alkaline phosphatase activity in water ( $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ ) in 2011.

| No            | Analysis terming | Litoral | Sublitoral |
|---------------|------------------|---------|------------|
| 2011          |                  | 1 m     | 4 m        |
| 1.            | April            | 349,1   | 343,9      |
| 2.            | May              | 442,8   | 412,7      |
| 3.            | June             | 504,7   | 435,9      |
| 4.            | July             | 615,2   | 532,7      |
| 5.            | August           | 511,9   | 472,8      |
| 6.            | September        | 429,5   | 382,5      |
| 7.            | November         | 358,9   | 339,2      |
| Average value |                  | 458,9   | 417,1      |

The results presented in in Tables 1 to 5 demonstrate that total alkaline phosphatase activity in the waters of Szmaragdowe lake over the five-year period of study oscillated between 242,3 to 642,1  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ . The oscillation range in both zones of the analyzed water body was similar. In the littoral it ranged from 312,3 to 642,1  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ , and in sublittoral from 242,3 to 536,9  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ .

**Table 5.** The total alkaline phosphatase activity in water ( $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ ) in 2012.

| No            | Analysis terming | Litoral | Sublitoral |
|---------------|------------------|---------|------------|
| 2012          |                  | 1 m     | 4 m        |
| 1.            | April            | 341,7   | 327,4      |
| 2.            | May              | 458,9   | 404,1      |
| 3.            | June             | 508,2   | 417,9      |
| 4.            | July             | 582,7   | 521,8      |
| 5.            | August           | 518,9   | 423,1      |
| 6.            | September        | 421,5   | 349,7      |
| 7.            | November         | 312,3   | 304,1      |
| Average value |                  | 449,2   | 392,6      |

Comparing 5-year average values of the analyzed activity in the waters of selected Rusalka lake zones, it was established that it was lower in the littoral than in the sublittoral.

Total alkaline phosphatase activity in the water and bottom sediments of the analyzed water body was subject to seasonal oscillations. Irrespectively of the state of the environment aggregation, they typically demonstrated similar course in both analyzed zones. Both in the water and in the bottom sediments a higher level of the activity was determined in spring (May) and in full summer period (July and August). In the pelagic zone a maximum of total alkaline phosphatase activity occurred in July, which is consistent with the results of research the author of this paper conducted on other lakes.

What is noteworthy is the fact that higher values of the studied activity were not always accompanied by larger number of bacteria and saprophytic fungi [13, 19, 20], which would confirm the importance of algae affecting its level.

Whereas in the bottom sediment an increase in total alkaline phosphatase activity in July and August clearly showed a link between the number of heterotrophic bacteria, which most probably results from an influx into the sediments of phytoplankton, dying after spring blooms.

#### 4. CONCLUSIONS

1. Total alkaline phosphatase activity in Szmardgowe lake waters was the highest in the top layer of the littoral.
2. The results presented in in tables 1 to 5 demonstrate that total alkaline phosphatase activity in the waters of Szmardgowe lake over the five-year period of study oscillated between 242,3 to 642,1  $\text{nmol PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ . The oscillation range in both zones of the

analyzed water body was similar. In the littoral it ranged from 312,3 to 642,1 nmol  $\text{PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ , and in sublittoral from 242,3 to 536,9 nmol  $\text{PO}_4 \cdot \text{dm}^{-3} \cdot \text{h}^{-1}$ .

3. Total alkaline phosphatase activity both in the water and in the sediment was subject to seasonal changes, and their course was of similar nature. A maximum activity was observed in both environments in the spring (May) and in the summer (July and August).

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