THE INFLUENCE OF THE RECREATIONAL RESERVOIR ON WATER QUALITY IN AUŠPERSKÝ STREAM

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Abstract
The article focuses on monitoring the quality of water in the Aušperský stream, which flows through 2 reservoirs - Horní rybník and Dolní rybník. Horní rybník serves as aquatic habitat for waterfowl and amphibians. Horní rybník is used for recreation and sport fishing. Under Dolní rybník, treated wastewater from the industrial area flows into the Aušperský stream. The Periodic sampling was performed on selected specific profiles. Furthermore, algae and cyanobacteria were collected and determined. The evaluated analyzes of selected water quality indicators were subsequently compared with the valid legislation of the Czech Republic. The evaluation showed that none of the reservoirs had a higher incidence of cyanobacteria, only an increased number of green algae and diatoms, especially in the summer months. According to selected indicators, the reservoirs do not have a negative effect on the quality of the water in the stream.

Key words: monitoring, water quality indicator, cyanobacteria, aquatic habitat, sport fishing

Introduction

Small water reservoirs (SWR) are an integral part of the agricultural landscape and make a significant contribution to the protection and creation of the environment. In addition, SWR significantly contribute to the improvement of water quality in the river basin (Pelikán et al., 2020). The quality of water in water reservoirs intended for recreation changes during the year. The problem of eutrophication and increased concentrations of pollution in tanks has also multiplied in recent years due to high temperatures and droughts, where minimal inflows into tanks and increased evaporation cause low water levels in reservoirs and consequently increased concentrations of pollutants (Hubačíková et al., 2020). Eutrophication is also associated with blooms of toxin-producing cyanobacteria. In some species of cyanobacteria, the exudate pool can include a suite of toxic compounds that are harmful to human health. For example, microcystin is among the most commonly occurring toxin produced by cyanobacteria in natural waters, and can cause liver complications and damage to the nervous system if ingested (Walls et al., 2017). The quality of water in the reservoirs is also affected by the number of visitors in the summer months. Their increasing number threatens the ecological functions of water bodies. Ponds are "significant landscape elements" and are subject to protection under the Nature and Landscape Protection Act No. 114/1992 Sb., on water areas that are intended for swimming and recreation according to Decree No. 568/2020 Sb. Another piece of legislation is Act No. 151/2011 Sb., sets out the hygienic requirements for outdoor swimming pools and the obligations of their operators. The requirements are specified in the implementing decree No. 568/2020 Sb., the operator of a natural or artificial swimming pool or sauna is obliged to ensure that bathers are not exposed to health risks resulting from bathing water pollution. Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC This Directive contains provisions for:
(a) monitoring and classification of bathing water quality;
(b) bathing water quality management; and
(c) informing the public about the quality of bathing water.

Water quality in streams is often affected by treated and untreated wastewater from municipalities. The quality of wastewater can affect the flow positively and negatively. For wastewater discharged into surface waters, the limits are set by Government Regulation No. 401/2015 Sb. on indicators and values of permissible surface and waste water pollution and permits for the discharge of waste water into surface waters.

Materials and methods

The Aušperský stream flows through the village of Popůvky, which is located about 12 km southwest of Brno. The total catchment area of the Aušperský stream is 7.27 km^2. The Aušperský stream springs

in the forest at an altitude of about 380 m. The valley of the nameless stream creates waterlogged meadows, which were declared a natural monument Aušperský stream in 1989. The subject of protection is an ecologically important landscape element, a preserved meandering stream with natural meadow vegetation. The locality is also important as a nesting place for endangered bird species and a breeding ground for amphibians (Němcová, 2017). Aušperský stream feeds Horní rybník and Dolní rybník. Below Dolní rybník, the stream flows under the same name.
The ponds were built in the 18th century in the northwestern part of the village of Popůvky on the Aušperský stream by the owners of the Troubky estate. At least one of the ponds existed as early as 1749. The Dolní rybník was at the beginning of the 20th century released and turned into a field, but in 1949 its revitalization began and a year later it was re-impregnated. At present, the Horní rybník and the Dolní rybník belong to a private owner (Rouzek, 2015).
Horní rybník is about 177 m wide and about 128 m long, the total water area is about 2 ha. The shores of the pond are unmaintained, overgrown with coastal vegetation and trees. In the water of the pond there is a large number of broken branches and leaves from the surrounding trees. The pond currently serves primarily as a nesting place for birds and a place for frogs to breed. Due to the number of fallen branches, the pond is not very suitable for swimming. Dolní rybník is about 180 m wide and about 390 m long, the total water area is about 7 ha. The shores of the pond are maintained and regularly mowed. Dolní rybník is currently used for fish farming and commercial fishing. The pond is also used by locals for swimming and relaxation in the summer months (Němcová, 2017). Under the reservoirs, treated water from the industrial area flows into the stream.
From April 2019 to March 2020, regular monthly sampling was carried out in specified profiles. Water quality indicators - amount of O_2, electrolytic conductivity, pH and water temperature were determined in the field, other indicators - total, chemical oxygen demand, nitrate nitrogen, were analyzed in the DALE laboratory. Hach instruments (HQ30d portable multimeter, DR/4000V spectrophotometer and Digital Reactor Block 200 mineralizer) were used to measure and analyze the samples. The results of the analysis were compared with the valid legislation of the Czech Republic, with RG No. 401/2015 Sb. (Haluzová, 2017). Furthermore, in the locality of interest, in the vegetation period of 2016, the collection and determination of algae and cyanobacteria were performed (Němcová, 2017).

Fig. 1: Area of interest and sampling profiles (source:mapy.cz, edited authors)

To monitor the quality in the stream, 5 sampling profiles were selected with regard to the location of the ponds and the location of the outlet of the treated wastewater from the industrial area.

Results and Discussion
A total of 7 water quality indicators were monitored on the Aušperský stream. Nitrate and total phosphorus indicators were chosen for the contribution. The other indicators show a similar trend as the two presented below.

Nitrates
Nitrogen together with phosphorus are among the most important biogenic elements in water. Nitrogen compounds are used in all biological processes taking place in groundwater, surface water and wastewater. Nitrates are the final product in the aerobic environment in the decomposition of

organic matter. Nitrates can be anthropogenic, they come from fertilizers that are used in agriculture or they come from wastewater from households, industry.

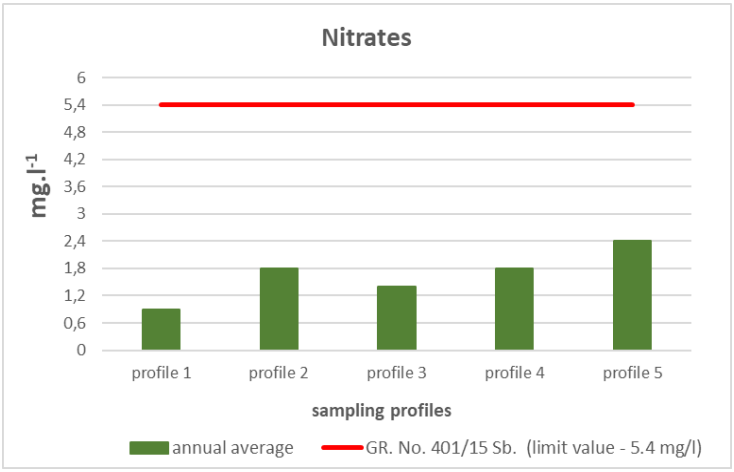

Fig. 2: Annual average values of nitrates (source: authors)

According to GR. No. 401/2015 Sb., the limit value for nitrates in surface waters is set at 5.4 $mg.l^{-1}$. The graph shows that during the annual monitoring of nitrates, the values of all monitored profiles are below the limit value, which is 5.4 $mg.l^{-1}$. Although nitrates are found in all waters, much of them enter the water by flushing from the surrounding farmland.

Total Phosphorus

The main indicator of polluted wastewater discharged into surface waters is total phosphorus. At the same time, the phosphorus content has a major effect on water eutrophication. This indicator was also monitored on the Aušperský stream. Phosphorus sources can be anthropogenic. The following Fig.3 shows the annual average values in the individual profiles.

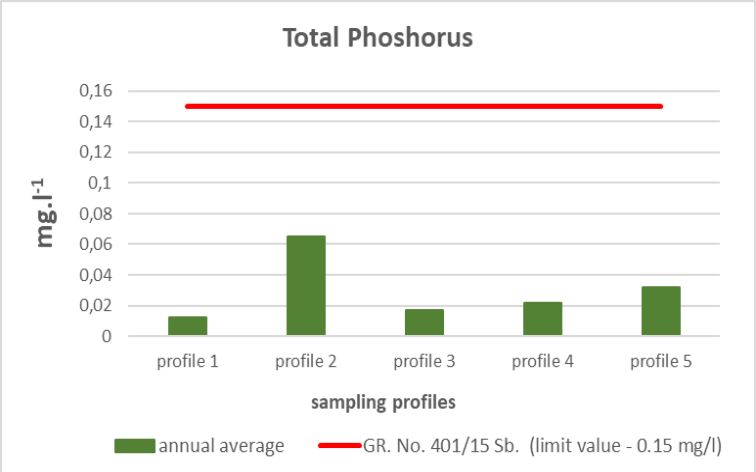

Fig. 3: Annual average values of total phosphorus (source: authors)

Limit value of total phosphorus according to GR. No. 401/2015 Sb., is 0.15 $mg.l^{-1}$. All monitored profiles of the Aušperský stream show below-limit values. Here, phosphorus sources can have an organic character in the decomposition of biomass phytoplankton and zooplankton, which are located at the bottom of both reservoirs and in the stream.

Cyanobacteria and algae

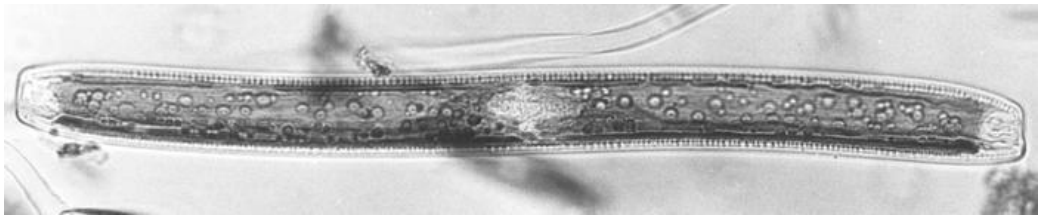

Fig.4 *Nitzschia sigmoidea* ((Nitzsch) W. Smith) (source:nordicmicroalgea.org)

221 taxa were determined in the monitoring of cyanobacteria and algae. From the total number of 221 taxa, there were 10 taxa of cyanobacteria, 27 taxa of euglen, 120 taxa of diatoms, 51 taxa of green algae, 10 taxa of conjunctiva and 3 taxa of other algae. During the entire growing season, the most abundant diatom was *Nitzschia sigmoidea* ((Nitzsch) W. Smith), which occurred in all localities, the second most numerous were the green algae *Dinobryon stipitatum* (Stein). The highest number of taxa of cyanobacteria and algae was determined in the Horní rybník (156 taxa), followed by the Dolní rybník with 142 taxa and the lowest number of taxa was determined in the Aušperský stream (126 taxa).

Conclusion

Legislative limits were not exceeded in any of the indicators in all samples profiles. The water in the Aušperský stream is of very good quality. The monitoring results show that the water of the Horní and Dolní rybník and the Aušperský stream does not detect an increased amount of cyanobacteria in the summer. This information is very positive due to the use of Dolní rybník for swimming.

The Aušperský stream is not negatively affected by both reservoirs, not by the treated wastewater flowing from a nearby industrial area.

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Souhrn

Článek je zaměřen na sledování kvality vody v Aušperském potoce, který protéká 2 nádržemi - Horní rybník a Dolní rybník. Aušperský potok pramení v lese v nadmořské výšce asi 380 m. V oblasti nad

rybníky potok protéká lesem, kde se na něj asi ve vzdálenosti 1,5 km od pramene napojuje jeho jediný přítok bezejmenný potok. Údolí bezejmenného potoka vytváří podmáčené louky, které byly v roce 1989 vyhlášeny přírodní památkou Ausperský potok. Předmětem ochrany je ekologicky významný krajinný prvek, zachovalý meandrující tok s přirozenými lučními porosty. Lokalita je také významná jako hnízdiště ohrožených druhů ptactva a místo rozmnožování obojživelníků Horní rybník slouží jako vodní stanoviště pro vodní ptactvo a obojživelníky. Dolní rybník slouží k rekreaci a sportovnímu rybolovu. Pod Dolním rybníkem přitékají do potoka vyčištěné odpadní vody z průmyslového areálu. Periodický odběr vzorků byl proveden v letech 2019 - 2020 na vybraných profilech. Dále byly během vegetačního období 2016 sbírány a determinovány řasy a sinice. Vyhodnocené rozbory vybraných ukazatelů jakosti vody byly následně porovnány s platnou legislativou ČR. Z hodnocení vyplynulo, že žádná z nádrží neměla vyšší výskyt sinic, pouze zvýšený počet zelených řas a rozsivek, zejména v letních měsících. Což je z hlediska koupání v Dolním rybníce pozitivní informace. Nádrže, dle vybraných ukazatelů jakosti vody, nemají negativní vliv na kvalitu vody v toku. Kvalitu vody výrazně neovlivňuje ani vypouštěná odpadní voda z průmyslového areálu.

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