

## PHYSICOCHEMICAL PROPERTIES OF SELECTED DRAINAGE DITCHES IN POLESIE NATIONAL PARK

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**Summary.** The construction of the drainage system of the Wieprz-Krzna Canal within Polesie has exerted negative effects on water conditions in that area. Practices have consisted mainly in drying many valuable natural habitats and introducing fertile waters through the system of ditches, which has modified the habitat conditions over a large area. At present, after making some reclamation works within the Polesie National Park, dammed drainage ditches do not play their attributed functions any longer. They have become the place where many plant and animal species have settled. Neither the habitats nor the biocenoses had not been studied earlier. As the study objects, four drainage ditches located within the Polesie National Park have been selected. The ditches have cut diverse phytocenoses that have affected their habitat and morphological traits. Physico-chemical measurements as well as water quality assessments were carried out in all selected objects in upper stagnating water layers.

**Key words:** drainage ditches, physicochemical parameters of water, habitat, Polesie National Park

### INTRODUCTION

From the natural point of view, building the drainage system of Wieprz-Krzna Canal in an area that is at present within the Polesie National Park had negative influences by modifying water conditions. It disturbed the water outflow rate, which led to the lack of its stagnation [Chmielewski and Radwan 1993], while allochthonic waters directed through the system of canals and ditches, characterised by different trophies and chemical composition, contributed to altering the habitat conditions [Wilgat 1991, Michalczyk and Turczyński 1998, Turczyński *et al.* 2000].

At present, the drainage ditches passing through the Polesie National Park do not play their typical drainage role any longer. Some of them got overgrown, whereas others were dammed as part of a reclamation program, and they are now extremely important as a place of living for many species, including species suppressed from dried areas. Those astatic, sometimes strongly overgrown, small wet habitats are a valuable element that enhances the species and landscape diversity of the Park. At the same time, the habitats are not recognized, namely with reference to abiotic conditions. Therefore, there is a need to survey and analyse the habitat conditions in the drainage ditches within the Polesie National Park. Knowledge on these issues is necessary for managing the protected areas, namely when active protection programs are created.

## MATERIAL AND METHODS

Four selected drainage ditches located in the Polesie National Park (Fig. 1), different relating to their habitats and morphology, were the study objects.



Fig. 1. Distribution of measurement points within Polesie National Park [Kałmucki *et al.* 2001, modified]

Selected parameters of abiotic environment were determined in all studied objects by measuring in the upper layers of stagnating waters in the ditches. The measurements were performed in three seasons: summer, autumn 2007 and spring 2008. Water acidity and electrolytic conductivity were measured *in situ*.

Water samples from particular points were collected for laboratory analyses. The analyses included the following nutrients: total nitrogen, nitrates, ammonia, total phosphorus, phosphates. Chemical determinations were carried out in accordance with the standard PN-EN ISO/IEC 17025: 2001 in the laboratory POMIAR – GIG Przedstawiciel Głównego Instytutu Górnictwa Sp z o.o.

Achieved results were subjected to statistical analysis using Canoco software.

The indirect method Detrended Correspondence Analysis was applied to determine the taxons and sample distribution along the environmental gradients [ter Braak 1995, Lepš and Šmilauer 2003].

## RESULTS AND DISCUSSION

The differentiation of habitat conditions in drainage ditches is greatly affected by ditch-bed morphology, the development stage of embankments and littoral flora, as well as water flow rate along with its physical and chemical properties [Ilnicki and Łoś 1989].

The selected survey objects were characterised by diverse abiotic and biocenotic conditions. Point No. 1 was located in the north-western part of the Park near Zbójno village and near Zienkowski Flow within the Zienkowskie Meadows area (Fig. 1). A drainage ditch of about 1.5 m in depth, with apparently steep embankments, was the studied object. The highest water level was observed in spring. In other seasons, depending on the weather, water level surface oscillations were significant. During low rainfall and warm periods, the ditch remained dry. Phytocenoses with large percentage of *Molinio-Arrhenatheretea* class species were recorded nearby.

Point No. 2 was situated near Pieszowola village, in the northern part of the Polesie National Park (Fig. 1). The study object consisted of a drainage ditch of about 2 m depth, passing the western side of Graniczny Pond located beside the natural path „Perehod”. It bordered with dry meadows and *Pinus silvestris* and *Betula pendula* with a share of *Calluna vulgaris* patches on the west, and it was adjacent to a dam near the mentioned pond from its eastern direction. Water in the ditch was present during the whole vegetation season, although, depending on the weather, great oscillations of its levels were recorded.

Point No. 3 was located within the peat-bog complex „Bagno Bubnów” near Sęków village (Fig. 1). „Bagno Bubnów” is a peat-bog area of carbonate character [Różycki 1998]. It was incorporated into the Polesie National Park in 1994. At the beginning of the 90's of the 20th century, melioration works were conducted in its north-western part, during which drainage ditches in chalk sub-

soil were dug [Wojciechowski 1998]. The drainage ditch of about 2 m depth and continuously filled with water was the survey object. High water level with only slight changes did not allow for settling its slopes by land plants. The surroundings of the ditch were abundantly grown by *Phragmites australis*.

Point No. 4 was situated along a didactic path leading from lake Moszne to Jamniki village (Fig. 1). A shallow drainage ditch cutting the swamp forest complex with characteristic plant communities [Urban 2003] was the studied object. A major part of the studied area was grown by *Sphagnum* sp. with a small number of vascular flora patches. It was a very shallow ditch, with disappearing or a complete lack of embankments.

The living conditions, shape of plant communities patches, as well as the course of the overgrowing process in drainage ditches strongly depends mainly on the presence or lack of water, as well as on its chemical composition [Podbielkowski 1967].

The highest water acidity value (pH 7.23) was recorded in spring 2008 in object No. 3, while the lowest (pH 3.46) in autumn 2007 in object No. 4 (Tab. 1). High acidity of water from object No. 4 results from its location near oligotrophic peat-bogs and near a poor, although acidic habitat of pine forest. Relatively low acidity in object No. 3 was affected by chalk character of the subsoil.

Table 1. Values of pH, electrolytic conductivity, and concentrations of nutrients ( $\text{mg dm}^{-3}$ ) in water of drainage ditches within Polesie National Park in 2007–2008

Point No	Date	pH	conduct. $\mu\text{S cm}^{-1}$	N tot.	N- $\text{NO}_3^-$	N- $\text{NO}_2^-$	N- $\text{NH}_4^{4+}$	P tot.	P- $\text{PO}_4^{(3-)}$
1	summer 2007	7.02	428.0	3.65	0.06	0.02	0.25	0.20	0.05
	autumn 2007	6.89	458.0	0.93	< 0.02	< 0.01	0.35	0.29	0.15
	spring 2008	7.06	524.0	2.12	0.15	< 0.01	0.32	0.07	< 0.01
2	summer 2007	6.32	188.0	6.21	0.20	0.03	1.30	0.27	0.05
	autumn 2007	6.09	299.0	0.94	< 0.02	< 0.01	0.39	0.09	0.14
	spring 2008	6.41	199.0	1.02	0.34	< 0.01	0.29	0.12	0.16
3	summer 2007	7.06	368.0	4.48	0.16	0.03	0.50	0.05	0.01
	autumn 2007	7.08	402.0	1.50	< 0.02	< 0.01	0.61	0.02	0.03
	spring 2008	7.23	481.0	1.58	0.14	< 0.01	0.32	< 0.05	< 0.01
4	summer 2007	4.89	172.0	26.16	2.53	0.04	7.90	0.08	0.02
	autumn 2007	3.46	310.0	9.55	1.68	< 0.01	4.20	0.06	0.06
	spring 2008	4.81	159.1	6.87	1.06	< 0.01	4.80	0.12	< 0.01

The extreme values of water electrolytic conductivity were recorded in spring – the highest in study object No. 1 and the lowest in object No. 4 ( $524.0$  and  $159.1 \mu\text{S cm}^{-1}$ , respectively, Tab. 1). High electrolytic conductivity in ditch No. 1 resulted probably from the cultivated fields and pastures adjacent to the ditch. On the other hand, low electrolytic conductivity values recorded in the water of object No. 4 ( $211.80 \mu\text{S cm}^{-1}$ ) was the consequence of nearby dystrophic environments. Values of electrolytic conductivity qualified these waters to the 1st purity class [Decree... 2004].

Chemical analyses of water revealed diverse concentrations of selected nutrients ions (Tab. 1).

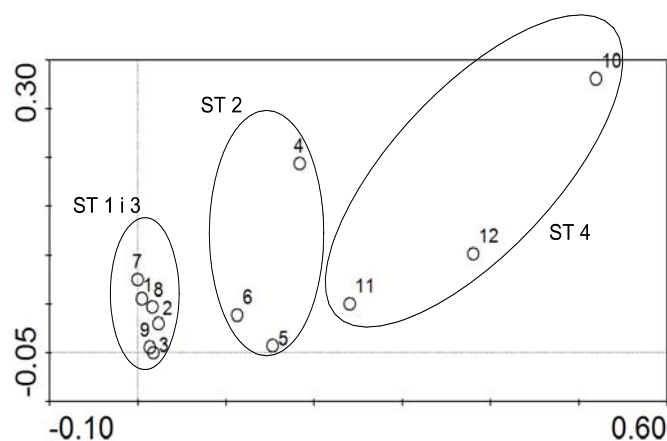


Fig. 2. Sample ordering in the first two DCA axis system: ST 1 – Point No. 1: 1 – summer 2007, 2 – autumn 2007, 3 – spring 2008; ST 2 – Point No. 2: 4 – summer 2007, 5 – autumn 2007, 6 – spring 2008; ST 3 – Point No. 3: 7 – summer 2007, 8 – autumn 2007, 9 – spring 2008; ST 4 – Point No. 4: 10 – summer 2007, 11 – autumn 2007, 12 – spring 2008

The lowest total nitrogen concentration was recorded in autumn 2007 in ditches No. 1 and No. 2 ( $0.94$  and  $0.93 \text{ mg N}_{\text{tot}} \text{ dm}^{-3}$ ), whereas the highest – also in autumn in object No. 4 ( $9.55 \text{ mg N}_{\text{tot}} \text{ dm}^{-3}$ ).

Nitrate concentration reached the lowest levels ( $< 0.02 \text{ mg NO}_3\text{-N dm}^{-3}$ ) in autumn in three of the four studied drainage ditches (No. 1, 2 and 3), while the highest level of nitrate ions was found in object No. 4 in spring ( $2.53 \text{ mg NO}_3\text{-N dm}^{-3}$ ). Low nitrates content may be attributed to extensive agricultural management near the studied object and surrounding peat-bog biocenoses.

Concentration of nitrite form of nitrogen in all studied objects was low and did not exceed the level of  $0.04 \text{ mg NO}_2\text{-N dm}^{-3}$  on any date of measurement. Total nitrogen, nitrites, and nitrates qualified the studied waters to the 1st and/or 2nd purity class.

Concentration of ammonia ranged from  $0.25$  in summer 2008 (object No. 1) to  $7.90 \text{ mg NH}_4\text{-N dm}^{-3}$  in the same season in object No. 4. In a majority

of the studied objects, ammonia concentrations were quite low and characteristic for the 1st and 2nd water purity classes, except for object No. 4, where ammonia content qualified waters to the 5th class [Decree... 2004]. Such high levels of ammonia specimens were probably due to large tourist traffic on the didactic path „Dąb Dominik” that crosses the area.

Contents of total phosphorus and available phosphates in the water of the surveyed ditches were low, ranging from  $0.02 \text{ mg P}_{\text{tot}} \text{ dm}^{-3}$  in autumn 2007 in object No. 3 and  $< 0.01 \text{ mg PO}_4\text{-P dm}^{-3}$  in spring 2008 in object No. 1 to  $0.29 \text{ mg P}_{\text{tot}} \text{ dm}^{-3}$  in autumn 2007 in object No. 1 and  $0.16 \text{ mg PO}_4\text{-P dm}^{-3}$  in spring 2008 in object No. 2. Phosphorus concentrations recorded qualified the waters of the studied ditches to the 1st or 2nd quality class [Decree... 2004], which could result from abundant aqueous plant communities growing at the ditches bottoms and embankments.

Analysis of the sample distribution along gradient determined by the first ordering axis, reveals samples No. 1 through 9 localized on the left side of the axis. They are samples collected from object No. 1 within the complex of the Zienkowskie Meadows (1–3) and from object No. 3 – drainage ditch in carbonate peat-bog (7–9). The highest calcium concentration, high electrolytic conductivity, and pH values were recorded on all measurement dates in these ditches. On the right side of the axis there are samples collected from the drainage ditch at Lake Moszne; their scattering may indicate they are diverse, and the water was characterised by the highest total nitrogen content (the highest concentration was recorded in summer 2007 – sample No. 10). Samples collected from object No. 2 (ditch along natural path „Perehod”) are grouped in the middle. The sample differentiation in particular seasons was also greater in that object; the highest total nitrogen and iron contents were recorded in summer 2007.

## CONCLUSIONS

Mainly habitat type and its management exerted the strongest influences on the physicochemical properties of water from the studied drainage ditches.

Changing the status of drainage ditches due to damming and slowing down the surface waters runoff caused the re-growth of many flora and fauna species characteristic for wet areas.

The drainage ditches within the Zienkowskie Meadows and within the carbonate peat-bog complex were characterised by the most stable habitat conditions; the least seasonal differences in studied parameters values were recorded in those objects as well.

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WŁAŚCIWOŚCI FIZYCZNO-CHEMICZNE WÓD  
WYBRANYCH ROWÓW MELIORACYJNYCH  
NA OBSZARZE POLESKIEGO PARKU NARODOWEGO

**Streszczenie.** Budowa systemu melioracyjnego Kanału Wieprz-Krzna na Polesiu Lubelskim miała negatywny wpływ na stosunki wodne tego obszaru. Zabiegi melioracyjne polegały głównie na osuszeniu wielu cennych przyrodniczo siedlisk oraz na wprowadzeniu systemem rowów żyznych wód allochtonicznych, zmieniających warunki siedliskowe na znacznym obszarze. Obecnie po przeprowadzeniu na terenie Poleskiego Parku Narodowego prac renaturalizacyjnych, przetamowane rowy melioracyjne nie pełnią właściwych sobie funkcji. Stały się one miejscem bytowania wielu gatunków roślin i zwierząt, które na nowo je zasiedliły. Zarówno siedliska, jak i występujące tam biocenozy nie były wcześniej szczegółowo badane. Jako obiekty badań wybrano cztery rowy melioracyjne położonych na terenie Poleskiego Parku Narodowego. Rowy te przebiegały przez różnorodne fitocenozy, które miały wpływ na ich cechy siedliskowe i morfologiczne. We wszystkich wybranych obiektach, w wierzchniej warstwie wody stagnującej przeprowadzono pomiary fizyczno-chemiczne i dokonano oceny jakości wody.

**Słowa kluczowe:** rowy melioracyjne, parametry fizyczno-chemiczne wody, siedlisko, Poleski Park Narodowy