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HABITAT DIFFERENTIATION OF THE MIETIUŁKA RIVER IN RELATION TO CHANGES IN ITS ROUTE AND IN LAND USE WITHIN ITS CATCHMENT

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Summary. The aim of the pilot field study was to determine current habitat conditions existing within the area of the Mietiułka River and the influence which is exerted on these conditions by the adjacent habitats used in different ways. Based on historical and modern maps, changes in the route of the river within the Polesie National Park and in land use in its catchment area were determined. In the study sectors designated, morphometric features of the river channel were documented as well as values of some abiotic factors of the environment in the water of the watercourse were measured *in situ*, confronting them with the results of ecological analyses of the flora.

Key words: Mietiułka River, habitat conditions, Polesie National Park

INTRODUCTION

The Mietiułka River is a small, anthropogenically transformed watercourse, flowing through the northern part of the Polesie National Park (PNP). This river is situated on the eastern side of the watershed running through the Park (in the Bug River basin), and its catchment area is estimated to be 3965.8 ha. The river originates in the area of Pieszowola, right by the Park boundary, it flows through a vast meadow complex, starting from the Zremieniska nature sanctuary, right beside the pond complex of Pieszowola Ponds (Stawy Pieszowolskie), further down through Pociągi and Ochoża to the pond complex of Brus Ponds (Stawy Bruskie), flowing around it on its southern side. Its next section cuts across a part of hay meadows in the area of Mietiułka Village, and its mouth to the Włodawka River is located just upstream of Lake Wytyckie. The total length of the

river within the Park is 9.25 km [Chmielewski 1992, Cebrykow *et al*. 2001, Michalczyk *et al*. 2002].

The river runs mainly through muck-peat soils formed on a peat plain, with a small proportion of black muck soils, typical groundwater gley soils, gley-peat soils and typical podzolic soils (Zienki Meadows – Łąki Zienkowskie), as well as through surface-water gley soils, fen peat soils, rusty podzolic soils and muddy peat soils (the outlet section of the river) [Wicik and Piotrowski 2002].

Due to the location of the river in a natural depression in the land surface and agricultural use of the area around the Park, the waters carried by the Mietiułka River are characterised by a high content of nutrient minerals [Janiec 1994, Michalczyk *et al*. 1999].

The aim of the pilot field study was to determine current habitat conditions existing within the area of the Mietiułka River and the influence which is exerted on these conditions by the adjacent habitats used in different ways.

METHODS

The pilot study was carried out in May and July 2006 as well as in July 2007 in the northern part of the Polesie National Park through which the Mietiułka River flows.

During the first stage of the field study, a site visit was conducted in the study area, with the objective of making a preliminary identification of vegetation cover and variation in the habitats adjacent to the river. Six study sectors were established (I–VI, Fig. 1) with the same length (25 m), and one sampling site was set up in each sector. The selection of the location of the sectors was guided by the variation in vegetation cover and habitats bordering the investigated watercourse.

In each sector, morphometric measurements of the river channel were made: channel length, width and depth in its initial, middle and end section (using a metric tape measure). The water acidity (pH, using a field pH-meter) and water electrolytic conductivity ($\mu S\ cm^{-1}$, using a field conductometer) were measured *in situ* twice (in July 2006 and 2007). Water samples were also collected in order to determine the cation concentration of some elements (K^+, Na^+, Ca^{2+}, Mg^{2+}) in the water. Analyses were performed in the Central Testing Laboratory of the University of Life Sciences in Lublin.

The status of the flora in particular study sectors was documented in the period from May to July 2006 [Stelmach 2008, Szadkowski 2008]. In office investigations *Ecological indicator values of vascular plants* [Zarzycki *et al*. 2002] was used to determine selected habitat characteristics based on that.

Historical and modern maps of the region were also analysed with a view to tracing changes in the route of the Mietiułka River as well as transformations of the landscape and habitats of adjacent areas. For this purpose, the Topographic

Map of the Kingdom of Poland [1843] (Fig. 2), Karte des westlischen Russlands [1915], a topographic map of the Polish Military Geographical Institute (WIG) [1938], modern topographic maps [1992, 2002] were used.

RESULTS

When comparing the maps of the Łęczna-Włodawa Lakeland area from 1843 until 1987, it can be noted that distinct changes took place in the landscape of the study area. The western part of the river (sectors I–IV) appeared on the map as late as the year 1938, and the status which is most similar to the current one can only be observed in 1987 (the map was published in the years 1992 and 2001). The course of the Mietiułka River in the section from the village of Mietiułka to the river mouth to the Włodawka River (sectors V and VI) did not change significantly (Figs 1 and 2).

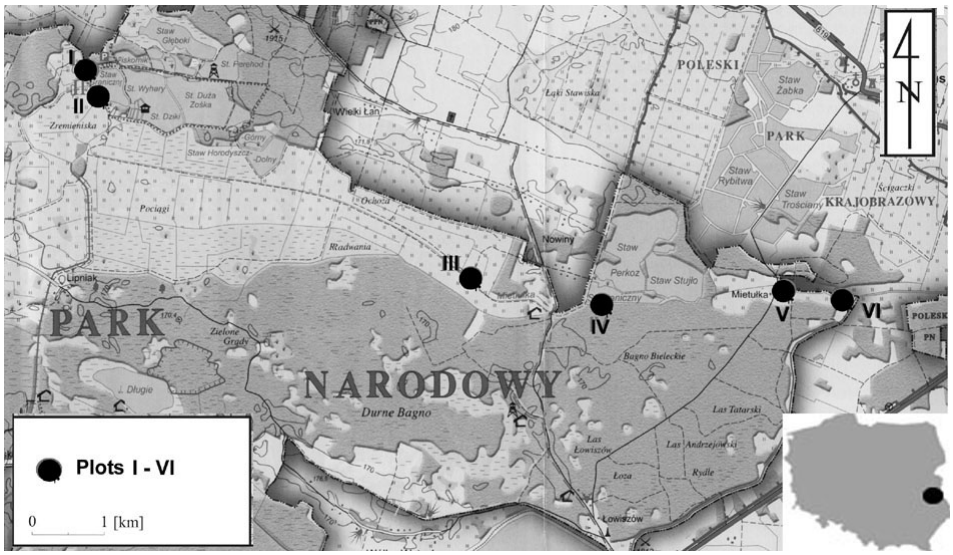

Fig. 1. Study sectors I–VI

In analysing the abovementioned maps, a gradual decrease in the area of dense tree stands, accompanied by a constant increase in developed areas (after the year 1843), can be noted in the study area. Changes also relate to non-forest land use. Vast peat bogs and waterlogged meadows were transformed into agricultural land, commercial fish ponds were also established, which later on were partially drained.

The morphometric parameters of the Mietiułka River channel do not change gradually from the river source to its mouth, but they are irregular (Tab. 1). The most similar sections of the watercourse, in terms of their width and depth, are

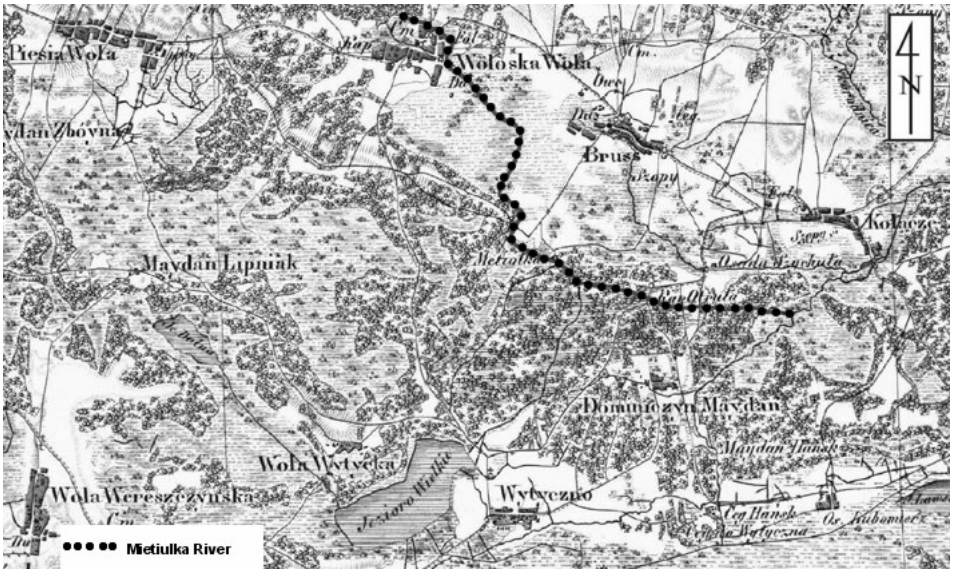

Fig. 2. Map of the-Kingdom of Poland in 1843 with Mietułka River

located in the area of the Pieszowola Ponds (sector II), Zienki Meadows (sector III) and Brus Ponds (sector IV). At those places, the channel is the deepest and widest. No water flow was observed in any of the study sectors. The channel width and depth do not have any visible effect on species richness of the studied sections of the watercourse.

The stagnant water of the river, investigated at the sampling sites, had a slightly acidic or neutral pH (sporadically alkaline). The highest water pH values were recorded in sector III (pH 8.26 and 7.05), and the lowest in sector II at both sampling dates (pH 6.09 and 6.19, Tab. 2).

The cation content of some elements was generally the highest in water collected from the sampling sites in sectors III and IV, and the lowest in sector I (Tab. 2).

Table 1. Morphometric features of the Mietiułka River channel in particular study sectors, in the years 2006–2007

Sector	Width of river channel, cm			Depth, cm		
	Initial section	Middle section	End section	Initial section	Middle section	End section
I	90	90	40	12	28	12
II	400	460	220	80	80	20
III	790	700	440	152	145	130
IV	530	530	500	110	115	110
V	280	270	265	38	35	30
VI	250	260	210	35	30	50

Table 2. Values of some abiotic factors measured in the water of the Mietiułka River, in the years 2006 and 2007

Sector		I		II		III		IV		V		VI	
Year		2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Acidity (pH)		6.66	6.32	6.09	6.19	8.26	7.05	6.83	6.74	7.16	6.56	7.41	7.13
Electrolytic conductivity ($\mu S\ cm^{-1}$)		123	97.9	373	185	932	302	341	348	384	235	340	243
Cation concentration ($mg\ dm^{-3}$)	Na^+	1.82	2.71	5.54	6.84	4.49	3.79	5.53	4.48	4.86	4.63	6.63	4.52
	K^+	3.90	4.41	3.15	2.92	5.25	0.46	2.99	1.33	2.11	1.53	2.33	1.49
	Ca^{2+}	24.97	12.61	31.05	15.76	48.50	36.38	49.41	30.72	41.85	23.69	41.23	21.98
	Mg^{2+}	0.28	1.80	0.56	2.95	0.58	3.22	5.4	3.54	5.4	2.86	5.8	2.86

Table 3. Species proportions of different ecological groups in the flora of the slopes and channel of the Mietiułka River [acc. to Zarzycki *et al*. 2002]

Selected indicators	Sector	Indicator values						
		1	2	3	4	5	6	Stenobionts
W – soil moisture value	I	2.1	21.3	36.2	38.3	38.3	17.0	55.3
	II	0.0	10.6	36.2	46.8	40.4	21.3	44.7
	III	0.0	2.9	23.5	32.4	38.2	35.3	70.6
	IV	0.0	0.0	31.6	26.3	26.3	47.4	68.4
	V	0.0	5.0	27.5	40.0	42.5	37.5	47.5
	VI	0.0	2.4	26.8	39.0	48.8	34.2	43.9
Tr – trophy value (acc. to species from watercourse scarps)	I	6.4	19.1	51.1	68.1	4.3	-	59.6
	II	0.0	8.5	51.1	87.2	8.5	-	51.1
	III	0.0	5.9	52.9	97.1	2.9	-	44.1
	IV	0.0	10.5	57.9	94.7	5.3	-	36.8
	V	0.0	5.0	47.5	87.5	7.5	-	50.0
	VI	0.0	4.9	43.9	87.8	2.4	-	58.5
Tr – trophy value (acc. to channel macrophytes)	I	0.0	9.1	63.6	100.0	9.1	-	36.4
	II	0.0	21.4	78.6	85.7	0.0	-	28.6
	III	0.0	13.3	80.0	100.0	0.0	-	20.0
	IV	0.0	25.0	75.0	100.0	0.0	-	25.0
	V	0.0	7.7	69.2	92.3	0.0	-	23.1
	VI	0.0	7.7	69.2	92.3	0.0	-	23.1
R – soil (water) acidity (pH) value (acc. to species from watercourse scarps)	I	4.3	8.5	36.2	85.1	34.0	-	44.7
	II	0.0	6.4	12.8	93.6	29.8	-	55.3
	III	0.0	2.9	5.9	88.2	55.9	-	4.1
	IV	0.0	0.0	15.8	89.5	57.9	-	47.4
	V	0.0	0.0	15.0	85.0	47.5	-	47.5
	VI	0.0	0.0	7.3	85.4	39.0	-	56.1
R – soil (water) acidity (pH) value (acc. to channel macrophytes)	I	0.0	0.0	27.3	100.0	45.5	-	54.5
	II	0.0	14.9	14.9	92.9	71.5	-	14.3
	III	0.0	6.7	0.0	80.0	80.0	-	33.3
	IV	0.0	0.0	15.8	75.0	87.5	-	37.5
	V	0.0	0.0	7.7	76.9	69.2	-	23.1
	VI	0.0	0.0	7.7	76.9	61.5	-	30.8

D – soil granulometry value (acc. to species from watercourse scarps)	I	2.8	13.9	44.4	88.9	30.6	-	38.9
	II	3.0	6.1	24.2	93.9	39.4	-	48.3
	III	5.3	5.3	26.3	82.2	36.8		52.6
	IV	0.0	9.1	36.4	90.9	63.6	-	18.2
	V	0.0	14.8	33.3	96.3	44.4	-	37.0
	VI	3.6	17.9	32.1	89.3	42.9	-	32.1
H – organic matter content value (acc. to species from watercourse scarps)	I	13.9	75.0	50.0	-	-	-	66.7
	II	3.0	75.8	42.4	-	-	-	75.8
	III	0.0	63.0	47.4	-	-	-	89.5
	IV	0.0	63.6	45.5	-	-	-	90.9
	V	7.4	70.4	51.9	-	-	-	47.1
	VI	3.6	71.4	46.4	-	-	-	82.1

The analysis performed based on indicator values, describing preferences of the species found in the study sectors, allowed us to find that moisture-loving plants (characteristic of both fresh soils and moist wet soils, but also typical of aquatic environments) were the main component of the flora of the studied sectors. The species inhabiting the slopes of the river banks indicated nutrient-rich soils (from 68% of species in sector I up to 97% of species in sector III) or moderately poor soils (43–57% species in different sectors), mineral-humic soils (more than 80% of species inhabiting the slopes in all the study sectors), with a neutral pH (which is indicated by more than 85% of species preferring substrate pH within a range of 6–7) or an alkaline pH, sandy clays and silty deposits (more than 80% of species, with the majority of them having a wide range of ecological amplitude and also tolerating sands as well as heavy clays and silts). Aquatic vegetation was composed of taxa with wider spectra of ecological tolerance, preferring meso- and eutrophic waters, with pH within the range of 6–7 (Tab. 3).

DISCUSSION

Little direct information on the Mietiułka River itself can be found in literature. When comparing the historical maps of the Łęczna-Włodawa Lakeland with the current ones, changes taking place within the area of the current Polesie National Park can be observed. It can be clearly seen that the current course of the Mietiułka River is a result of intentional anthropogenic transformations of the environment, associated with land drainage work, which is also indicated by the morphometric parameters of this watercourse investigated in the period of 2006–2007. The western part of the river, studied in the years 2006–2007, is visible on the map not earlier than in the year 1938, and the status closest to the current condition of the river can be observed as late as 1987. The route of the river from the village of Mietiułka to the mouth of the watercourse in question to the Włodawka River did not change significantly. These observations find confirmation in the publications of Łoś [1992, 1995] and Michalczyk [1994, 2002] who, when describing the history of land drainage improvements carried out in

the Polesie Lubelskie region, also mention the origin of the rivers located there (including the Mietiułka).

The area of dense tree stands located in the vicinity of the river gradually decreased from the year 1843, whereas the proportion of developed areas increased. The forest area of the Mietiułka River catchment changed from 18.4% (in 1915) to 12.6% (in 1950) and 16.9% (in 1988) [Paszczuk 1992].

It is impossible to compare the results of the study of abiotic and biocenotic factors of the environment of the Mietułka watercourse with the results of other studies on rivers conducted in Poland. It seems justified to confront these data only with habitats of the drainage ditches investigated in the Warsaw area [Podbielkowski 1967] and in the Polesie National Park [Banach 2009], in which no clear current was noted, but water stagnation.

Podbielkowski [1967] divided the drainage ditches investigated in the peat bogs near Warsaw, in terms of water pH, into two groups and compared them with ion concentration values for the most important elements. In the first group he included the drainage ditches characterised by water pH from 5 to 6, whereas in the second group those with pH from 6.2 to 9. According to Banach [2009], the water in most of the drainage ditches studied in the Łęczyna-Włodawa Lakeland had pH higher than 6.2, except for the drainage ditches immediately adjacent to the peat bogs. The waters of the Mietiułka River, in different sections of its course, have pH higher than 6.0.

Podbielkowski [1967] noted that the water in the drainage ditches with pH of 6.2–9.0 was characterised by higher phosphate content and much larger, even tenfold, magnesium and calcium concentration. The studies of Banach [2007] did not confirm similar correlations in the waters of the drainage ditches of the PNP. The analysis of the results of chemical properties of the water samples collected from the Mietiułka watercourse also did not show any clear relationship between the pH and the content of ions Ca^{2+} and Mg^{2+}.

Potassium occurs in natural surface waters in small amounts [Hermanowicz *et al*. 1976]. The concentration of potassium ions in the waters of all the drainage ditches in the PNP studied by Banach [2007] did not exceed 4.00 mg K^+ dm^{-3}, whereas in the water of the Mietiułka River it was in the range between 0.46 and 5.52 mg K^+ dm^{-3} and exhibited significant fluctuations, depending on the sampling date and site.

The average concentration of potassium ions in natural surface waters is 20–30 mg Na^+ dm^{-3} [Hermanowicz *et al.* 1976]. In the stagnant waters in the ditches of the PNP, the amount of this element did not exceed 9 mg Na^+ dm^{-3}, hence, it was very low, likewise in the water of the Mietiułka River (the highest concentration of 6.84 mg Na^+ dm^{-3} was noted in 2007).

According to Hermanowicz [1967], the concentration of calcium ions in natural surface waters can be very high and can amount to several hundred mg Ca^{2+} dm^{-3}. The calcium content in the water of the ditches within the Park area ranged from 14.5 to 120.3 mg dm^{-3} [Banach 2007], similarly to the waters in the

ditches of the peat bogs near Warsaw (3.6–134.2 mg Ca^{2+} dm^{-3}) [Podbielkowski 1967]. The concentration of this element in the water sampled in different sections of the Mietułka watercourse was much lower (from 12.61 to 49.41 mg Ca^{2+} dm^{-3}).

Magnesium ions in the waters of the drainage ditches studied by Banach [2007] were found in small concentrations, both in the PNP (maximum 7.61 mg Mg^{2+} dm^{-3}) and in the peat bogs in the Warsaw area (15.2 mg dm^{-3}) [Podbielkowski 1967]. Still lower values of the ion concentration of this element were found in the waters of the Mietiułka River (0.28 up to 5.80 mg Mg^{2+} dm^{-3}). Hermanowicz reports [1976] that in natural waters the concentration of magnesium ions is low and reaches up to 100 mg Mg^{2+} dm^{-3}.

Banach [2007] found that the higher content of some elements in the waters of the ditches studied by her could have been an effect of the natural processes of decomposition of plant organic compounds or, less frequently, an effect of fertilizer runoff from nearby crop fields. The results of the study of ion concentrations of some elements in the water of the Mietiułka River (2006–2007) show that the water sampled from different sites is characterised by their small content. It can be clearly seen that the most fertile habitats are located in the river sections subjected to the greatest human pressure (sector III and IV).

The habitat conditions in the study sectors, determined based on the flora analysis, showed in the different parts of the watercourse their relatively low variation in terms of trophy, substrate moisture content, substrate pH as well as the particle size composition and organic matter availability, which can be attributable to one type of bedrock (a Holocene plain formed from fens) dominant within this area and small variation in soils formed on it (peat-muck soils are predominant) [Wicik and Piotrowski 2002]. To sum up, the abovementioned habitat analyses and *in situ* measurements made at the sampling sites show that the pH of the water of the studied watercourse was neutral and even alkaline at places. The species composition of the flora indicated mesotrophic and eutrophic habitats, however, the chemical analysis of the water revealed a deficiency of ions of the studied elements, which confirms to a large extent low water electrolytic conductivity.

REFERENCES

Banach B., 2007. Species diversity of the flora of drainage ditches in the Polesie National Park and its buffer zone. Doctoral dissertation (in Polish). Kat. Ekologii Ogólnej UP w Lublinie.

Banach B., 2009. Vascular flora of drainage ditches in forest area of the Polesie National Park. Acta Agrobot. 62 (1), 117–126.

Cebrykow P., Grzechnik L., Kałamucki K., 2001. The Polesie National Park. 1 : 50 000 tourist map (in Polish). Kartpol s.c., Lublin.

Chmielewski T. J., Pizoń Z., 1992. Evaluation of the scale of variability in water relations in the years 1915–1990 (in Polish) [in:] The conservation of aquatic ecosystems in the Polesie National Park and its buffer zone. Vol. III. Maszynopis w PPN, Lublin.

Hermanowicz W., Dożańska W., Dojlido J., Koziorowski B., 1976. Physicochemical investigations of water and sewage (in Polish). Arkady, Warszawa, 118–133.

Janiec B., 1994. The effect of the Wieprz-Krzna Canal on the transfer of contaminants to the aquatic environment (in Polish) [in:] Radwan S. (red.) The natural environment in the impact area of the Wieprz-Krzna Canal. TWWP, Lublin.

Karte des westlichen Russlands, 1915. 1 : 100 000 topographic map (in Polish). M 36 Łeczna.

Łoś M.J., 1992. The effect of the Wieprz-Krzna Canal on water relations and ecological differentiation in the Polesie National Park and its buffer zone (in Polish) [in:] The conservation of aquatic ecosystems in the Polesie National Park and its buffer zone. Vol. II. Maszynopis w Poleskim Parku Narodowym, Lublin.

Łoś M.J., 1995. The effect of the Wieprz-Krzna Canal on water relations and ecological differentiation in the Polesie National Park (in Polish) [in:] Radwan S. (red.) The conservation of aquatic ecosystems in the Polesie National Park and its buffer zone. TWWP, Lublin.

Michalczyk Z., 1994. A change in the hydrographic network in the impact area of the Wieprz--Krzna Canal (in Polish) [in:] Radwan S. (ed.) The natural environment in the impact area of the Wieprz-Krzna Canal. TWWP, Lublin.

Michalczyk Z., 2002. The Polesie National Park in relation to the Łęczna-Włodawa Lakeland (in Polish) [in:] Radwan S. (red.) The Polesie National Park. Natural monograph. Wydawnictwo MORPOL, Lublin.

Michalczyk Z., Bartoszewski S., Chmiel S., Dawidek J., Głowacki S., Turczyński M., 2002. Water resources of the Polesie National Park (in Polish) [in:] Radwan S. (ed.) The Polesie National Park. Natural monograph. Wydawnictwo MORPOL, Lublin.

Michalczyk Z., Bartoszewski S., Turczyński M., Chmiel S., Dawidek J., Głowacki S., Zielińska B., 1999. The Polesie National Park conservation plan. Water resources and aquatic systems conservation specifications. Part I. Water resources (in Polish). Poleski Park Narodowy (unpublished).

Państwowe Przedsiębiorstwo Geodezyjno-Kartograficzne, 2001. 1 : 25 000 topographic map, 126.44 Stary Brus (in Polish). OPGK. Rzeszów S.A.

Państwowe Przedsiębiorstwo Geodezyjno-Kartograficzne, 1992. 1 : 25 000 topographic map, 126.43 Sosnowica (in Polish). OPGK, Polska Agencja Ekologiczna S.A. Rzeszów.

Paszczuk W., 1992. Evaluation of the scale of variability in land use and development (in Polish) [in:] The conservation of aquatic ecosystems in the Polesie National Park and its buffer zone. Vol. III. Poleski Park Narodowy, Lublin (unpublished).

Podbielkowski Z., 1967. Overgrowing of drainage ditches in peat bogs in the Warsaw area (in Polish). Monographiae Botanicae (Warszawa) 23, 1, 11, 16, 19–24, 40–41.

Stelmach Ł., 2008. Variation in the flora of the Mietułka River section in the eastern part of the Polesie National Park. Master's thesis (in Polish). Zakł. Ekologii Ogólnej UP w Lublinie (unpublished).

Szadkowski P., 2008. Species richness of the flora of the Mietułka River section in the western part of the Polesie National Park. Master's thesis (in Polish). Zakł. Ekologii Ogólnej UP w Lublinie (unpublished).

Topograficzna Karta Królestwa Polskiego, 1843. The Topographic Map of the Kingdom of Poland. 1 : 126 000 topographic map (in Polish); kolumna VI, Sekcja IX, wykonana przez Kwatermistrzostwo Generalne Wojska Polskiego w latach 1822–1831 i przez Korpus Topografów Armii Rosyjskiej w latach 1832–1843, Warszawa.

Wojskowy Instytut Geodezyjny, 1938. 1 : 100 000 topographic map, Zone 36, Pillar 36 (in Polish). Łęczna. Warszawa.

Wicik B., Piotrowski W., 2002. Soils of the Polesie National Park (in Polish) [in:] Radwan S. (red.) The Polesie National Park. Natural monograph. Wydawnictwo MORPOL, Lublin.

Zarzycki K., Trzcińska-Tacik H., Różański W., Szeląg Z., Wołek J., Korzeniak U., 2002. Ecological Indicator Values of Vascular Plants of Poland (in Polish) [in:] Szafer Institute of Botany, Polish Academy of Science, Kraków.

ZRÓŻNICOWANIE SIEDLISKOWE RZEKI MIETIUŁKI NA TLE ZMIAN TRASY JEJ PRZEBIEGU I UŻYTKOWANIA TERENU ZLEWNI

Streszczenie. Celem pilotażowych badań terenowych było określenie aktualnych warunków siedliskowych panujących w obrębie rzeki Mietiułki oraz wpływu, jaki na nie wywierają użytkowane w różny sposób siedliska sąsiadujące. Na podstawie map historycznych i współczesnych określono zmiany w trasie przepływu rzeki na terenie Poleskiego Parku Narodowego oraz w sposobie użytkowania terenu jej zlewni. W wyznaczonych sektorach badań udokumentowano cechy morfometryczne koryta rzeki, a także zmierzono *in situ* wartości wybranych czynników abiotycznych środowiska w wodzie cieku, konfrontując je z wynikami analiz ekologicznych flory.

Słowa kluczowe: rzeka Mietiułka, warunki siedliskowe, Poleski Park Narodowy