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MACROPHYTES OF SMALL WATER BODIES OF THE SUWAŁKI LANDSCAPE PARK (NORTH-EASTERN POLAND)

ABSTRACT: Aquatic and eulitoral vegetation of 21 small water bodies in the Suwałki Landscape Park was investigated. On most sites the submerged vegetation prevails with consideration to the dominant species, four groups of water bodies were distinguished: with dominating, elodeids, pleustonic plants, nympheids and helophytes. On the basis of species colonising the shores, two subtypes of water bodies were distinguished – water bodies with shores of fen and peat bog types. Particular groups of plants may indicate the main routes and cycling rate of nutrients as well as the type of hydrological regime within small water bodies.

KEY WORDS: macrophytes, small and shallow water bodies, Suwałki Landscape Park.

1. INTRODUCTION

The characteristic feature of the Suwałki region, formed by young, post glacial relief is amongst others a considerable number of areas within permanent (about 36% of the whole area) or periodically water outflow (28% of the whole area) with plenty of small water bodies. These water bodies with constant stagnant water occur on a substrate with low permeability, water is supplied mostly by atmospheric precipitation, and its loss by evaporation, although it cannot by excluded that in some water bodies water exchange has also the form underground of inflow and outflow. Periodically these water bodies are supplied also by surface runoff. Small water bodies are significant for water retention on the Suwałki Landscape Park (SLP) area and are a trap for matter exported by the watershed. The vegetation colonising them

may significantly assist these functions. In comparison to other communities, macrophytes produce a considerable amount of organic matter and cumulate great amounts of nutrients for long periods (D e n n y 1987).

Vegetation of small SLP water bodies had not been investigated before. The aim of this study was to determine to what extent the water bodies examined are overgrown by macrophytes and what ecological types of vegetation dominate in them. This would allow to determine the trophy of water bodies examined, main routes and cycling rate of elements there and the kind of water supply.

2. AREA AND METHODS

The studies were conducted in the years 1983 and 1984 in 21 small water bodies in the Suwałki Landscape Park and its protective zone (Fig. 1). The surface of these water bodies does not exceed 0.5 ha, and maximal depth 5.0 m (Table 1). The direct watershed of 40% water bodies examined are meadows and pastures, 20% arable land, and the remaining area is of a mixed land use (meadows, fields and forests).

The pH, electrolytic conductivity and organic matter content in sediments were analysed. Organic matter content was determined by combusting in a muffle furnace (R y b a k 1969).

The floristic analysis was conducted both within the basin and at the 5 m shore zone of each water body. A list was made of all species occurring in a given water bodies and its eulittoral, indicating the dominance structure in a 3-degree scale. Plants from deeper parts were sampled using a floristic anchor.

3. RESULTS

The water bodies examined have differed considerably as regards the environmental parameters analysed. Electrolytic conductivity fluctuated between 48 and 395 µS, pH between 4.0 and 8.0, whereas organic matter content in bottom sediments between 8.5 and 67.8% dry weight (Table 2). Water bodies with the lowest conductivity and pH occurred in a mixed forest-meadow watershed or with a distinct shrub margin, whereas water bodies with the highest parameters – among arable fields on much inclined slopes.

Among 21 water bodies analysed three (nos 8, 10, 19) did not have aquatic plants, nor helophytes on the shores. The shores up to the water level were pastures, meadows or fields. Other water bodies were overgrown by macrophytes a different degree from 15 to 95%, the majority of them being overgrown by macrophytes in about 50%.

The water bodies under investigations can be divided into 4 groups taking into consideration dominant ecological types of macrophytes colonising of water bodies.

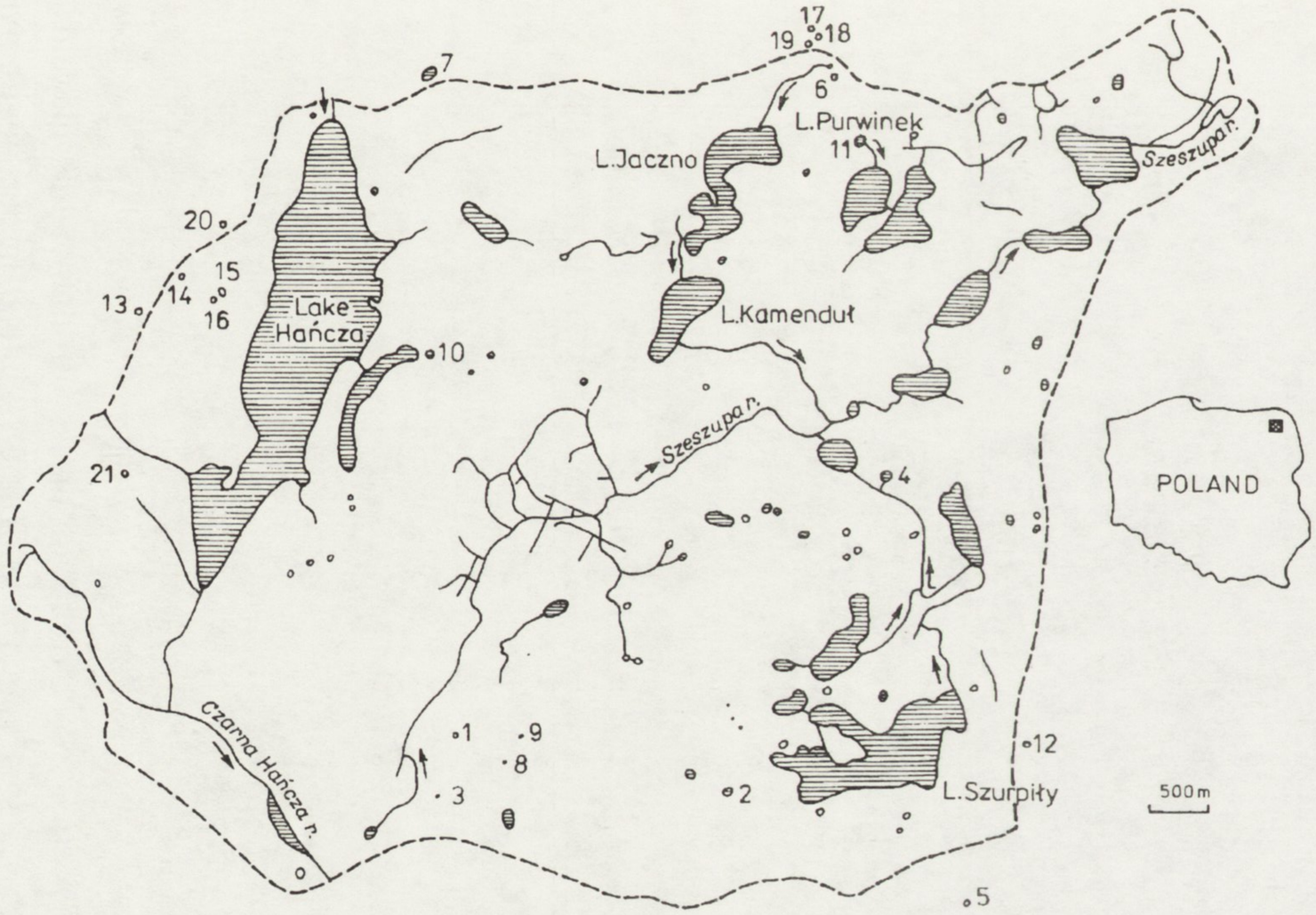

Fig. 1. Distribution of small water bodies in the Suwałki Landscape Park and its protective zone
1–21 number of water bodies investigated

Table 1. Surface and depth of 21 small water bodies in the Suwałki Landscape Park

No of water body	Surface (ha)	Depth (m)
1	0.13	1.5
2	0.40	0.8
3	0.20	0.5
4	0.50	5.0
5	0.13	0.5
6	0.13	0.8
7	0.45	1.0
8	0.07	0.5
9	0.07	0.7
10	0.02	0.2
11	0.39	4.0
12	0.05	0.8
13	0.04	0.5
14	0.04	0.5
15	0.05	1.5
16	0.03	0.6
17	0.02	0.5
18	0.02	0.5
19	0.01	0.5
20	0.01	0.5
21	0.01	0.5

The water bodies classified into I group are those with dominating elodeids (Tables 3–6) into II group – with pleustonic plants (Table 7), into III group – with nympheids (Table 8) and into IV group – with helophytes (Table 9). The most abundant was group I (9 water bodies), whereas other groups were represented by 2–4 water bodies. Eulittoral vegetation in the majority of water bodies was of fen type, whereas only in three – of raised bog type.

Vegetation of particular water bodies was usually dominated by one species, both among typical aquatic vegetation and that overgrowing the shores. The most differentiated vegetation was observed in the group of water bodies with the

Table 2. The pH, electrolytic conductivity of water and organic matter content in bottom sediments of small water bodies in Suwałki Landscape Park

No of water body	pH	Electrolytic conductivity (μS*)	Organic matter in bottom sediments (% in dry wt)
13	4.0	48	12.2
20	4.0	50	16.2
14	4.5	85	–
16	5.0	72	13.8
12	5.5	105	13.0
15	5.5	200	8.8
17	5.5	125	–
18	5.5	140	9.8
3	6.0	100	19.9
5	6.5	195	22.0
21	6.5	395	–
4	7.0	345	–
10	7.3	140	13.0
9	7.5	320	67.8
1	8.0	220	17.6

*Unpublished data of A. Kowalczewski.

dominance of submerged vegetation. Their greatest number was dominated by *Elodea canadensis* (Table 3) overgrowing the bottom in 50 to 90% (Table 3, Fig. 2C). The contribution of other aquatic plants was rather small. Littoral vegetation of these water bodies had a fen character of varying species abundance according to water body. Water bodies with the most differentiated aquatic vegetation also had the most differentiated shore vegetation.

In a water body *Chara fragilis* dominated (Table 4), overgrowing the bottom in 60–80%. Contribution of other aquatic plants was small. In reservoir No 5 littoral vegetation was very poor, only the single occurrence of *Sparganium ramosum* was recorded.

In one of the water bodies with submerged vegetation (No 7) *Fontinalis antipyretica* (Table 5) dominated forming a monospecies aggregation overgrowing 80% of the bottom. Shore vegetation was also poor, it was represented by three species among which *Acorus calamus* dominated.

Table 3. Taxonomic composition of macrophytes in small water bodies of *Elodea canadensis* type in the Suwałki Landscape Park

Taxon	No of water body					
	6	12	1	2	17	15
Submerged plants						
Elodea canadensis Rich.	+++	+++	+++	+++	+++	+++
Potamogeton rutilus Wolfg.	–	–	–	+	+	+
Utricularia vulgaris L.	–	–	–	–	+	+
Chara fragilis Desv.	–	–	–	–	+	–
Myriophyllum spicatum L.	–	–	–	–	–	+
Plants with floating leaves						
Lemna minor L.	–	–	–	+	+	+
Potamogeton natans L.	–	–	+	–	–	+
Hydrocharis morsus-ranae L.	–	–	–	–	+	–
Emergent plants						
Phragmites australis (Cav.) Trin. ex Steudel	+	–	–	–	–	–
Acarus calamus L.	–	+	+	–	–	–
Eleocharis palustris (L.) Roem. et Schult.	–	+	–	+	–	–
Eleocharis acicularis (L.) Roem. et Schult.	–	–	–	+	–	–
Glyceria fluitans R. Br.	–	–	–	+	–	–
Sparganium ramosum Huds.	–	–	–	++	+	+
Alisma plantago-aquatica L.	–	–	–	+	+	+
Equisetum palustre L.	–	–	–	+	+	+
Mentha aquatica L.	–	–	+	+	+	+
Myosotis palustris (L.) Nathorst.	–	–	–	+	+	+
Inula britannica L.	–	–	–	+	+	–
Comarum palustre L.	–	–	–	–	+	+
Oenanthe aquatica (L.) Poir	–	–	–	–	+	+
Bidens tripartitus L.	–	–	–	–	+	+
Carex sp.	–	–	–	–	+	+
Galium palustre L.	–	–	–	–	–	+
Menyanthes trifoliata L.	–	–	–	–	–	+
Hottonia palustris L.	–	–	–	–	–	+
Typha latifolia L.	–	–	+	–	–	+
Lysimachia nummularia L.	–	–	–	–	–	+

+++ dominants, ++ subdominants, + accompanying, – do not occur.

Fig. 2. Distribution of vegetation in water bodies of different floristic type
A–G are water bodies with fen; A_1, F_1 – are water bodies with bog

Table 4. Taxonomic composition of macrophytes in small water bodies of *Chara fragilis* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	Water body No 5
Submerged plants	
Chara fragilis Desv.	+++
Pleustonic plants	
Lemna minor L.	–
Lemna trisulca L.	+
Stratiotes aloides L.	+
Plants with floating leaves	
Nuphar lutea (L.) Sm.	–
Polygonum amphibium L.	–
Emergent plants	
Sphagnum sp.	–
Marchantia polymorpha L.	–
Oxyccocus quadripetalus Gilib.	–
Drosera rotundifolia L.	–
Menyanthes trifoliata L.	–
Epilobium hirsutum L.	–
Comarum palustre L.	–
Hippuris vulgaris L.	–
Carex sp.	–
Sparganium ramosum Huds.	+

Also only in one water body *Potamogeton rutilus* (Table 6, Fig. 2D) dominated. It overgrow 70% of the bottom. In the shore zone *Sparganium ramosum* dominated.

In the group of three water bodies, dominated by floating plants (pleustonic), *Lemna minor* (Table 7, Fig. 2E) dominated. It covered 50–70% of water surface, limiting significantly the penetration light and thus the occurrence of other aquatic plants. Sedge dominated on the shores.

The two water bodies with plants having floating leaves (nympheids) were also homogenous. *Nymphaea alba* and *Nuphar lutea* (Table 8, Fig. 2F) co-dominated. Other aquatic plants occurred sporadically. Nevertheless, these water bodies differed in the character of shore vegetation. In the water body No 11 it had the character of raised bog, whereas in water body No 4 – of fen, but with a very rich species composition.

Table 5. Taxonomic composition of macrophytes in a small water body of *Fontinalis antipyretica* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	Water body No 7
Submerged plant	
Fontinalis antipyretica Hedw.	+++
Plant with floating leaves	
Potamogeton natans L.	+
Emergent plants	
Acorus calamus L.	+++
Equisetum palustre L.	+
Carex sp.	+

Table 6. Species composition of macrophytes in small water body of *Potamogeton rutilus* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	Water body No 3
Submerged plant	
Potamogeton rutilus Wolfg.	+++
Plaustonic plants	
Lemna trisulca L.	+
Emergend plants	
Sparganium ramosum Huds.	+++
Acorus calamus L.	+

In the last group of four water bodies dominated by emergent vegetation *Comarum palustre* dominated (Table 9, Fig. 2G). This plant forms a dense net of aboveground shoots and rhizomes overgrowing the shore and water surface. Drepanocladus sp. and *Juncus effusus* were the most frequent and most abundant accompanying taxons. Community of shore vegetation and that growing in the water body do not differ in species composition.

Table 7. Taxonomic composition of macrophytes in small water bodies of *Lemna minor* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	No of water bodies		
	21	18	9
Pleustonic plants			
Lemna minor L.	+++	+++	+++
Spirodela polyrrhiza (L.) Schleid.	+	–	+
Submerged plants			
Utricularia vulgaris L.	+	+	+
Myriophyllum spicatum L.	+	–	–
Emergent plants			
Carex sp.	+++	+++	+
Typha latifolia L.	+	+	–
Epilobium hirsutum L.	+	+	–
Inula britannica L.	+	+	–
Rumex hydrolapathum Huds.	+	–	–
Alisma plantago-aquatica L.	–	+	+
Juncus effusus L.	–	+	–
Bidens tripartitus L.	–	+	–

Table 8. Taxonomic composition of macrophytes in small water bodies of *Numphaea alba* – *Nuphar lutea* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	No of water bodies	
	4	11
Plants with floating leaves		
Nymphaea alba L.	+++	+
Nuphar lutea (L.) Sm.	+	+++
Potamogeton natans L.	+	+
Nymphaea candida Presl.	–	–
Lemna minor L.	+	–
Hydrocharis morsus-ranae L.	+	–
Submerged plants		
Ceratophyllum demersum L.	+	–
Potamogeton acutifolius Link.	+	–
Elodea canadensis Rich.	–	–

Table 8, continued

Myriophyllum spicatum L.	–	–
Utricularia vulgaris L.	–	–
Stratiotes aloides L.	–	–
Emergent plants		
Glyceria sp.	+++	–
Typha latifolia L.	+	+
Phragmites australis (Cav.) Trin. ex Steudel.	+	–
Schoenoplectus lacustris (L.) Palla	+	–
Acorus calamus L.	+	–
Epilobium hirsutum L.	+	–
Rumex hydrolapathum Huds.	+	–
Sium latifolium L.	+	–
Equisetum palustre L.	+	–
Ranunculus lingua L.	+	–
Lysimachia vulgaris L.	+	–
Lysimachia nummularia L.	+	–
Caltha palustris L.	+	–
Galium palustre L.	+	–
Senecio paludosa L.	+	–
Solanum dulcamara L.	+	–
Hottonia palustris L.	+	–
Bidens tripartitus L.	+	–
Drepanocladus sp.	+	–
Marchantia polymorpha L.	+	–
Comarum palustre L.	+	–
Sphagnum sp.	+	+++
Oxyccocus quadripetalus Gilib.	–	+
Drosera rotundifolia L.	–	+
Andromeda polifolia L.	–	+
Menyanthes trifoliata L.	+	–
Calla palustris L.	–	–
Filipendula ulmaria (L.) Maxim.	–	–
Dryopteris telyptheris (L.) A. Gray	–	–
Lythrum salicaria L.	–	–
Oenanthe aquatica (L.) Poir	–	–
Cyperus sp.	–	–

Table 9. Taxonomic composition of macrophytes in small water bodies of *Comarum palustre* type in the Suwałki Landscape Park
Explanations see Table 3

Taxon	No of water bodies			
	20	13	14	16
Emergent plants				
Comarum palustre L.	+++	+++	+++	+++
Drepanocladus sp.	+	+	+	+
Juncus effusus L.	+	+	+	–
Hottonia palustris L.	+	–	+	–
Inula britannica L.	–	+	+	+
Galium palustre L.	–	+	–	+
Sparganium ramosum L.	–	+	+	+
Mentha aquatica L.	–	+	–	–
Equisetum palustre L.	–	–	+	+
Alisma plantago-aquatica L.	–	–	+	+
Epilobium hirsutum L.	–	–	+	+
Carex sp.	–	–	+	+
Lysimachia vulgaris L.	–	–	+	+
Plants with floating leaves				
Potamogeton natans L.	–	+	–	–
Emergent plants				
Utricularia vulgaris L.	–	+	–	–
Potamogeton rutilus Wolfg.	–	–	+	–
Calitriche verna L.	–	–	–	+

4. DISCUSSION

The SLP water bodies, despite a similar genesis, locality and in many cases of a similar type of drainage basin management, differ in water chemistry and also in the character of vegetation. Despite the similar age the overgrowth stages of water bodies vary. Whole spectrum has been recorded – from water bodies void of vegetation to such, where the bottom or water surface are almost entirely overgrown by macrophytes. These differences may be mainly due to way of utilisation, as some water bodies are used as watering places and the vegetation is damaged by animals, other are periodically dried up by a system of artificial ditches.

All water bodies with the lowest pH (not exceeding 5) and electrolytic conductivity (not exceeding 85 μS) have been dominated by *Comarum palustre*.

This confirms the literature data that this species prefers poor habitats (Podbielkowski and Tomaszewicz 1979). Thus *Comarum palustre* has a good indicatory value of trophy of water bodies. Averagely high organic matter content in bottom sediments is probably due to the production of this species of considerable amounts of hardly decomposing biomass and thus poorly fertilizing the water.

Water bodies dominated by different species of submerged plants were quite differentiated as regards environmental parameters from slighly acid to basic water reaction and electrolytic conductivity between 100 and 200 μS. As shown by literature data all species of this group of water bodies occur in a quite broad trophy spectrum (Dąmbska 1964, Kadono 1984, Denny 1987, Pip 1988) and thus are of little indicatory significance.

Similarly *Lemna minor*, representing the group of water bodies with pleustonic vegetation occurred in a broad pH and electrolytic conductivity range. As shown by Landolt (1984) this species has a broad amplitude as related towards different environmental factors. However, it achieves the best development in fertile and very fertile waters. The pleustonic plants use water as the only source of nutrients (apart from carbon), then at high plant biomass they may exhaust during a short period, e.g., the whole pool of phosphates (Culley and Epps 1973). In water bodies from this group over 90% of nutrients taken earlier return at the end of vegetation season to water and sediments. Nevertheless, a significant amount of up – taken nutrients (10–15%) remains accumulated for winter in wintering parts of plants.

Submerged plants dominant in the most numerous group of water bodies are capable of using as a source of nutrients both water and bottom sediments (Agami and Waisel 1986, Denny 1987). Because of phenological cycles the fate of nutrients accumulated in plants differ. And so, for example, *Chara fragilis* and *Fontinalis antipyretica*, most frequently wintering in the green form retain a large pool of nutrients also through the winter. But *Elodea canadensis*, which winters in shallow, freezing to the bottom water bodies, in the form of turions, retains only a slight part of nutrients for a longer period. The majority of them returns to water and bottom sediments at the end of vegetation season.

Analysing the character of vegetation colonising the shores of water bodies examined it was found that in the majority of cases there is the vegetation of fen type and in three cases of bog type. Character of shore vegetation may indicate the kind of water supply to a given water body. In the case of bog vegetation the water body should be expected to be supplied only by precipitation, i.e., it is a typical water body without outflow. In the case of dominance of fen vegetation, it should be expected that at least these water bodies are periodically supplied by underground waters and thus are only apparently without outflow.

Concluding, it can be said that aquatic vegetation colonizing a small water body itself may indicate the routes and cycling rate of nutrients and its trophic type. Vegetation growing on shores may be useful for indicating the type of water supply to a given water body.

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5. SUMMARY

A floristic analysis of 21 small water bodies (Table 1) in the Suwałki Landscape Park and its protective zone was conducted (Fig. 1). The floristic analysis was conducted both within the bed of each water body and in the shore zone. Furthermore, the pH was analysed, as well as electrolytic conductivity and organic matter content in bottom sediments (Table 2). In three water bodies there were not any aquatic plants, in other vegetation covered 15–95% of their area. Four groups of water bodies were distinguished: with dominance of elodeids (Tables 3–6), pleustonic plants (Table 7) plants with floating leaves (Table 8), and emergent macrophytes (Table 9). Among these four groups, seven groups of water bodies were distinguished with dominant species as follows: *Elodea canadensis* (Table 3, Fig. 2C), *Chara fragilis* (Table 4, Fig. 2A), *Fontinalis antipyretica* (Table 5, Fig. 2B), *Potamogeton rutilus* (Table 6, Fig. 2D), *Lemna minor* (Table 7, Fig. 2E), *Nymphaea alba – Nuphar lutea* (Table 8, Fig. 2F) and *Comarum palustre* (Table 9, Fig. 2G). Vegetation colonizing the shores of water bodies examined was mostly of fen type and only in two cases of bog type.

6. POLISH SUMMARY

Przeprowadzono analizę florystyczną 21 drobnych zbiorników wodnych (tab. 1), usytuowanych na terenie i w otulinie Suwalskiego Parku Krajorazowego (rys. 1). Analizę florystyczną przeprowadzono zarówno w obrębie niecki każdego zbiornika, jak i w pasie przybrzeżnym. Ponadto analizowano pH, przewodnictwo elektrolityczne wody i zawartość materii organicznej w osadach dennych (tab. 2). W trzech zbiornikach nie stwierdzono roślin wodnych, w pozostałych roślinność zajmowała od 15 do 95% ich powierzchni. Wyróżniono cztery grupy zbiorników: z dominacją elodeidów (tab. 3–6), roślin pływających (tab. 7), roślin o liściach pływających (tab. 8) i z dominacją makrofitów wynurzonych (tab. 9). Wśród tych czterech grup wyróżniono siedem grup zbiorników o dominacji następujących gatunków: *Elodea canadensis* (tab. 3, rys. 2C), *Chara fragilis* (tab. 4, rys. 2A), *Fontinalis antipyretica* (tab. 5, rys. 2B), *Potamogeton rutilus* (tab. 6, rys. 2D), *Lemna minor* (tab. 7, rys. 2E), *Nymphaea alba -- Nuphar lutea* (tab. 8, rys. 2F) i *Comarum palustre* (tab. 9, rys. 2G). Roślinność zasiedlająca brzegi badanych zbiorników była w większości przypadków typu torfowisk niskich, zaś w dwóch przypadkach typu torfowisk wysokich.

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