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The state of plant conservation in small water bodies located within the city limits of Olsztyn

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Abstract

The interior depressions in the Olsztyn area are characterized by high biodiversity. On the basis of floral surveys of 32 small water bodies, 200 species of vascular plants and 10 species of bryophytes were recorded. Phytosociological analysis indicated 45 plant associations. Among the phytocoenoses described, some communities require more attention, including *Wolffietum arrhizae*, *Riccietum fluitantis*, *Charetum fragilis*, the pondweeds *Potametum nitentis* and *P. compressi* as well as communities with *Potamogeton trichoides* and *P. pusillus*.

In light of their significant natural value, some of the basins studied units should be protected as ecological grounds. Reservoirs located in the Jaroty District, in the vicinity of Lake Track or some reservoirs located within the Gutkowo and Kortowo districts are important points of peat-water or water accumulation. These small water bodies limit the nutrient and pollutant input into the numerous lakes located in the Olsztyn area. Some basins are of a recreational character, including the reservoir located in the central quarter of the town and the water bodies of the Kortowo District. The remaining reservoirs need restoration and litter collection to restore their recreational functions.

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INTRODUCTION

The urban agglomeration of Olsztyn is located in the zone of a basal moraine of the latest glaciation. Numerous interior depressions are a specific feature of that Young Glacial landscape; some of the depressions are constantly or periodically, due to the natural configuration of the surface and an impermeable substratum, capable of water storage. This kind of water bodies is characterized by high fluctuation of water level that delimits their area. These forms are usually of glacial origin. The analysis of topographic maps of Olsztyn showed the existence of 60 interior depressions that gives a density index of 0.68 units km⁻². The role of small basins and marshy grounds within the limits of Olsztyn is significant due to their ability to increase local water retention, for economic functions, and to create ecological corridors.

The professional literature provides scant information on vascular plants typical of small water bodies (Roll 1940; Solińska 1963; Podbielkowski 1968; Bolmier 1993; Koc 1994a,b,c,d; Ozimek and Rybak 1993; Paczuska and Paczusi 1997; Ciecierska 2002; Grzybowski and Słabuszewska 2006), and small ponds found in the urban landscape arouse even less interest among researchers. (Gawrońska at al. 1994a,b; Ciecierska 2002; Endler and Grzybowski 2002; Grzybowski and Słabuszewska 2006).

MATERIALS AND METHODS

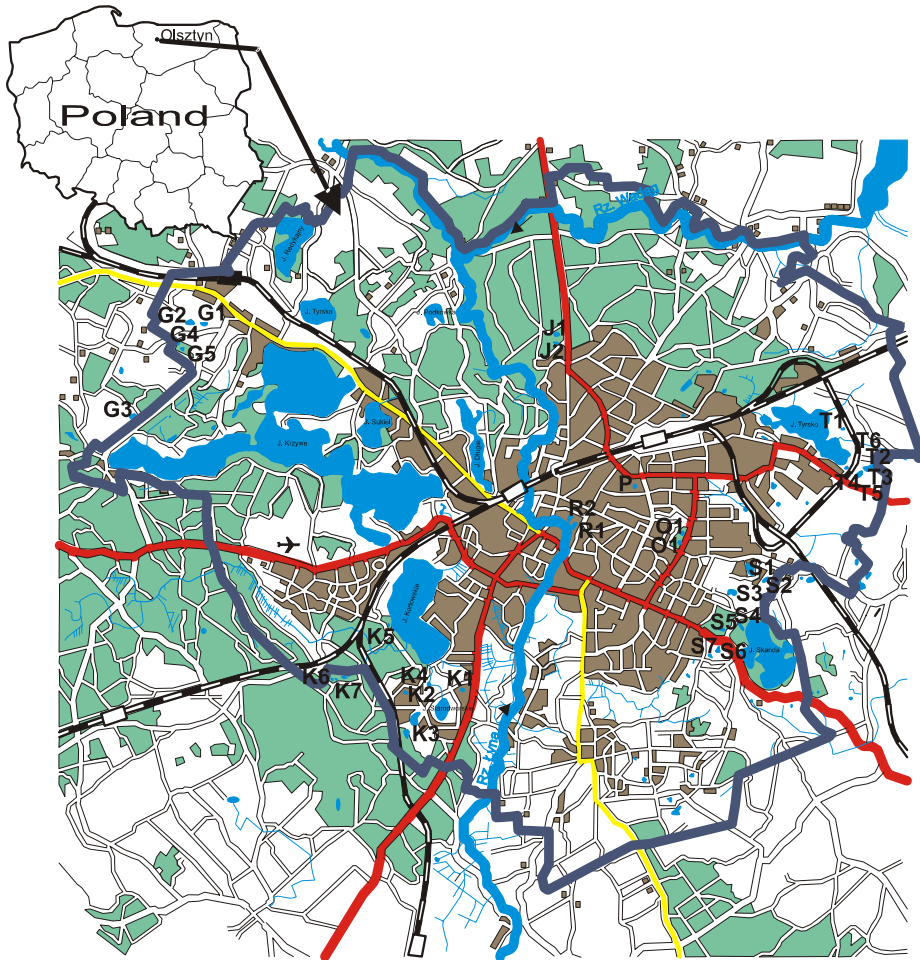
The analysis of vegetation of urban, interior basins within the city limits of Olsztyn was based on 32 reservoirs representing all types of plant cover (Fig. 1). Field studies were carried out in 2005–2006.

The studied water bodies are usually small and shallow (Table 1), of a pond-like character; two of them are typical, astatic reservoirs. All basins are located on areas undergoing economic use. The number of analyzed water bodies and instability of their waters resulted in a wide range of recorded values of physicochemical parameters (Table 2) that, in turn, depend on seasonal changes of water level in the particular reservoirs.

The nomenclature of vascular plants was adopted according to Rutkowski (2004). The names of bryophyte species were given according to *Die Moos – und Farnpflanzen Europas* (Frey and Frahm 1995).

The remaining syntactic units were adopted according to the common nomenclature of Matuszkiewicz (2001).

The vegetation of 32 small water bodies was compared in the study of small water bodies located within the city limits of Olsztyn using the *Statistica 7.1* program and the *Complete Link* method that belongs to the hierarchic agglomeration methods group. The Euclidian measure was used to calculate the



K1-7, G1-5, J1-2, O1-2, P, R1-2, S1-6, T1-6 - SMALL WATER-BODIES

Fig.1. Location of inland water bodies in the city of Olsztyn.

matrix of distances between sites. The result of the analysis are hierarchic trees of clusters and similarity dendrograms graphically showing the significance of similarities between the phytoceonoses of small water bodies located within the city limits of Olsztyn.

Table 1

Morphometry of the small water bodies in the city of Olsztyn (Ciecierska 2002, Gawrońska et al. 1994a).

	Small water bodies	Water surface (ha)	Depth Max. (m)	Max. length (m)	Max. width (m)	Shoreline length (m)	Shoreline complexity (m ha ⁻¹)	Visibility (m)
1.	Skanda S ₁	0.08	1.0	50	20	130	1625	0.5
2.	Skanda S ₂	0.06	0.6	40	20	100	1660	0.4
3.	Skanda S ₃	0.08	2.0	45	20	120	1500	1.1
4.	Skanda S ₄	0.10	3.7	40	30	150	1500	1.6
5.	Skanda S ₅	0.45	3.5	100	50	250	556	0.8
6.	Skanda S ₆	0.20	3.0	50	45	130	650	1.6
7.	Skanda S ₇	1.50	1.0	300	130	100	667	0.7
8.	OZOS O ₁	0.40	1.0	75	50	300	750	1.0
9.	OZOS O ₂	1.50	1.5	250	100	700	467	0.4
10.	Track T ₁	0.20	1.7	70	40	230	1150	1.0
11.	Track T ₂	1.50	1.7	250	100	600	400	1.2
12.	Track T ₃	1.40	1.0	300	110	800	571	1.0
13.	Track T ₄	0.20	0.2	70	40	250	1250	0.2
14.	Track T ₅	1.90	1.8	300	110	800	264	0.4
15.	Track T ₆	1.00	0.3	200	100	500	500	0.3
16.	Relaks R ₁	0.30	2.0	150	25	350	1167	0.7
17.	Relaks R ₂	0.40	1.0	250	7	400	1000	1.0
18.	Kusociński Park P	0.20	0.7	70	30	170	850	0.4
19.	Jakubowo J ₁	1.00	1.5	150	70	400	400	0.6
20.	Jakubowo J ₂	0.40	3.5	70	60	220	550	0.7
21.	Kortowo K ₁	0.8	5	l.d.	l.d.	l.d.	l.d.	0.5
22.	Kortowo K ₂	1.1	1.1	l.d.	l.d.	l.d.	l.d.	0.5
23.	Kortowo K ₃	1.8	2.5	l.d.	l.d.	l.d.	l.d.	1.5
24.	Kortowo K ₄	3.5	3.0	l.d.	l.d.	l.d.	l.d.	1.0
25.	Kortowo K ₅	0.12	1.0	l.d.	l.d.	l.d.	l.d.	0.7
26.	Kortowo K ₆	2.2	l.d.	l.d.	l.d.	l.d.	l.d.	l.d.
27.	Kortowo K ₇	1.8	l.d.	l.d.	l.d.	l.d.	l.d.	l.d.
28.	Gutkowo G ₁	0.10	1.0	l.d.	l.d.	l.d.	l.d.	l.d.
29.	Gutkowo G ₂	0.14	l.d.	l.d.	l.d.	l.d.	l.d.	l.d.
30.	Gutkowo G ₃	0.10	l.d.	l.d.	l.d.	l.d.	l.d.	l.d.
31.	Gutkowo G ₄	0.05	0.5	l.d.	l.d.	l.d.	l.d.	l.d.
32.	Gutkowo G ₅	0.65	l.d.	l.d.	l.d.	l.d.	l.d.	l.d.

l.d. – lack of data

RESULTS AND DISCUSSION

The direct surroundings of the studied reservoirs are largely affected by anthropogenic pressure. The buffer zone of the reservoirs is usually composed of semi-natural meadows of *Molinio-Arrhenatheretea*, anthropogenic communities of trodden areas of the Plantaginetales order and nitrophilous hovels of *Artemisietea* and *Chenopodietea* communities. Remains of forest communities and segetal vegetation of the *Secalietea* class were also recorded. Osier hedges (willow shrubs) with *Salicetum pentandro-cinereae*, constituting a natural barrier against nutrient input into the reservoirs, were often recorded in

Table 2

Physicochemical indicators of small water bodies in the city of Olsztyn (Gawrońska at al. 1994).

Parameters	unit	mean	min.	max.
Temperature	°C	18.13	1.8	25.7
Color of water	mg Pt dm ⁻³	77.84	30	320
Reaction	PH	7.53	5.73	9.63
Oxygen	mg O ₂ dm ⁻³	7.56	0.3	17.3
BOD ₅	mg O ₂ dm ⁻³	5.27	1.4	25.6
Oxidizability	mg O ₂ dm ⁻³	34.81	16	75.2
Carbon dioxide	mg CO ₂ dm ⁻³	14.80	3	59
Chlorides	mg Cl dm ⁻³	33.95	4	290
Manganese	mg Mn dm ⁻³	0.47	0.02	2.43
Iron	mg Fe dm ⁻³	4.60	0.12	157
Alkalinity	mval dm ⁻³	2.48	0.3	6.4
Hardness	°n	9.96	1	30.8
Calcium	mg Ca dm ⁻³	56.60	5	168.5
Magnesium	mg Mg dm ⁻³	8.20	0.8	28.8
Ammonium nitrogen	mg N dm ⁻³	0.15	0.002	1.98
Nitrite nitrogen	mg N dm ⁻³	0.01	0.003	0.03
Nitrate nitrogen	mg N dm ⁻³	0.22	0.02	0.48
Total nitrogen	mg N dm ⁻³	2.79	1.15	9.52
Phosphate phosphorus	mg P dm ⁻³	0.17	0.01	1.13
Organic phosphorus	mg P dm ⁻³	0.18	0.03	0.84
Total phosphorus	mg P dm ⁻³	0.36	0.08	1.55
Chlorophyll	µg dm ⁻³	20.40	0.7	142.6

small basins in the western part of Olsztyn and scarcely appeared in the eastern part of the town.

Interior depressions in the area of Olsztyn show high biodiversity. On the basis of the results of floral surveys of 32 small water bodies, 200 species of vascular plants and 10 species of bryophytes were recorded (Grzybowski and Słabuszewska 2006). Phytosociological analysis indicated 45 plant associations: 41 of them were recognized as an association and four as a community (Table 3). Five of all the analyzed associations were classified as pleustophytes within the *Lemnetea minoris* class. *Charophyte* beds were represented by a single association of the class *Charetea*. Aquatic communities representing the *Potametea* class included 14 syntaxa within which the submerged vegetation of

Tab 3

Tab 3

the *Potamion* alliance constituted nine of the total number and plants with floating leaves – five. Rush vegetation was represented by 21 *Phragmitetea* associations among which the proper rush of the *Phragmition* alliance constituted 1, *Carex* rush of the *Magnocaricion* alliance – 9 and manna grass rush of the *Sparganio-Glycerion fluitantis* alliance – 1. Moreover, the occurrence of herbal plants growing on reservoirs banks, i.e., *Molinio-Arrhenatheretea* – 2 associations and a single association of salicaceous hope of the *Alnetea glutinosae* class were recorded. Among the phytocoenoses described, some communities require more attention including *Wolffietum arrhizae*, *Ricciatum fluitantis*, and *Charetum fragilis*, and among pondweeds *Potametum nitentis* and *P. compressi* as well as communities of *Potamogeton trichoides* and *P. pusillus*.

The distribution of vegetation in the majority of the analyzed water bodies show distinct zonality that is usually observed in large bodies of water (lakes) and quite rare in small, shallow ones. In the studied water bodies, except for four small bodies of water, vegetation covers their entire surface. All of them may be classified as eutrophic or polytrophic waters, which is confirmed by the presence of plant communities typical of such habitats. All phytocenoses that developed in the examined water bodies benefit from the inflow of nutrients and thus usually occupy more fertile habitats. Pleustonic plants are rather numerous, although they do not play an important role in the process of waters becoming shallow. These plants can be found in nutrient-reach, eutrophic water bodies. Among the 32 analyzed small bodies of water, pleustonic plants were recorded in 19 (Table 3). An elodeid zone, the presence of which can indicate an early stage of the process of overgrowing with plants, does not occur in eleven small water bodies within the city limits of Olsztyn. Phytocenoses of rigid hornwort, *Ceratophylletum demersi*, soft hornwort, *Ceratophylletum submersi*, fennel pondweed, *Potamogetonum pectinati*, shining pondweed, *P. lucentis*, and Canadian pondweed *Elodeetum canadensis*, which grow in eutrophic or even polytrophic waters, cover a high proportion of this zone (Sculthorpe 1985, Tomaszewicz and Kłosowski 1990). The nympeid zone is represented primarily by the assemblage of curly pondweed *Polygonetum natantis* (Table 3). The occurrence of this species as well as other members of the genus *Potamogeton* (*P. trichoides*, *P. pusillus*) indicates the existence of eutrophic habitats in the water bodies studied (Preston 1995).

Rushes and sedges developed excellently in all of the water bodies studied. The rush communities were dominated by phytocenoses of water manna grass, *Glycerietum maximae*, common reed, *Phragmiteteum*, and common cattail, *Typhetum latifoliae*, while the sedge communities were dominated by phytocenoses of acute sedge, *Caricetum gracilis*, blister sedge, *Caricetum vesicariae*, and reed Canary-grass, *Phalaridetum arundinaceae*. According to

Solińska (1963), communities of tall sedges occupy bodies of water at an advanced stage of overgrowing (compare S_2). Due to its typically astatic character (periodic drying-out), water body S_2 has been overgrown with vegetation to the highest degree. Phytocenoses of bulrush, *Scirpetum silvatici*, which develop in periodically flooded sites, have also contributed greatly to the formation of vegetation cover. The last stage of water becoming shallow in land depressions without outlets is their overgrowing with willow (*Salix cinerea*) thickets, which add variety to the landscape.

Due to increasing environment eutrophication, natural succession in the studied type of water bodies is greatly disturbed (Borysiak and Ratyńska 1984). The dynamics of biocenotic changes in the studied reservoirs is more pronounced than in lakes (Lampert and Sommer 1996). The rate of vegetation is usually higher in small basins as they warm much earlier than do large, deep reservoirs. The development of biocenotic structures of basins without drainage located within urban areas depends on anthropogenic conditions including the spatial structure formed by habitat and transportation functions, service, and industrial sectors with highly-developed infrastructure.

Dendrogram analysis (Fig. 2) as well as that of aquatic and rush plants in 32 inland water bodies in Olsztyn (Table 3) revealed the highest biocenotic diversity was in the water bodies situated in the Kortowo quarter as well as of single water bodies located in the Gutkowo quarter and in the vicinity of Lake Skanda, which are subjected to the lowest industrial pressure of the city center.

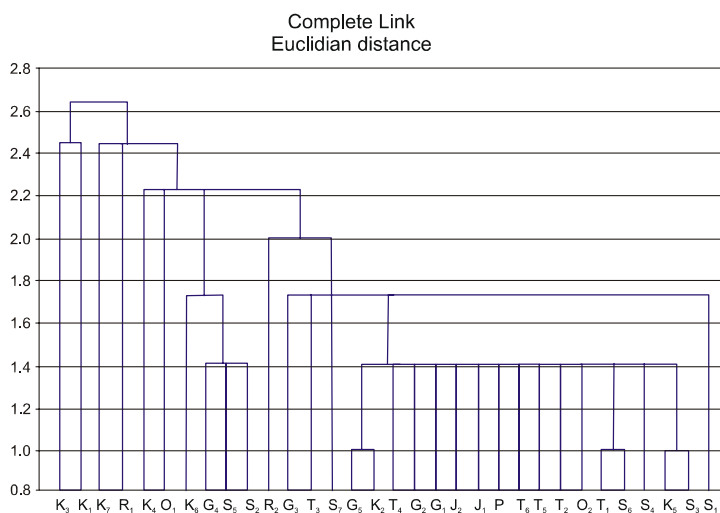


Fig. 2. Dendrogram of similarity between the communities of the small water bodies studied in the city of Olsztyn.

CONCLUSIONS

In light of their significant natural value, some of the studied water bodies should be protected as ecological grounds (K₃). Reservoirs located in the Jaroty District, in the vicinity of Lake Track, and some reservoirs located within the Gutkowo (G₃) and Kortowo districts are important points of peat-water or water accumulation. These small water bodies limit the nutrient and pollutant input into numerous lakes located in the Olsztyn area. Some water bodies are of a recreational character, including the reservoir located in the central quarter of the town and the water bodies of the Kortowo District. The remaining reservoirs need restoration and litter collection to restore their recreational functions.

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