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FLORISTIC DIVERSITY OF FISH PONDS IN SOSNOWICA REGION

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Abstract. The aim of study was to evaluate the richness and distribution of the aquatic macrophytes in ponds. . Studies were carried out in July 2013 and July 2014 on the six largest and oldest ponds (functioning since the First World War) in the Łęczna-Włodawa Lake District – Sosnowica ponds. Studies have shown that despite the fishing use of ponds, they can provide valuable habitat for aquatic plants biodiversity. Distribution of plants in the ponds was typical mosaic. Phytolittoral often developed from one bank to another. Macrophyte beds occupied a significantly large percentage of the studied pond areas. Emergent macrophytes were dominant group of macrophytes in investigated ponds.

Key words: IVI index, macrophytes, ponds, biomass, cover with macrophytes

INTRODUCTION

Fishponds are man-made ecosystems built primarily for fish-breeding purposes. However, these ponds often provide much needed refuge for rare plant and animal species who's habitats have been altered or destroyed. In addition to their ecological roles, fishponds can also serves as water retention basins and mitigate the negative impacts of flooding [Guziur *et al*. 2003, Della Bella *et al*. 2008].

Fishponds are shallow water bodies of varied area that are regulated by hydrological systems throughout the year. Ponds are characterized by a significant buffer capacity and can considerably purify enriched waters from outside sources [Bieniarz *et al*. 2003, Wróbel 2003].

Maintaining balance of ecological processes is essential to preserving ecosystem fiction, services, and production provided by these ponds. Can these aquatic ecosystems that were built for human use and economic gain also provide valuable habitats for plants and animals? Assessing macrophyte communities in such ponds may provide insight to this question. Macrophytes fulfil various ecological functions in these ecosystems, are good indicators of ecosystem health, and are relatively easy to study.

In the Łęczna-Włodawa Lake District exist several pond complexes one of which is the Sosnowica complex. These pond complexes have been altered for harboring and breeding carp. From an economic standpoint, eutrophication is beneficial as it stimulates the growth of organisms that serve as the base of the food chain for fish.

Studies were conducted on the six largest and oldest ponds (functioning since the First World War) in the Łęczna-Włodawa Lake District, Sosnowica ponds. The aim of study was to evaluate the richness and distribution of the aquatic macrophytes in ponds. The ponds were all located within the border areas of protected natural areas (in the Natura 2000 protected area The Forest of Parczew PLB060006 (51°40'N; 23°10'W). Physical, chemical, morphological, and macrophyte data were collected.

MATERIAL AND METHODS

Aquatic macrophyte occurrence within each pond was exhaustively surveyed by using a boat, wading, and using a floral anchor and rake and the Lowrance Elite – 5 sonar. Studies were carried out in July 2013 and July 2014. We recorded all species among 4 groups of macrophytes (emergent, floating-leaved, submerged and flood-meadow taxa). Nomenclature for aquatic macrophytes followed Matuszkiewicz [2008]. In each pond we established horizontal research transects, that extending from the shore to the maximum range of macrophytes occurrence. The number of transects depended on the size of the pond and ranged from 7 (Strategiczny pond) to 21 (Anielski pond). Total macrophyte richness was calculated as the sum of emergent, floating-leaved, and submerged macrophytes. Free – floating macrophytes were classified as floating-leaved plants.

All emergend macrophytes were counted and then collected from a 0.5 m^2 frame to determine species density, frequency, richness and measure biomass. Submerged macrophytes were sampled using the floral rake (with sampling area 0.16 m^2). Plants sampled were collected at a depth of 0.5 m, 0.7 m, and 1 m. On this basis, the qualitative composition, frequency, and macrophyte biomass was determined. The importance value index (IVI) was determined for each species in each studied pond [Dangol and Shivakoti 2001].

Total macrophyte richness in the present study was calculated as the sum of number of emergent, floating-leaved and submerged macrophytes. Free – floating macrophytes were classified as floating-leaved plants.

The pond and phytolittoral surface and the length of the shoreline inhabited by macrophytes were based on the method of retrospective photointerpretative analysis using aerial photographs taken in 2014, as well as satellite images from

Rapid Eye taken in 2014. The photographs were converted to the form of an orthophotomap (pixel 0.5 m). Maps of actual structure of macrophyte cover in the riparian zone was made in an environment of GIS software.

The study ponds were characterised using variables describing morphology, water chemistry. Conductivity, pH and dissolved oxygen were recorded by field meters. Water samples were analyses for:

– total nitrate and ammonia nitrogen – spectrophotometer PC Aqualytic,

– pH, conductivity (K) – microcomputer analyzer Multi-340i WTW.

Biomass differences in particular ponds was calculated using t-test.

RESULTS AND DISCUSSION

Investigated Sosnowica ponds were located within one pond complex (GPS location 51˚31'54"N, 23˚5'47"E). They all were shallow with different area and capacity (Table 1). The three largest ponds do not loose water completely at any point throughout the year. The rest of studied ponds were temporary having shorter wet-phase duration < 200 days.

Table 1. Hydraulic parameters of ponds

Pond	Total area ha	SD m	Water area ha	Mean depth, m	Capacity m^3	Power supply
Hetman	90	0.7	54.5	1.0	530	permanent
Anielski	83	0.7	44.7	1.0	440	permanent
Kłoda	64	1	31.6	0.8	248	permanent
Jedlina	41.5	0.9	30.4	1.2	360	temporal
Renta	15.5	0.4	13.3	0.9	117	temporal
Strategiczny	3.3	0.5	3.2	0.5	100	temporal

The water of Sosnowica ponds was always alkaline and changes in pH were small. Conductivity was low and typical for lakes (200–400 μs cm^{-2}). TSI Carlson' index values were described for eutrophic waters in all ponds (N and P above 1 mg dm^{-3}). Surface water was characterized by very low levels of ammonia and azotes nitrogen and sulphates and chlorides. Nutrients content differ slightly among ponds (Table 2), differences were not statistically significant.

Distribution of plants in the ponds was typical mosaic. Phytolittoral zones often developed from one bank to another. Different growth forms of macrophytes were found: submerged, helophytes, floating, and flood-meadow taxa. The most abundant aquatic plant species found in Sosnowickie ponds were flood-meadow species. They represented up to 67% of aquatic species of some ponds (ponds Anielski and Kłoda). They covered the shallowest zones of ponds and partially covered dikes. In total, 59 species of macrophytes occurred in the studied complex. Species from The Red List of Poland [Kaźmierczakowa *et al*. 2011] were present in investigated ponds (among others *Nuphar lutea*, *Nymphea alba*).

Table 2. Some phisical and chemical paramiters In surface water of ponds in 2014

Pond	pH	Conductivity $\mu S \cdot cm^{-1}$	% O_2	$N\text{-}NH_4$ $mg \cdot dm^{-3}$	NO_3 $mg \cdot dm^{-3}$	N $mg \cdot dm^{-3}$	SO_4 $mg \cdot dm^{-3}$	Cl $mg \cdot dm^{-3}$	TSI
Hetman	7.5	389	7	0.45	0.46	1.4	25	18	62.22
Anielski	8.0	209	9.5	0.09	0.65	0.5	30	16	54.79
Kłoda	7.2	237	21.2	0.11	0.48	0.9	32	14	56.46
Jedlina	7.7	276	19.5	0.16	0.51	0.7	43	11	54.30
Renta	7.4	302	33	0.06	0.61	0.9	69	4	63.07
Strategiczny	7.3	220	12.5	0.08	0.60	0.6	21	12	58.53

There were different numbers of species comprising the phytolittoral zone in the ponds investigated. The total number of species in particular ponds ranged from 37 in Kłoda pond to 15 Renta pond. Submerged macrophytes comprised the poorest group, representing only 6 species. The highest diversity of submerged macrophytes as well as floating-leaf species were found in Renta pond (Fig. 1).

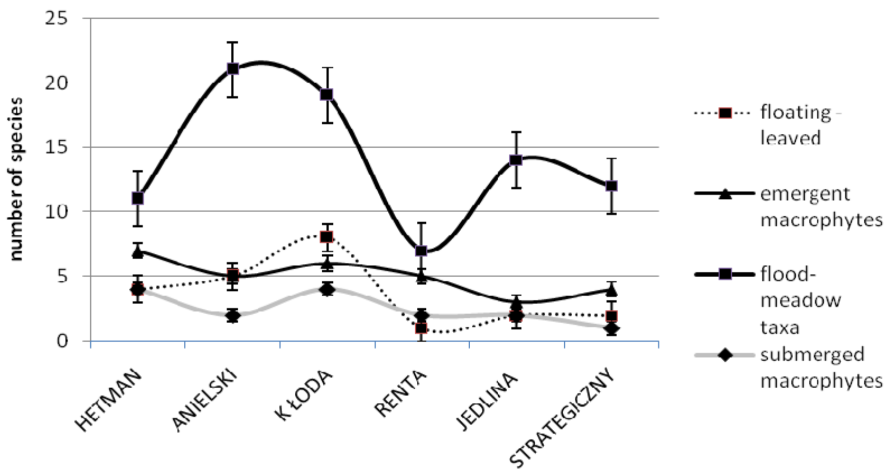

Fig. 1. Number of plant species in ponds

Macrophyte IVI

According to IVI values *Phragmites australis* (80,54) and *Typha angustifolia* (69,16) dominants ponds due to their higher relative density, relative frequency, and relative dominance value. *P. australis* and *T. angustifolis* were observed in all investigated ponds. Among flood-meadow taxa *Phalaris arundinacea* (33,7) was found to be the dominant species. IVI values were rather low for all submerged and floating-leaved macrophytes. *Potamogeton pectinatus* and *P. crispus* were observed in almost all ponds but index values were low and ranged from 64,5 to 2,4 (Table 3).

Table 3. Species composition with important value index (IVI)

Plant species	Pond					
	Hetman	Anielski	Kłoda	Renta	Jedlina	Strategiczny
Submerged macrophytes						
Stratiotes aloides	5.3					
Fontinalis antipyretica	10.9					
Potamogeton pectinatus		64.5	36.8	23.4		28.4
Ceratophyllum demersum			49			
Potamogeton crispus	5.1		8.2	30.6	25.3	
Potamogeton natans			5.3			
Elodea canadensis	4.8	4.4	3.9		29.3	
Floating macrophytes						
Nymphea alba	34.7	5.8	23.6			
Lemna trisulca	35.3	41.5	32.2		13.7	12.4
Spirodela polyrrhiza	57.1		16.4			2.7
Lemna minor		45.5	30.4		6.1	
Hydrocharis morsus-ranae		33.5	23.1			
Nuphar lutea			1			
Nymphoides peltata		3.3				
Polygonum amphibium	3.4		5.3			
Eemergent macrophytes						
Phragmites australis	99.5	71.2	79.2	85.5	67.3	58.9
Typha angustifolia	80.8	81.1	64.4	65.2	54.3	44.4
Acorus calamus	8.5					
Alisma plantago-aquatica	10.9	19.9			5.6	
Sparganium emersum	19.4		18.3	15.7		
Sagittaria sagitifolia	5.4		42.4		4.4	
Schoenoplectus lacustris		6.1		5.7	11.3	
Glyceria aquatica		16.5				3.5
Thelypteris palustris			18.7	31.3		
Eleocharis palustris	4.9		5.7		3.9	15.6
Flood-meadow taxa						
Agrostis stolonifera				11.9	9.9	21.9
Bidens tripartita	17.3	5.6	4.8	17.3	3.9	5.2
Caltha palustris	5.7				6.1	
Carex acutiformis		10.3				
Carex gracilis			6.2			
Carex rostrata			7.3			
Chelidonium majus		4.6				11.2
Oeante aquatica		4.3				42.5
Eupatorium cannabinum					11.7	
Epilobium hirsutum	5.3	5.5	6.4			
Filipendula ulmaria		4.8				
Galium palustre		17.3				
Iris pseudoacorus	5.8	7.9	8.1		3.6	3.8
Juncus articulatus	5.6	4.9	5.6			
Juncus effusus	4.4		4.7			
Juncus inflexus		12.3				2.2
Lycopus europaeus		19.3	8.4			

Lythrum salicaria		20.1				
Myostis palustris	5.9		6.7			
Phalaris arundinacea	31.3	28.6	26.3		48.7	31.3
Polygonum persicarie				4.4		23.9
Potentilla anserina		4.8			12.3	4.1
Rorippa palustris				7.3	6.3	
Rumex hydrolapathum		6.8	5.6			
Salix aurita			19.1			
Salix cinerea			25.6		19.8	
Salix pentandra			6.4		7.5	
Scirpus sylvaticus		22.3				
Solanum dulcamara		14.5	17.8		21.1	4.9
Symphytum officinale			5.8			
Urtica dioica		21.3				5.1
Plantago maior	3.3	4.5	4.2	5.2	5.7	5.9
Lolium perenne	9.9	9.2	10.2	17.1	14.2	5.1
Elymus repens	4.2	4.1	5.8	3.2	5.7	

Phytolittoral surface in investigated ponds was strongly differentiated. Macrophyte beds occupied a significantly large percentage of the studied pond areas. Coverage higher than 50% was very common. Only in two studied ponds, Jedlina and Renta, macrophytes covered less than 20% (Fig. 2).

In all investigated ponds emergent macrophytes prevailed and covered an area from 1.02 ha to 55.72 ha. In most of the ponds, especially large ones (>60 ha) originally embanked areas have shallowness average of 2 ha.These were likely cause by the decrease in lake surface reflectivity as well as succession of the plant community. These places are mostly overgrown with rushes with a large share of shrub communities. The share of plants with floating leaves and submerged was especially low in the small ponds subjected to dredging (Fig. 3).

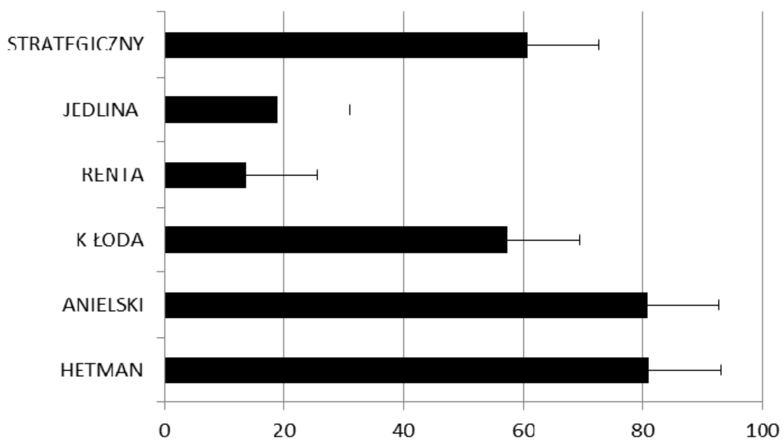

Fig. 2. Percentage coverage of pond’s surface

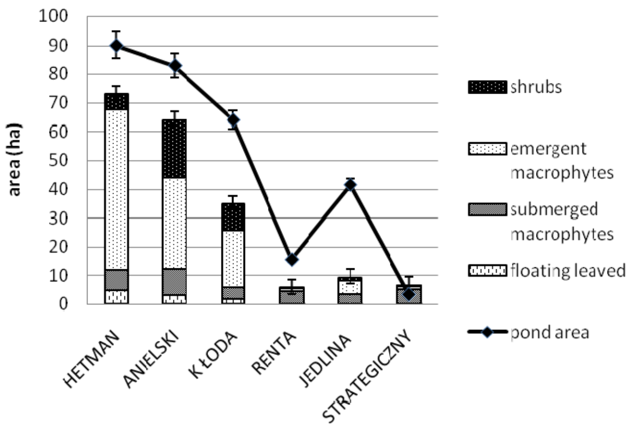

Fig. 3. Pond area covered by various group of macrophytes

Total biomass of macrophytes covering pond surface was significantly different especially between big, persistently wet ponds and small, temporary ones ($F_{1,12} = 8.99$, $p < 0.007$). Plant biomass was higher in big and persistently wet (Fig. 4). In eutrophic lakes (Kunów, Firlej) from Polesie Region total biomass was higher and ranged from 0.75 t per ha to 1.04 t per ha respectively [Sender 2012].

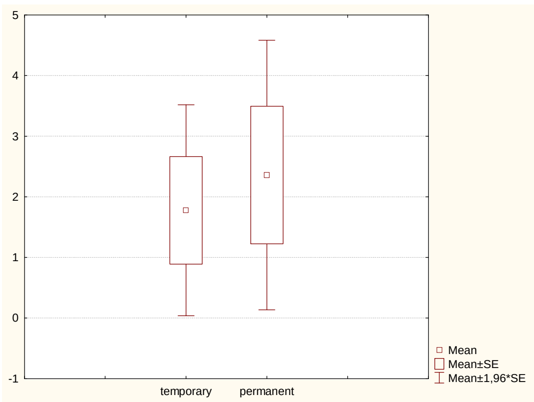

Fig 4. Macrophyte biomass (t_{DW}/ha) in two types of ponds

Submerged and floating-leaved macrophytes in ponds had very low biomass, especially in large, persistently wet ponds. Most of the biomass in big ponds was comprised of emergent macrophytes, but in small submerged ones (Fig. 5). Plant biomass differed strongly among plant vegetation types (Anova: $F_{2,16} = 27.14$ $P < 0,001$).

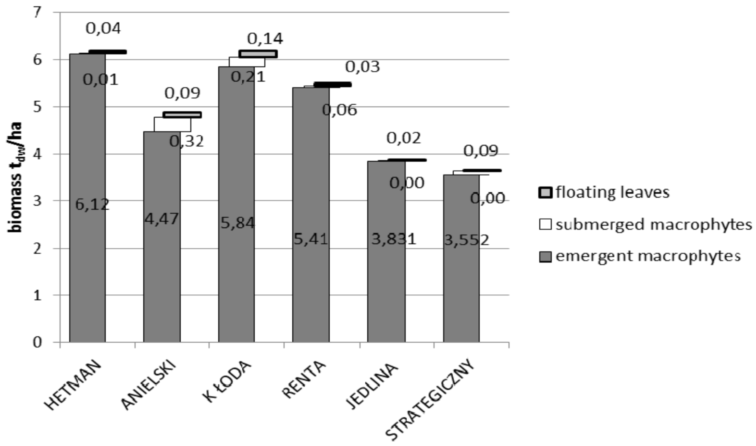

Fig 5. Biomass of all groups of macrophytes in ponds (t $_{DW}$/ha)

Biomass of emergent macrophytes was higher in investigated ponds than in shallow, very hihgly eutrophic lakes (Syczyńskie) or dystrophic lakes (Święte, Orchowe), but was lower than in slightly or eutrophic lakes (Lipieniec, Czarne Sosnowickie) from Polesie Lubelskie region [Sender 2015].

This study showed that ponds are valuable habitat for wetland plant biodiversity. In 6 of the studied ponds there were 44 species (mean species per pond 10). In a study of lowland ponds of Great Britain the recorded mean was found to be 6 species in temporary ponds and 11 species in permanent ones [Williams *et al*. 1998], and 9 species were average in ponds from central Italy [Della Bella *et al*. 2008]).

The overall study revealed only two species *Phragmites australis* and *Typha angustifolia* had IVI values more than 50 and they may be considered dominant in these ponds. Among submerged macrophytes, *Potamogeton pectinatus* was found to have the highest IVI values. The remaining aquatic plants present had low poor IVI values of less than 50. In could means that physical and environmental conditions were not getting suitable [Malik and Namdeo 2010].

CONCLUSIONS

Studies have shown that despite the fishing use of ponds, they can provide valuable habitat for aquatic plants biodiversity. Distribution of plants in the ponds was typical mosaic. Phytolittoral often developed from one bank to another. Macrophyte beds occupied a significantly large percentage of the studied pond areas. Emergent macrophytes were dominant group of macrophytes in investigated ponds.

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RÓŻNORODNOŚĆ FLORYSTYCZNA STAWÓW RYBNYCH W SOSNOWICY

Streszczenie. Celem badań była ocean różnorodności florystycznej oraz analiza rozmieszczenia i pokrycia makrofitami stawów rybnych. Badania przeprowadzono w lipcu, w latach 2013 i 2014, w sześciu największych i najstarszych (funkcjonujących od I wojny światowej) stawach sosnowickich, położonych w granicach Pojezierza Łęczyńsko-Włodawskiego.

Badania pokazały, iż pomimo użytkowania rybackiego stawów stanowią one cenną ostoję dla roślin wodnych. Rozmieszczenie ich nie było typowe dla jezior ze względu na morfometrię mozaikową. Fitolitoral często występował na całej powierzchni zbiorników, rozwijając się od jednego brzegu do drugiego. W związku z tym, mimo zabiegów gospodarskich, różnego czasu przesuszania, makrofity pokrywały duże powierzchnie stawów. Dominującą grupą makrofitów we wszystkich badanych stawach były helofity.

Słowa kluczowe: IVI indeks, makrofity, stawy, biomasa, pokrycie jeziora przez makrofity