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Anna Zagórowicz *

Present state and changes that occur within plant communities growing on the floating mat that surrounds the Moszne lake (Polesie National Park)

Stan obecny i zmiany zachodzące w zbiorowiskach roślinnych występujących na splei otaczającej jezioro Moszne (Poleski Park Narodowy)

*Mgr Anna Zagórowicz - Institute of Environmental Protection-National Research Institute, Krucza 5/11d St., 00-548 Warsaw, e-mail: anna.zagorowicz@ios.gov.pl

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Abstract
The first recordings of flora and vegetation in the surroundings of the Moszne lake (Polesie National Park) started from 1960. In 1980s the water conditions in this area changed and affected the organisms that lived there. The aim of this research was to recognize the present state and changes that occurred within flora and vegetation in the course of 18 years (1995–2013). In 2013, at the beginning of June, 34 phytosociological relevés were made on the floating mat that surrounds the Moszne lake in the same locations as they were done in 1995. The obtained data was collated with figures from the literature by comparing the frequency of plant species and plant communities, average plant species coverage and by calculating Sørensen indexes. The results showed that almost the same plant communities were identified in both terms of research. It was found that 35% of the plant species had disappeared after 18 years and that the biggest increase in percentage coverage was noted in case of *Phragmites australis* and *Sphagnum fallax*. Those findings show that it is very difficult and sometimes even impossible to reverse the negative influence of water condition change on bogs.

Streszczenie
Pierwsze dane dotyczące flory i roślinności występującej na splei otaczającej jezioro Moszne (Poleski Park Narodowy) pochodzą z 1960 r. W latach 80-tych nastąpiła zmiana warunków wodnych na tym terenie, co wpłynęło na związaną z tym obszarem roślinność. Celem podjętych badań było rozpoznanie obecnego stanu oraz zmian, jakie zaszły w obrębie szaty roślinnej na przestrzeni 18 lat (1995-2013). Na początku czerwca 2013 r. na splei otaczającej jezioro Moszne wykonano 34 zdjęcia fitosocjologiczne w tych miejscach, w których były one wykonane w 1995 r. Następnie, uzyskane dane zestawiono z literaturą poprzez porównanie: występowania zbiorowisk roślinnych oraz gatunków roślin, obliczenie średniego procenta pokrywania oraz poprzez obliczenie wskaźnika Sørensena dla każdej grupy zdjęć fitosocjologicznych. Uzyskane wyniki pokazały, że: niemal te same zbiorowiska roślinne zostały zidentyfikowane w dwóch terminach badań, po 18 latach nie odnaleziono 35% gatunków z roku 1995, największy wzrost pokrycia odnotowano w przypadku *Phragmites australis* i *Sphagnum fallax*. Uzyskane wyniki wskazują, że bardzo trudno jest cofnąć (lub jest to niemożliwe) skutki zmian stosunków wodnych i ich wpływ na roślinność torfowiskową.

1. INTRODUCTION

Wetlands are one of the priority habitats in countries of the European Union [Council Directive 92/43/EEC] because of their capacity to control flood, their ability to adapt to climate change, mitigation potential and biodiversity [Ramsar Convention Bureau 2001, Kadykalo Findlay 2016]. Due to changes in the environment and human economy (changes in water condition, fertility, pH, overgrowth of abandoned open areas), they are at a risk of extinction [Hu et al. 2017]. Thus they need to be protected [Council Directive 92/43/EEC].

The first recordings of vegetation that occurred in the Moszne lake (Polesie National Park (PNP)) and in its surroundings were made by Fijałkowski [1960]. The Moszne lake was then a dystrophic forest reservoir surrounded by vast peat bogs, overgrown by plant communities characteristic of transitional bog. In 1980s a lowering of the water level occurred, which also affected vegetation of the Moszne lake as evident by an increase in the area of shrub and tree encroachment [Chmielewski 2010]. Still the most valuable species survive, but plant communities have undergone changes, such as *Characeae* was replaced by *Myriophyllum spicatum* association, and the area covered by submerged macrophytes increased [Sender 2008]. Nowadays, waters of the Moszne lake are characterized as eutrophic, but they are still surrounded by a floating peat [Obidziński 2010]. The efforts undertaken by PNP to stop and reverse changes in ecological conditions are still in process. Thus there is a need to continue PNP's efforts to alleviate the effects of last century's actions, which changed the water conditions [Obidziński 2010].

The aim of the research on flora and vegetation of the Moszne

lake was to investigate the current state and changes that occur within them over time.

2. MATERIALS AND METHODS

Research was conducted during the vegetation season at the beginning of June 2013 in the area that surrounds the Moszne lake. The maximum depth of the lake is 1 m and its catchment area occupies 17.5 ha [Sender 2008]. This area is overgrown by bog vegetation.

Thirty-four phytosociological relevés using the Brown–Blanquet method were made. Plant nomenclature was adopted following Mirek et al. [2002], moss nomenclature was adopted from Ochyra et al. [2003], Marchantiophyta nomenclature was taken from Szweykowski [2006] and syntaxonomic affiliation was made according to Matuszkiewicz [2002]. The locations of phytosociological relevés were selected in such a manner to match the relevés that were made in 1995. The next step was to combine this data with literature [Sugier i Popiołek 1998] by comparing the frequency of plant communities (Tab. 1) and plant species (Tab. 2), average plant species coverage in each year [Van der Maarel 2007]. The Braun–Blanquet scale was transformed into an average percentage coverage and then each species's average percentage coverage was summed in each year and divided by the total number of relevés (34).

3. RESULTS AND DISCUSSION

In both 1995 and in 2013, almost the same number of plant communities (12 and 11) and the same types of plant communities were identified on the floating mat that surrounds the Moszne lake. In 2013 two plant communities were not identified: *Typhetum latifoliae* and *Vaccinio uliginosi-Pinetum.* One was not present in 1995: *Eriophoro vaginati-Sphagnetum recurvi*.

Although almost the same plant associations were identified in both terms of research, only in 20 out of 34 research points the same plant associations were identified in both terms. In five cases, the plant community, which was different after 18 years, was *Phragmitetum australis*. In two other cases, *Sphagno-Caricetum rostratae* was different in both terms.

In case of number of species identified in both terms of research, the differences are higher. In 1995 researchers identified 35% more species than in 2013. There were 54 species that were recorded in both terms of research, of which 37 were present only in in 1995 and 6 identified only in 2013.

The following species reached higher percentage coverage in 1995 than in 2013: *B. pubescens* (17%), *T. palustris* (11%), *M. trifoliate* (9%) and *S. cinerea* (6%). In 2013 the species that covered more space of researched area are *Sph. fallax* (25%), *P. australis* (7%) and *E. vaginatum* (5%) (Sugier i Popiołek 1998, Table 3). *B. pubescens* grows on moist and acidic surfaces and it avoids places where the soil is dry. *T. palustris* often forms a floating mat at the end of overgrowing of eutrophic lakes. *M. trifoliate* helps to form a floating mat. *S. cinerea* grows on peat in places that are usually flooded [Kłosowski, Kłosowski 2001]. *P. australis* is an expansive species that has massive appearance on bogs, leading to biodiversity loss [Próchnicki 2005, Próchnicki 2011]. *E. vaginatum* occurs on bogs and poor fens forming tussocks [Kłosowski, Kłosowski 2001].

Table 1. Plant communities identified on the floating mat that surrounds Moszne lake.

Plant communities	1995	2013
Phragmitetum australis (Gams 1927) Schmale 1939	+	+
Typhetum latifoliae Soó 1927	+	-
Sphagno-Caricetum rostratae (Steffen 1931) em. Dierss, 1982	+	+
Caricetum appropinquatae (Koch 1926) Soó 1938	+	+
Caricetum limosae Br.-Bl. 1921	+	+
Caricetum lasiocarpae Koch 1926	+	+
Carici canescentis-Agrostietum caninae R. Tx. 1937	+	+
Eriophoro vaginati-Sphagnetum recurvi Hueck 1928 pro ass.	-	+
Ledo-Sphagnetum magellanici Sukopp 1959 em. Neuhäusl 1969	+	+
Molinietum caeruleae W.Koch 1926	+	+
Salicetum pentandro-cinereae (Almq. 1929) Pass. 1961	+	+
forest community from *Alnetea glutinosae*	+	+
Vaccinio uliginosi-Pinetum Kleist 1929	+	-
Total number of plant communities	12	11

In the moss layer, the most significant change is diminishing *Sph. cuspidatum* and growth in the percentage coverage of *Sph. fallax*. Both *Sph. cuspidatum* and *Sph. fallax* are species occurring in hollows of bogs, which are highly moist habitats [Kłosowki, Kłosowski 2001]. *Sph. cuspidatum* is one of the most aquatic species of *Sphagnum* and is normally found in very acidic habitats. It has poor competitive strengths and its coverage decreases when water table is low [Breeuwer et al. 2009, Robroek et al. 2007]. *Sph. fallax*, on the other hand, is tolerant of rather wide range of hydrological and chemical conditions. Its competitive strength is related to nitrogen and phosphorus availability [Temmink et al. 2017]. Gąbka and Lamentowicz [2008] report that *Sph. fallax* is an invasive species, which causes a decline of biodiversity of wetlands.

Changes in plant composition in wetlands are widely researched [Wentzell et al. 2016, Ma et al. 2017, Moges et al. 2017]. In many cases, changes in plant composition are conducted in relation to changes of some parameters in the environment: potential influence of climate change [Weltzin et al. 2003, Dieleman et al. 2014], changes in water chemistry [Leps 2004, Vicherova et al. 2015] after and during restoration [Hedberg et al. 2012, Kotowski et al. 2013, Van Diggelen et al. 2015] or trying to find the best way to sustain characteristic features of those habitats [Bergamini et al. 2009, Seer Schrautzer 2014]. Surveys involving plant composition changes taking time as the factor are rarer [Dyderski, Jagodziński 2016].

Researchers conducted in similar plant associations that formed on floating mat surrounding the Karzełek lake in a span of 13 years showed no differences in species composition nor in identified plant associations [Namura-Ochalska, Barszcz 2012]. After researching peat vegetation changes over the period of 14

Table 2. Species identified on the floating mat that surrounds the Moszne lake.

Species	1995	2013
Agrostis canina L.	+	+
Alnus glutinosa (L.) Gaertn.	+	+
Andromeda polifolia L.	+	+
Aulacomnium palustre (Hedw.)Schwaegr.	+	+
Betula humilis Schrank	+	+
Betula pubescens Ehrh.	+	+
Carex appropinquata Schumach	+	+
Calliergon stramineum (Brid.) Kindb.	+	+
Calliergonella cuspidata (Hedw.)	+	+
Carex canescens L.	+	+
Carex chordorrhiza L.	+	+
Carex echinata Murray	+	+
Carex elata All.	+	+
Carex lasiocarpa Ehrh.	+	+
Carex limosa L.	+	+
Carex nigra Reichard	+	+
Carex panicea L.	+	+
Carex pseudocyperus L.	+	+
Peucedanum palustre (L.) Moench	+	+
Phragmites australis (Cav.) Trin. *ex* Steud	+	+
Pinus sylvestris L.	+	+
Polytrichum strictum Menzies *ex* Brid.	+	+
Quercus robur L.	+	+
Ranunculus lingua L.	+	+
Salix cinerea L.	+	+
Salix lapponum L.	+	+
Salix myrtilloides L.	+	+
Salix pentandra L.	+	+
Salix repens L. ssp. *rosmarinifolia* (L.) Hartm. Hartm.	+	+
Scheuchzeria palustris L.	+	+
Sphagnum fallax (Klinggr.) Klinggr.	+	+
Sphagnum magellanicum Brid.	+	+
Sphagnum palustre L.	+	+
Sphagnum teres (Schimp.) Ångstr.	+	+
Stellaria palustris Retz.	+	+
Thelypteris palustris Schott	+	+
Typha latifolia L.	+	+
Vaccinium uliginosum L.	+	+
Carex rostrata Stokes.	+	+
Comarum palustre L. (L.)	+	+
Drosera rotundifolia L.	+	+
Dryopteris cristata (L.) A. Gray	+	+
Equisetum fluviatile L.	+	+
Eriophorum angustifolium Honck	+	+
Eriophorum vaginatum L.	+	+
Frangula alnus Mill.	+	+
Galium palustre L.	+	+
Menyanthes trifoliata L.	+	+
Molinia caerulea (L.) Moench	+	+
Oxycoccus palustris Pers.	+	+
Lysimachia thyrsiflora L.	+	+

Species	1995	2013
Lysimachia vulgaris L.	+	+
Ledum palustre L.	+	+
Dactylorhiza incarnata (L.) Soó	+	+
Lophocolea heterophylla (Schrad.) Dumort.	+	-
Lycopus europaeus L.	+	-
Lythrum salicaria L.	+	-
Mentha aquatica L.	+	-
Agrostis stolonifera L.	+	-
Bryum pseudotriquetrum Relh.	+	-
Calamagrostis canescens (Weber) Roth	+	-
Calla palustris L.	+	-
Calliergon giganteum (Schimp.) Kindb.	+	-
Campylium polygamum (Schimp.) C.E.O. Jensen	+	-
Carex acuta L.	+	-
Carex diandra Schrank	+	-
Carex elongata L.	+	-
Carex flava L.	+	-
Cephalozia connivens (Dicks.) Lindb.	+	-
Cirsium palustre (L.) Scop.	+	-
Drepanocladus aduncus (Hedw.) Warnst.	+	-
Limprichtia revolvens (Sw. *ex* anon.) Loeske *in* Nitardy	+	-
Eleocharis palustris (L.) Roem. et Schult.	+	-
Epipactis palustris (L.) Crantz	+	-
Hydrocharis morsus-ranae L.	+	-
Juncus articulatus L. em. K. Richt.	+	-
Nymphaea candida C. Presl	+	-
Pedicularis palustris L.	+	-
Pedicularis sceptrum-carolinum L.	+	-
Potentilla erecta (L.) Raeusch.	+	-
Plagiothecium denticulatum Schimp. *in* Bruch, Schimp. & W. Gümbel	+	-
Plagiomnium elatum (Brunch & Schimp.) T.J. Kop. *giomnium elatum*	+	-
Pohlia nutans (Hedw.) Lindb.	+	-
Scorpidium scorpioides (Hedw.) Limpr.	+	-
Scutellaria galericulata L.	+	-
Solanum dulcamara L.	+	-
Sphagnum cuspidatum Hoffm.	+	-
Sphagnum nemoreum (Ehrh.) Hedw.	+	-
Stratiotes aloides L.	+	-
Triglohin palustre L.	+	-
Utricularia vulgaris L.	+	-
Viola palustris L.	+	-
Acorus calamus L.	-	+
Betula pendula Roth	-	+
Campylium stellatum (Hedw.) Lange & C. Jens. *pylium stellatum* (Hedw.) C. Jens.	-	+
Galium uliginosum L.	-	+
Juncus effusus L.	-	+
Sphagnum rubellum Wilson	-	+
Total number of species	**92**	**60**

Table 3. Plant associations identified in 2013.

Zespół	A										B								C	D	E		F	G		H		I	J				K
Nr zdjecia	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Numer stanowiska w terenie	49	31	46	43	55	29	54	27	28	30	44	36	32	37	41	40	38	39	42	26	50	45	58	48	47	53	52	62	51	59	60	56	57	61
Warstwa drzew a	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	60	-	-	15	25		80
Warstwa krzewów b	-	20	-	-	-	5	-	-	-	5	5	-	-	10	-	-	10	-	-	15	5	5	-	-	5	30	30	40	-	-	50	90	70	15
Warstwa runa c	100	90	85	70	60	45	90	75	95	80	95	95	90	95	95	90	95	95	80	90	90	85	85	100	95	95	95	75	90	85	95	90	80	80
Warstwa mchów d	80	75	90	60	90	50	60	100	95	90	90	95	80	95	90	90	95	90	50	95	85	95	95	70	90	85	90	90	85	5	75	75	80	65
Powierzchnia zdjęcia [m^2]	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Liczba gatunków w zdjęciu	9	13	16	16	12	11	13	19	21	8	8	13	8	8	16	14	12	11	20	21	12	20	18	20	11	10	11	17	12	12	14	16	21	16
Ass. *Phragmitetum australis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phragmites australis	5	4	4	4	3	3	3	3	4	4	-		+	+	2	-	-	-	3	2	-	-	-	+	-	-	-		+		3	1		2
Ass. *Caricetum rostratae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex rostrata	+	-	-	-	-	-	-	-	-	2	5	4	4	4	4	3	3	3	+	-	-	-	+	+	1	+	+	1	1	+	-	+	+	-
Ass. *Caricetum appropinquatae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex appropinquata	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	2	-	-	-	-	-	-	-	-	1	-
Ass. *Caricetum limosae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex limosa	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-	-	3	1	+	-	+	-	-	-	-	-	-	-	-	-	-
Scheuchzeria palustris	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	1	1	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	+
Ass. *Caricetum lasiocarpae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex lasiocarpa	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	1	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Ass. *Caricetum chordorrhizae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carex chordorrhiza	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Ass. *Carici-Agrostietum caninae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrostis canina	-	-	1	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	-	+	-	-	-
Carex canescens	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Carex echinata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Ass. *Molinietum caeruleae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molinia caerulea	-	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
Ass. *Salicetum pentandro-cinereaee*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Continued Table 3. Plant associations identified in 2013.

Zespół	A										B									C	D	E			F	G			H		I	J				K
Salix pentandra	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-
Salix cinerea	-	2	-	+	-	+	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	1	2	3	3	3	+
Cl. *Phragmitetea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equisetum fluviatile	-	-	+	-	-	-	-	-	1	-	-	+	-	-	-	-	-	-	-	-	-	2	1	+	+	-	-	-	-	+	-	+	-	-	1
Acorus calamus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	2	-
Carex pseudocyperus	-	-	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peucedanum palustre	-	+	+	+	+	-	+	+	1	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	+	-	-	-	-	-	-	-	-	+	1	-
Galium palustre	-	1	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-
Cl. *Scheuchzerio-Caricetea fuscae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eriophorum angustifolium	-	-	-	-	-	-	-	+	-	-	-	+	-	+	+	+	-	-	-	-	+	+	1	1	-	-	-	-	-	1	+	-	-	-	-	-
Carex nigra	-	-	-	-	-	-	+	1	-	-	-	-	-	-	-	-	-	+	1	+	-	-	-	-	-	-	-	+	+	1	-	-	-	-	-	-
Stellaria palustris	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	+	-
Menyanthes trifoliata	-	-	+	-	-	+	-	+	2	-	-	1	+	-	+	-	-	-	-	-	+	2	+	-	1	-	-	-	1	+	1	1	1	1	2
Comarum palustre	-	2	+	+	+	1	-	1	+	-	-	+	-	-	+	-	-	-	+	1	-	+	+	+	-	-	-	-	-	+	+	+	+	+	+
Cl. *Oxycocco-Sphagnetea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Drosera rotundifolia	-	-	+	-	-	+	-	+	+	+	-	-	-	-	-	+	-	+	-	+	-	+	-	+	+	+	-	+	-	-	-	-	-	-	-	-
Sphagnum teres	-	1	-	-	-	2	-	-	+	-	1	-	-	-	2	-	-	-	3	-	-	-	2	-	-	-	-	2	-	-	-	-	-	-	2
Aulacomnium palustre	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	+	-	-	-	-
Oxycoccus palustris	4	2	2	2	2	3	2	3	4	3	4	3	4	3	4	4	5	4	+	3	2	3	3	1	4	2	4	2	4		2	1	3	2
Andromeda polifolia	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	+	+	-	-	+	+	1	-	-	-	1	1	+	-	-	-	-	-	-	-	-
Eriophorum vaginatum	1	-	-	-	-	-	-	-	-	1	2	-	-	1	-	+	2	1	-	-	-	-	-	-	4	4	4	3	-	-	-	-	+	-
Polytrichum strictum	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	2	-	-	2	-	2	1	-	-	-	-	-	-	-	-
Sphagnum magellanicum	-	-	1	-	1	-	-	-	-	-	-	1	1	-	1	-	-	3	-	-	2	-	2	-	-	3	1	2	-	-	-	-	-	-	-	-
Cl. *Molinio-Arrhenatheretea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lysimachia vulgaris	+	+	-	+	-	-	+	-	+	-	-	-	-	-	+	-	-	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	+	+	+
Cl. *Alnetea glutinosae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus glutinosa a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Alnus glutinosa b	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Thelypteris palustris	-	1	-	2	-	+	+	2	1	-	-	-	-	-	+	-	-	-	+	1	-	1	1	3	-	-	-	-	-	1	-	3	3	-

Continued Table 3. Plant associations identified in 2013.

Zespół	A										B								C	D	E		F	G		H		I	J				K
Salix rosmarinifolia	-	-	-	-	1	+	-	+	-	-	-	-	-	-	-	-	-	-	1	+	-	+	-	1	-	-	-	-	-	-	-	-	-	-
Cl. *Vaccinio-Piceetea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus sylvestris a	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-	1	-	-	1
Pinus sylvestris b	-	-	-	-	-	-	-	-	-	1	1	-	-	1	-	-	1	-	-	2	1	1	-	-	1	2	3	3	-	-	-	-	-	-
Pinus sylvestris c	+	-	1	-	-	-	+	+	+	+	-	+	+	+	-	-	+	+	-	+	+	+	-	-	+	+	1	-	+	-	-	-	+	-
Betula pubescens c	+	-	+	+	-	-	1	+	+	-	-	+	1	-	+	-	-	-	-	-	+	+	2	+	+	+	-	-	-	-	+	-	+	-
Vaccinium uliginosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	1	-	-	-	-	-	-	-
Ledum palustre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	+	1	2	3	-	-	+	-	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Betula pendula a	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2		1
Betula pendula b	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		1
Betula pendula c	-	+	-	1	1	1	+	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-
Frangula alnus	-	+	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	1	1	2
Salix myrtilloides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	+	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
Carex panicea	-	-	+	-	+	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Sphagnum fallax	4	4	3	4	5	2	4	5	5	3	3	5	4	5	2	5	4	3	1	5	3	3	3	4	4	2	4	3	5	+	4	5	4	3
Sphagnum palustre	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	+	1	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-
Dactylorhiza incarnata	-	-	-	-	+		+	+	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-

Sporadic species: *Carex elata* 8/+, 19/+; *Ranunculus lingua* 22/+, 23/1; *Lysimachia thyrsiflora* 20/+, 30/1; *Typha latifolia* 33/+; *Calliergon stramineum* 33/+; *Campylium stellatum* 24/2; *Salix lapponum* 28/1; *Calliergonella cuspidata* 18/+; *Sph. rubellum* 27/1; *Galium uliginosum* 4/+, 24/+; *Alnus glutinosa* c 9/1, 34/+; *Betula humilis* 5/1, 8/+; *Betula pubescens* a i b 28/1; *Quercus robur* c 19/+, 25/+; *Dryopteris cristata* 33/+, 34/+; *Juncus effusus* 34/+.

Explanations: **A** – *Phragmitetum australis,* **B** – *Sphagno-Caricetum rostratae,* **C** – *Caricetum paradoxae,* **D** – *Caricetum limosae,* **E** – *Caricetum lasiocarpae,* **F** – *Carici-Agrostietum caninae,* **G** – *Eriophoro vaginati-Sphagnetum recurvi,* **H** – *Ledo-Sphagnetum magellanici,* **I** – *Molinietum caeruleae,* **J** – *Salicetum pentandro-cinereae,* **K** – zbiorowisko leśne z klasy *Alnetea glutinosae.*

years, Dyderski and Jagodziński [2016] identified no significant shifts in plant species composition and the observed changes were not statistically significant. Sender [2008], who conducted research on long-term changes of macrophytes structure in the Moszne lake, noted a decrease of plant association variety as well as changes in their qualitative composition.

4. CONCLUSIONS

1. In the period of eighteen years, biodiversity of the studied area declined as evident by the fact that in 1995 there were 35% more species identified than in 2013.
2. In 2013 growth in percentage coverage of *P. australis*, *Phragmitetum australis* and *Sph. fallax* is identified, which could be affect the changes of water conditions and cause further biodiversity decline of the area that surrounds the Moszne lake.
3. Although Polesie National Park since its foundation is continuously working on an improvement of water condition of its area after changes had occurred in the past, the effects of these changes are still not reversed. Every change in water condition that affects bogs require a lot of time and effort to be reversed or it can be even impossible.

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