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PEAT BOG FLORA NEAR LAKE BIKCZE IN RELATION TO DIVERSE HABITAT CONDITIONS

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Summary. The aim of this research was to identify the flora and habitat conditions of the peat bog on Lake Bikcze in the Łęczna-Włodawa Lakeland. The present study was carried out in the years 2005–2007 in two study transects. The condition of phytocoenoses in the respective sectors and values of selected parameters of abiotic environment were determined. Analysis of the results of the study showed that habitat conditions in the peat bog on Lake Bikcze varied, ipso facto, the flora of this area was very diverse. The occurrence of populations of rare plant species: *Betula humilis, Salix myrtilloides, Dactylorhiza majalis, Drosera intermedia, Nuphar lutea, Nuphar pumila, Lingularia sibirica, Frangula alnus* and *Menyanthes trifoliate,* was recorded there. Over the period of the last 20 years, the proportion of expansive species in the phytocoenoses of the area has increased significantly, and ecological succession may threaten the biodiversity of the peat bog flora.

Key wards: Lake Bikcze, peat bog, flora, habitat conditions

INTRODUCTION

Lake Bikcze is situated in the south-eastern part of the Łęczna-Włodawa Lakeland (51°22’ N, 23°03’E). Until 1969, this was a flow-through water body, fed and drained by the Lower Piwonia River. During hydraulic improvements in this area, related to the construction of the Wieprz-Krzna Canal, the lake was surrounded by a drainage ditch and the Piwonia River channel was directed into it. Only several years after the improvements, transformation of the peat bogs adjacent to the lake shore on the western side was observed (fertile fens were transformed into transitional bogs, and then the transitional bogs into raised bogs). At the same time, the vegetation of the western part of the peat bog became dominated by willow-birch communities as well as by reed communities. A consequence of the succession process was a reduction in population size of

species typical of this area, including extremely valuable relict plant species [Wojciechowski *et al.* 1988, Lorens *et al*. 1998, Chmielewski *et al.* 2005].

The field study, involving the identification of the variation in species composition of the phytocoenoses and habitat conditions in the peat bog on Lake Bikcze, was designed to help in determining the direction of changes which are taking place in the natural environment of this area.

MATERIALS AND METHODS

The field study was carried out in the peat bog adjacent to the western shore of Lake Bikcze (in the Łęczna-Włodawa Lakeland) in the years 2005–2007. The first stage of the study involved making of an inventory of the peat bog's vegetation cover. Then, two study transects were established: northern transect (I – 226 m long) and southern transect (II – 130 m) with a width of 4 m, running perpendicularly to the shore of Lake Bikcze, in E-W direction (Fig. 1). The transects were

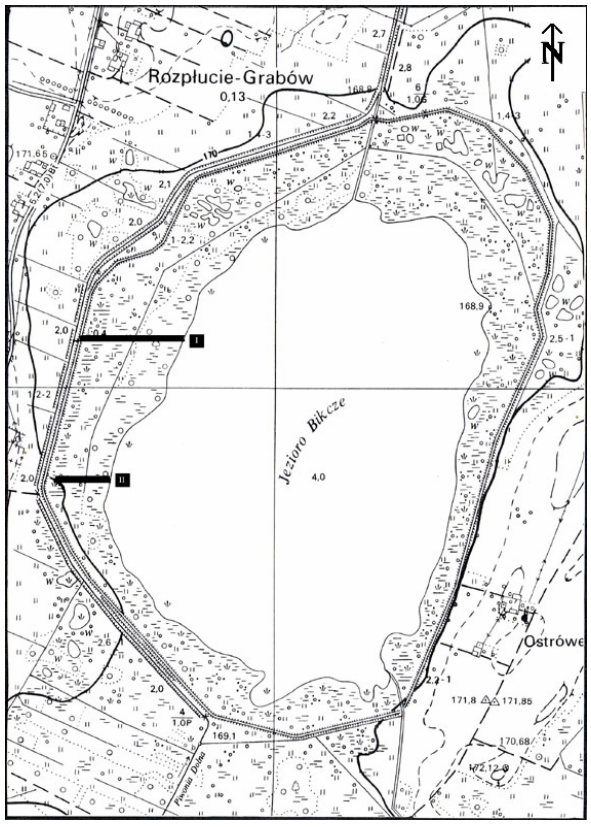

Fig. 1. The localization of study transects near Lake Bikcze

Table 1. Species composition of the flora of the northern transect I, including percentage proportions of particular plant species, in the peat bog on Lake Bikcze

No. of sector	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**		**9**		**10**		**11**		**12**		**13**		**14**		**15**	
Year	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**
Alisma plantago-aquatica	+	+																												
Alnus glutinosa ab	5	5	10	15	5	5	5	5	5	5	10	10			5	5	+		+	+	10	10	15	10			10	10		
Andromeda polifolia																							20	20						
Arrhenatherum elatius																											5		5	
Betula humilis b																					10	10	5	5	+		15	10		
Betula pendula ab			10	15																										
Betula pubescens ab					+	+	10	20			5	10	5	10	5	5	+	+	+		10	10	15	10	+	+	15	10	+	+
Bromus hordeaceus																													5	
Calamagrostis canescens			++		+	+																					15	10		
Calamagrostis epigejos																											15	15		
Calla palustris	+	+	40	50	60	50	5	5	5	5	15	10					5	5			15	15								
Carex nigra			+	+	+	+	+	+	+	+	+	+			+	+			5	10	+	+	+	+						
Carex pseudocyperus	+	+			+	+	+	+	+	+	5	+	5	+	+	+			5	5	+	5	+	+						
Carex rostrata			+	+									15	10									+	+						
Chamaenerion angustifolium																							+	+						
Cirsium palustre					+	+					+	+					5	5							10	10	15	10	20	20
Comarum palustre	+	+	5	+	+	+	+	+							+	5	5	5					+	5	5	5	+	+		
Dactylorhiza majalis											+																			
Deschampsia caespitosa																													+	+
Drosera intermedia					+		5																							
Equisetum fluviatile	+	+	5	5	+	5	30	50	10	10	15	10	5	5	60	60	5	5	20	30	10	10	+	+	10	10	+	+	+	5
Eriophorum vaginatum					+	+	+	+																	+	+				
Eupatorium cannabinum																													5	5
Festuca nigrescens																											+	+		
Frangula alnus ab																													+	+
Galium palustre	+	+	5	+	+	+	+	+			5	5	5	5									+	+	+	+				
Hydrocharis morsus-ranae	+																													

Juncus effusus											+	+	5	5																
Lingularia sibirica																									+	+	+	+		
Lycopus europaeus	5	5	5	5	+	+	+	+			5	+							20	20							5	+	+	+
Lysimachia thyrsiflora																									4		2			
Lysimachia vulgaris	+	+	5	10	+	+	+	+	+	+	5	5	5	5	5	5	10	15			10	10	5	5	5	5	5	5	+	5
Lythrum salicaria	+	+			+	+																	+	+			+	+	+	+
Mentha aquatica	+	+	5	+																										
Menyanthes trifoliata							25	30	60	60	15	20	15	15	10	10	5	5	20	30	10	10	+	+	5	+	+	5		
Molinia caeruela																													5	10
Myosotis palustris			5	+																										
Nuphar lutea	+	+																												
Nuphar pumila	+	+																												
Oxycoccus palustris							+	+	10	15															15	15				
Peucedanum palustre	+	+	5	5	5	5	+	+			5	5	5	5													+	+		
Phragmites australis																					10	10	60	70	30	30				
Poa palustris					+	+																							5	5
Poa pretensis																	5	5	20	20										
Quercus petrea			+	+	+	+																								
Quercus robur											5	+					+	+												
Ranunculus lingua	5	5	+	+																										
Rubus idaeus																													+	+
Salix aurita ab					+	+	15	15	5	5	25	30			5	5					5	5	+	+	+	+	5	5	+	
Salix cinerea ab	10	15	40	50	20	30	50	70	5	5	15	15	10	10	+	+	+	5			+	+	+	+						
Salix pentandra ab					+	+	+	+	25	40			5	5	5	5	+	+	+	+									+	+
Salix rozmarinifolia b																							10	10	+	+	5	5		
Sanguisorba officinalis																													5	5
Solanum dulcamara	5	+	5	5	+	+	+	+	+				5		+		+	+			10	10	+	+	+	+	+	+	5	5
Stratiotes aloides	+	+																												
Thelypteris palustris	30	30	5	5	5	5	+	+	+	+	15	15	15	20	10	20	50	50	20	20	15	15	+	+	+	+			5	5
Typha angustifolia	35	30	+	+	+	+	+	+													5									
Typha latifolia							+	+			5	5	5	5	+	+									5	5	10	10	5	5
Urtica dioica																													5	5
Viola palustris					+	+	20	10	++	+																				

+ single individuals of a given species, a – layer of trees, b –layer of shrubs in phytocoenosis

Table 2. Species composition of the flora of the southern transect II, including percentage proportions of particular plant species, in the peat bog on Lake Bikcze

No. of sector	1		2		3		4		5		6		7		8		9		10		11		12		13	
Year	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**	**05**	**07**
Alnus glutinosa ab											+	+														
Andromeda polifolia.																			+		5	5				
Betula pendula ab					15	15	20	20	+	+	5	5	20	20	40	40	60	60	20	20	40	40	20	20	10	10
Betula pubescens ab			+	+	+	+	10	10			+	+			+	+									50	60
Calamagrostis canescens									+	+	+	+									5	10				
Calla palustris	+	+	50	50	50	50	10	10	+	+	+	+	+	+												
Caltha palustris			+	+																						
Carex limosa																							5	5		
Carex nigra									+	+					+	+	+	+								
Carex rostrata							15	15	70	70	10	10	10	10	20	20	25	25	15	15	75	75	10	15		
Cicuta virosa																							+			
Cirsium arvense							+	+																	++	10
Comarum palustre			5	5	+	+	+	+	10	10			+	+	+	+	5	5	20	20	15	20	++	++		
Dactylorchiza majalis																	+	+								
Epilobium palustre																					+	+				
Equisetum fluviatile	+	+	15	15	10	20	20	30	15	15	40	40	30	30	45	45	35	35	20	20	45	55	20	40		
Eriophorum angustifolium																										
Eupatorium cannabinum																									+	+
Frangula alnus ab			+	+	+	+	+	+			+	+	+	+									+	+	+	+
Galium palustre				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+	+
Geum rivale								+																	+	+
Hydrocharis morsus-ranae	10	15																								
Juncus conglomeratus																									+	+
Juncus effusus									+	+																
Lycopus europaeus			5	5	+	+	5	5	+	+	+	+	+	+		+						+	5	+	+	+
Lysimachia thyrsiflora					5	5					+	+				+	+	+		+						
Lysimachia vulgaris.				+	5	5	+	5		+				+			5	5	+	+	+	5			+	+
Lythrum salicaria				+		+	+	+	+	+			+	+	+	+	+	+	+	+		+	+	+	+	+
Menyanthes trifoliata.			+	+									35	35	10	10			+	+	15	15	15	15		
Molinia caeruela			+	+	+	+	5	5	30	30															+	+
Oxycoccus palustris								+	+	+					+	+	+	+	30	30	70	60				
Peucedanum palustre			5	5	+	+			+	+					+	+							+	+	+	+

Phragmites australis.	+	+													+	+	+	+	+	+						
Populus tremula ab			+	+							+	+	+	+												
Potentilla erecta																									+	+
Ranunculus lingua	+	+	+	+				+	+	+	+	+	+	+		+										
Rubus idaeus b																									+	+
Rubus plicatus b																									+	+
Salix aurita ab			+	+	15	15													+	+	+	+				
Salix cinerea ab			90	90	20	20	50	50	30	30	90	90	50	50	25	25	25	25	60	60	5	10	80	90	20	25
Salix myrtilloides b																	20	20			+	+				
Salix pentandra ab			+	+	20	20	+	+															5	10		
Salix rozmarinifolia b					+	+							+	+			+	+	15	15	70	60	5	10		
Scutellaria galericulata											+	+			+	+							+	+	+	+
Solanum dulcamara			+	+	+	+																	+	+	+	+
Stellaria palustris			+	+																						
Thelypteris palustris	20	20	15	15	10	10	20	15	20	20	10	10	25	25	35	35	20	20	5	5	10	5	20	20	20	20
Typha angustifolia				+	+	+	+	+	+	+	+	+			+	+	+	+			5	10	+	+		
Typha latifolia	80	80																								
Urtica dioica																									+	+

+ single individuals of a given species, a – layer of trees, b –layer of shrubs in phytocoenosis

situated parallel to each other, at a distance of approx. 300 m, and they were divided into sectors, the size of which was dependent on the variation in vegetation cover (I – 15 sectors, II – 13 sectors).

In each sector, the flora species composition (including identification of the vertical structure and estimation of percentage proportions of particular species in the respective phytocoenosis) was determined twice (in May and July of the years 2005 and 2007). Special attention was paid to the occurrence of rare and protected plant species in the study area. Plants were identified using the key of Rutkowski [2005], botanical nomenclature (Polish and Latin) followed Mirek *et al*. [2002]. The assignment of particular species to syntaxonomic groups followed Matuszkiewicz [2005].

In situ measurements of selected groundwater properties were also made (in each sector) – water level in cm (with the bog surface pressed down by human weight), water pH (using a field pH-meter) and electrolytic conductivity ($\mu S \cdot cm^{-1}$; using a field conductometer).

During office investigations, *Ecological indicator values of vascular plants* [Zarzycki *et al*. 2002] was used to determine specific habitat conditions based on the affinity of plant species of the studied phytocoenoses with ecological groups.

RESULTS

In the study area, a total of 75 vascular plant species occurred (33 species common for both transects; 26 species found only in transect I, 16 species found only in transect II).

In the flora of the investigated area, a significant proportion of species of the classes *Phragmitetea, Scheuchzerio-Caricetea nigrae, Oxycocco-Sphagnetea, Alnetea glutinosae, Molinio-Arrhenatheretea* was noticeable; however, it was not possible to classify syntaxa due to the absence of characteristic species combinations.

The species composition and proportions of particular plant species in the phytocoenoses of the transects changed depending on their location in the peat bog (Tab. 1, 2).

In the peat bog on Lake Bikcze, ecological succession progresses both from the side of the surrounding drainage ditch (where the area is densely bush-covered and the substrate is dry) and from the side of the lake shore, where the dominance of expansive species (*Salix cinerea, Betula pubescens, Betula pendula*) in the phytocoenosis can be clearly seen.

The study confirmed the occurrence of rare and strictly protected plant species [Rozporządzenie... 2004]: *Betula humilis, Salix myrtilloides, Dactylorhiza majalis, Drosera intermedia, Nuphar lutea, Nuphar pumila, Lingularia sibirica*, and partially protected plant species: *Frangula alnus* and *Menyanthes trifoliata* (Tab. 1, 2).

Ecological analysis of the species composition of the flora of the investigated transects showed that plant species preferring moderately nutrient-poor and nutrient-rich habitats (mesotrophic and eutrophic), rich in organic matter, wet and humid, in which the substrate is characterised by neutral pH (6–7), made up the largest group. Species characteristic of moderately illuminated habitats were the most numerous group (Tab. 3).

Table 3. Percentage proportions of plant species with different habitat requirements in the phytocoenoses of transects I and II (calculated using ecological indicator values) [Zarzycki *et al.* 2002]

Selected indicators	Transect	Indicator values						
		Stenobionts	1	2	3	4	5	6
L – light value	I	83.3	0.0	3.3	20.0	83.3	11.6	0.0
	II	82.0	0.0	4.0	22.0	84.0	14.0	0.0
W – soil moisture value	I	31.6	0.0	1.6	15.0	63.3	73.3	20.0
	II	46.0	0.0	2.0	12.0	56.0	80.0	18.0
TR – trophy value	I	43.3	5.0	15.0	63.3	66.6	5.0	0.0
	II	48.0	4.0	16.0	70.0	56.0	6.0	0.0
R – soil (water) acidity (pH) value	I	55.0	3.3	11.6	33.0	75.0	26.6	0.0
	II	58.0	6.0	14.0	40.0	66.0	22.0	0.0
H – organic matter content value	I	76.6	5.0	46.6	68.3	0.0	0.0	0.0
	II	76.0	4.0	42.0	78.0	0.0	0.0	0.0

The abiotic factors of the environment (pH, electrolytic conductivity and the level of the highest groundwater layer), measured *in situ* in the sectors in which groundwater was accessible, varied along the entire length of both transects. The upper groundwater level in the peat bog decreased as one moved away from the lake shore. That was clearly visible in the northern transect I (from 9 cm in sector 1 to 0.2 cm in sector 7, in the year 2005). During the three seasons of the study, water-level fluctuations were insignificant in particular sectors of both transects. The terminal sectors (8–15) of transect I and the 13th sector of transect II were characterised by the absence of seeping groundwater (Tab. 4). In transect II, irregular groundwater level fluctuations were observed along the transect length, which was associated primarily with the presence of a section of the drainage ditch located in front of the embankment on the side of the peat bog.

The pH of the investigated groundwater changed along the lengths of the transects, showing a tendency of increasing values, starting from the initial sectors (located by the lake shore) and moving to the terminal ones which were located on the edge of the peat bog. In the successive years of the study, the groundwater pH in sector 1 of transect I (located closest to the lake) ranged from 6.62 to 6.56, and in transect II: 6.06–6.35. The water examined in the central part of the peat bog had an acidic pH (in sector 7 of transect I: pH 4.22–4.85, and in sector 10 of transect II: pH 4.5–5.0). On the fringes of the peat bog, in sector 12 of transect II, the pH of the substrate in different years ranged from 4.5 to 5.4 (Tab. 4).

Table 4. Values of selected abiotic factors of the environment in particular sectors of transects I and II in the peat bog on Lake Bikcze

Transects	Sectors	Level of ground water, cm			Water acidity, pH			Electrolytic conductivity, $\mu S\ cm^{-1}$		
		2005	2006	2007	2005	2006	2007	2005	2006	2007
I	1	9.0	8.0	8.5	6.62	6.53	6.56	202.0	225.0	239.0
	2	5.0	4.5	5.0	6.47	6.55	6.06	275.0	256.0	195.6
	3	3.0	3.0	3.0	5.38	5.55	5.78	58.3	125.0	100.1
	4	0.5	1.0	1.0	4.68	5.22	5.47	84.0	152.0	141.1
	5	1.0	1.0	0.5	4.34	4.43	5.13	78.4	88.0	176.8
	6	0.5	1.0	0.5	4.10	4.20	4.92	99.6	102.0	147.6
	7	0.2	0.0	0.2	4.23	4.22	4.85	382.0	333.0	331.0
	8–15	-	-	-	-	-	-	-	-	-
II	1	-	-	-	6.20	6.06	6.35	165.0	222.0	205.0
	2	9.5	8.0	13.0	5.20	5.55	5.80	157.0	214.0	216.0
	3	11.0	10.0	11.0	4.10	5.56	5.90	102.6	224.0	244.0
	4	5.0	6.0	9.0	5.50	6.25	7.00	136.7	156.0	249.0
	5	5.0	6.0	6.0	5.00	5.20	6.60	196.5	190.0	210.0
	6	3.5	5.0	4.0	5.20	5.25	6.50	220.0	196.0	175.2
	7	7.0	6.5	12.0	5.80	5.50	6.30	170.0	166.0	152.1
	8	6.0	4.5	4.0	5.00	5.25	6.30	169.5	163.0	180.6
	9	8.5	8.0	7.0	4.70	5.02	6.00	139.0	145.2	121.6
	10	6.5	8.0	9.0	4.50	4.50	5.00	96.4	96.6	96.2
	11	8.0	8.5	7.0	4.60	4.60	4.90	98.1	96.7	90.5
	12	7.0	12.0	18.0	4.80	4.50	5.40	112.8	103.3	78.4
	13	-	-	-	-	-	-	-	-	-

DISCUSSION

The first references in literature to the vegetation cover of Lake Bikcze appeared in 1953. On its east side, the lake had a sandy shore, whereas on the other sides it was surrounded by a belt of fens and transitional bogs with a width of about 200–250 m, with numerous peat pits (located on the western and northern shores). According to Wilgat [1953], the surface of the lake was surrounded by a wide belt of floating mat, whereas among the lakeshore vegetation common reed (*Phragmites australis*) was predominant.

During our study, *Phragmites australis* was noted only deep in the peat bog, but it was not found in the shore zone of the western part of the lake; however, a large proportion of *Typha angustifolia* was noted in this habitat.

Compared to the studies conducted in this area in the 1990's [Izdebski *et al*. 1996, Lorens *et al*. 1998], a distinct trend of an increasing proportion of *Salix*

cinerea in the peat bog communities was observed, which proves the clear expansion of this species within the study area. The large populations of willow, as well as of *Betula pendula* and *B. pubescens,* result in shading of a large area of the peat bog, which certainly affects changes in habitat conditions prevailing in it.

During the study, the occurrence of the association *Sphagno-Caricetum rostratae* was not noted; in the 1990's it was reported as one of characteristic associations of the study area. [Izdebski *et al*. 1996, Lorens *et al.* 1998]. Stands of species such as *Carex canescens, Carex chordorrhiza* and *Agrostis canina*, were not noted, either. According to Zarzycki *et al*. [2002], these species have narrow ranges of ecological tolerance in relation to substrate pH (acidic or moderately acidic) and light availability (moderate or full light), which may be the reason why their populations have not survived in the studied peat bog.

During the investigations conducted in the transects, the occurrence of protected plant species was found [Rozporządzenie... 2004]. Only the population of a relict species, *Salix myrtilloides*, was described in detail in this area in the 1950's. It is known that at that time it was numerous in the studied peat bog [Fijałkowski 1958]. However, it cannot be established whether the populations of the other species known from this area, i.e. *Betula humilis* or *Carex limosa*, occurred in a similar condition and similar numbers, since there is no data on this.

The results of the investigation of the abiotic factors and the analysis of the flora species composition, in terms of habitat preferences of particular taxa groups, showed that the described protected plant species found suitable conditions for growth and development in the studied peat bog.

A continuation of research on the flora and habitat conditions in the peat bog on Lake Bikcze would allow us to determine the proper direction and principles of active protection of this area, which seems to be necessary. It is particularly important due to the exceptional natural values which characterise the said peat bog.

CONCLUSIONS

Varying habitat conditions are found in the peat bog on Lake Bikcze, ipso facto, the flora of this area is also very diverse. Over the period of the last 20 years, the proportion of expansive species in the phytocoenoses of this area has increased markedly; through their rapid growth and development, these species cause changes in habitat conditions by shading and drying up the peat bog. Ecological succession, progressing at a fast pace, may pose a threat to species diversity of the flora of this area. Therefore, it seems expedient to take active protection measures in the studied peat bog. Active protection should involve primarily the removal of expansive species; coupled with the maintenance of a high water level in the peat bog, it will allow changes in habitat conditions, threatening the rare and protected plant species found in great numbers in this area, to be slowed down.

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FLORA TORFOWISKA NAD JEZIOREM BIKCZE NA TLE ZRÓŻNICOWANYCH WARUNKÓW SIEDLISKOWYCH

Streszczenie. Celem badań było rozpoznanie flory oraz określenie warunków siedliskowych panujących na torfowisku nad jeziorem Bikcze na Pojezierzu Łęczyńsko-Włodawskim. Badania prowadzono w latach 2005–2007, w dwóch wyznaczonych na torfowisku transektach, w których określono skład gatunkowy fitocenoz i wartości wybranych czynników abiotycznych środowiska. Analiza wyników potwierdziła, że na torfowisku panują zróżnicowane warunki siedliskowe, które mają wpływ na różnorodność flory. Odnotowano stanowiska gatunków rzadkich i chronionych: *Betula humilis, Salix myrtilloides, Dactylorhiza majalis, Drosera intermedia, Nuphar lutea, Nuphar pumila, Lingularia sibirica, Frangula alnus* i *Menyanthes trifoliata.* Stwierdzono, że w okresie ostatnich 20 lat wyraźnie wzrósł w fitocenozach udział gatunków ekspansywnych, a sukcesja ekologiczna zachodząca z ich udziałem może być zagrożeniem dla różnorodności gatunkowej flory torfowiska.

Słowa kluczowe: jezioro Bikcze, torfowisko, flora, warunki siedliskowe