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Changes of the *Phragmitetea* Class Vegetation in the Bystra Valley, Eastern Poland

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1. Introduction

The river valleys are an integral feature of agricultural landscape. They are characterized by varied habitat conditions both in terms of soil fertility and water content, which is reflected in the diversity of meadow plant communities occurring there. The persistence of plant communities depends on human activity, particularly the manner and intensity of management (Baryła & Urban 1999, Grzegorczyk & Grabowski 2010, Kryszak et al. 2006, Kulik et al. 2017, Shushpannikova 2014). On the other hand, the abandonment and disrupted moisture levels in habitats lead to changes in the species composition of grassland and the range of plant communities (Czyż et al. 2013, Kozłowska & Burs 2013, Kulik 2014, Myśliwy & Bosiacka 2009, Nekrošienė & Skuodienė 2012). A high variation of habitat condition can be observed mainly in river valleys, particularly in upland areas. These conditions are influenced by the geomorphology and relief of the catchment which, alongside climatic factors, determine the occurrence of floods to a considerable extent (Ziemnicki & Pałys 1963). River valleys in upland areas are deeply incised in the surrounding plateau tops, and the relief of their bottoms is determined by natural fluvial processes. Such habitats very frequently feature plant communities from the *Phragmitetea* class, of no fodder value (except for *Phalaridetum arundinaceae*), but of high environmental value because they provide a habitat for many water and marsh birds (Grzelak 2004, Grzelak et al. 2015, Jonsson & Malmqvist 2000, Riis &

Biggs 2003). Thanks to the dominance of one species, the plant communities of this class show the highest resistance to anthropogenic pressure (Kryszak et al. 2006). One of the areas with diverse plant communities of the *Phragmitetea* class is the valley of the Bystra river, a right-hand tributary of the Vistula in Eastern Poland (Reder et al. 2010).

The aim of the study was to (1) analyse the vegetation changes of the *Phragmitetea* class in the valley of the Bystra river in Eastern Poland after a period of 41 years, (2) identify the direction of plant communities succession, and to (3) analyse the vegetation changes based on Ellenberg's indicators.

2. Material and methods

2.1. The study area

The Bystra river (Eastern Poland) starts in Czesławice (vicinity of Nałęczów) and flows from the east to the west, emptying into the Vistula at Bochotnica (downstream from Kazimierz Dolny). It is fed by several, unnamed streams, the largest of which is the Czerka river. The mouths of these streams and the numerous springs (particularly in the Czerka river valley) form pools of stagnant water where rush communities of the *Phragmitetea* class occur. The Bystra catchment, covering about 299 km^2, encompasses the eastern part of the Kazimierz Plateau composed of Cretaceous rocks covered by post-glacial materials of varying thickness, overlain by a loess layer. A large network of gullies dissecting both sides of the valley is a characteristic feature of the catchment (Jahn 1956, Ziemnicki & Pałys 1977).

2.2. Field study

The studies were conducted in the years 1973 and 2014 in the valley of the Bystra river, on grasslands of an area of approx. 30 ha belonging to farmers from the following localities: Nałęczów (2.5 ha), Łąki (2.7 ha), Wąwolnica (4.9 ha), Mareczki (3.0 ha), Rogalów (2.3 ha), Zawada (1.6 ha), Bartłomiejowice (3.3 ha), Chmielnik (0.9 ha), Góra (1.1 ha), Szczuczki (1.4 ha), Łubki (2.4 ha) and Nowy Gaj (3.6). Rush meadows form a mosaic with hay and wet meadows from *Molinio-Arrhenatheretea* class. Most of them are currently mowed. 44 phytosociological relevés were performed in 1973 (unpublished data made by Baryła) and 41 in 2014 according to the Braun-Blanquet (1964) method. All relevés presented in this study were assigned to plant communities of the *Phragmitetea* class. In 2014, several mosaic meadows were observed and relevés were made for the most distinct patches covering a minimum of 25 m^2; the patches were marked with letters (a, b, c). The floristic diversity after a period of 41 years was identified based on the phytosociological structure and mean number of species calculated based on the number of species in the particular relevés of the phytocoenoses under study. Phytosociological taxonomy was based on Matuszkiewicz (2008), and the species names were provided according to Mirek et al. (2002).

2.3. Data analysis

The pragmaTax program (Cortex Nova, Bydgoszcz, Poland) was used to carry out the numerical classification for all relevés based on the quantitative share of the species. The WPGMA (Weighted Pair Group Method of Arithmetic averages) was used. A comparison of the dendrogram obtained in the classification made it possible to include groups of relevés of *Phragmitetea* class at alfa scale 0.4, similar in terms of community species composition.

Directions of changes in plant communities were assessed on the basis of the number of relevés taken in both periods. Changes of the climatic (L – light, T – temperature, K – continentality) and edaphic (F – moisture, R – reaction, N – nitrogen content) conditions were assessed using cover-abundance of species and ecological indicator values by Ellenberg et al. (1992). The multidimensional Principal Component Analysis (PCA) was used to identify patterns occurring in the dataset. PCA helped to determine which indices result in the greatest variability in the communities, and facilitated the visualisation of changes that occurred in the particular years of the investigation. Due to the search of mutual dependencies between indicators, the PCA was based on a correlation matrix. The software used to carry out the analysis was StatSoft Statistica v. 13.1.

3. Results and discussion

The following associations of the *Phragmitetea* class, distinguished based on phytosociological classification, were predominant according to the number of patches in the Bystra river valley: *Caricetum gracilis* (Graebn. et Hueck 1931) R.Tx. 1937, *Phragmitetum australis* (Gams 1927) Schmale 1939, *Glycerietum maximae* Hueck 1931 and

Phalaridetum arundinaceae (Koch 1926 n.n.) Libb. 1931. The numerical classification of phytosociological relevés showed a high similarity of the plant associations distinguished (Fig. 1).

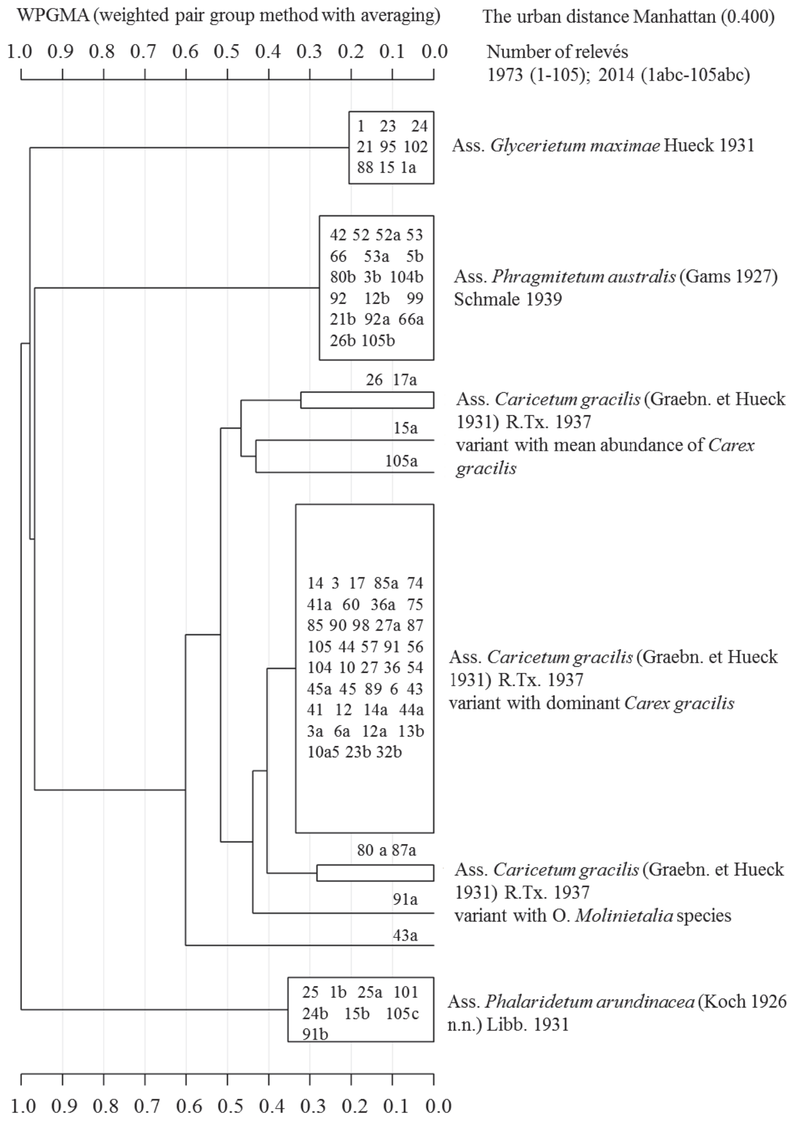

Fig. 1. Classification of the rush communities
Rys. 1. Klasyfikacja zbiorowisk szuwarowych

These associations were characterised by the dominant of the characteristic species and small number of other species forming the community (Table 1). Other rush communities occupied small areas or occurred very rarely, hence there were not included in this study. *Caricetum gracilis* was the most frequently occurring association, represented by the greatest number of patches (57%). Typical variant with the dominance of *Carex gracilis*, variant with a lower abundance by this species and variant with characteristic species of the *Molinietalia* order and *Molinio-Arrhenatheretea* class were distinguished (Fig. 1). The following were among the most frequently occurring species from this class: *Caltha palustris*, *Myosotis palustris*, *Trifolium hybridum*, *Equisetum palustre*, *Lychnis flos-cuculi*, *Poa trivialis*, *Poa pratensis*, *Agrostis gigantea*, *Ranunculus acris* and *Ranunculus repens*.

Table 1. Changes of the number of characteristic species
Tabela 1. Zmiany liczby gatunków charakterystycznych

Community Year		Syntaxonomy categories					Mean
		Mag	*Phr*	*Cal*	*Mol*	*Mol-Arr*	
		Range of species number in relevés					
Gly max	1973	1-3	1-4	1-3	0-1	0-3	9
	2014	1-2	1-2	3-3	2-5	0-5	14
Phr aus	1973	0-4	1-4	0-3	0-2	1-3	9
	2014	0-4	1-2	0-3	1-4	0-3	8
Car gra	1973	1-4	0-3	2-4	0-5	4-12	16
	2014	1-6	0-3	0-4	0-6	0-9	14
Pha aru	1973	2-3	0-2	2-2	0-2	0-1	9
	2014	1-2	0-1	1-3	0-5	0-4	10

Gly max – *Glycerietum maximae*; *Phr aus* – *Phragmitetum australis*; *Car gra* – *Caricetum gracilis*; *Pha aru* – *Phalaridetum arundinaceae*; *Mag* – ChAll. *Magnocaricion*; *Phr* – ChCl. *Phragmitetea*; *Cal* – ChAll. *Calthion*; *Mol* – ChO. *Molinietalia*; *Mol-Arr* – ChCl. *Molinio-Arrhenatheretea*

The numerous occurrences of the characteristic species of the *Calthion* alliance and *Molinietalia* order as well as the *Molinio-*

Arrhenatheretea class in the *Caricetum gracilis* phytocoenoses is confirmed by the results of other studies (Baryła 1964, 1970, Fijałkowski 1966, Wyłupek 2005, Kryszak et al. 2005, Warda & Stamirowska-Krzaczek 2009). The gradual drying of wetland habitats, combined with cutting utilisation, can lead to their transition to grass communities (Denisiuk 1980, Kryszak et al. 2005).

The *Caricetum gracilis* phytocoenoses occupied the area of a flood terrace with varying moisture levels. After the thaw in the spring and after abundant rainfall in the summer, the water stagnated on the surface of the terrace for a long time. On the other hand, dry periods characterised by lower groundwater levels enabled the cutting of rush meadows, which leads to increased floristic diversity and inhibits the changes in the species composition towards the dominance of one rush species. Thanks to the dominance of one species, the plant communities of the *Phragmitetea* class show the highest resistance to anthropogenic pressure (Kryszak et al. 2006).

Another plant community was *Phragmitetum australis*, where *Phragmites australis* was predominant. The reed rushes were characterised by the lowest floristic diversity (Table 1). Among other species, the following were recorded most frequently: *Poa trivialis* and *Lycopus europaeus* and, in the second period, *Cirsium rivulare*, *Equisetum palustre*, *Lysimachia vulgaris* and *Symphytum officinale*. It is an association typical of humid and wet habitats, and its range and persistence in the Bystra valley was linked with the lack of cutting management.

Much fewer patches represented the *Glycerietum maximae* association with smaller floristic diversity (Table 1). They were characterised by the dominance of *Glyceria maxima* and small share of other species, mainly *Phalaris arundinacea*, *Caltha palustris*, *Myosotis palustris* and *Scirpus sylvaticus*. The phytocoenoses of association occurred in small, neglected water reservoirs and small flooded areas within the tributaries of streams. These habitats were characterised by high moisture levels and a layer of alluvial sediments transported by flood waters. The *Phalaridetum arundinaceae* association was also represented by a small number of patches. A community with the dominant *Phalaris arundinacea* grew on narrow plots along some stretches of the river or occurred in the form of small patches forming a mosaic with other plant communities.

In the study, changes in the vegetation cover in connection with Ellenberg indices were also analysed. The Principal Components Analysis showed that the first axis explains about 66% variability in all dataset. The nitrogen (N), soil acidity (R), moisture (F) and light (L) indices had the positive impact on the first axis while the continentality (K) and temperature index (T) had the negative impact.

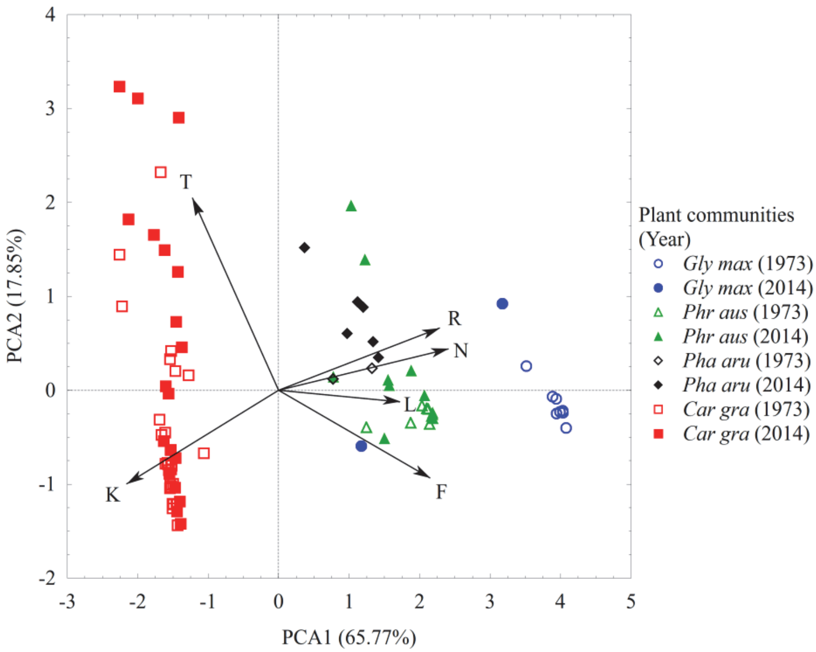

Fig. 2. Ordination diagram of relevés of rush communities (*Gly max – Glycerietum maximae*; *Phr aus – Phragmitetum australis*; *Car gra – Caricetum gracilis*; *Pha aru – Phalaridetum arundinaceae*) relative to the Ellenberg indices (F – soil moisture, R – acidity, N – trophism, L – light, T – temperature, K – continentality)

Rys. 2. Diagram ordynacyjny zdjęć zbiorowisk szuwarowych (*Gly max – Glycerietum maximae*; *Phr aus – Phragmitetum australis*; *Car gra – Caricetum gracilis*; *Pha aru – Phalaridetum arundinaceae*) w stosunku do wskaźników Ellenberga (F – wilgotność gleby, R – kwasowość, N – trofizm, L – światło, T – temperatura, K – kontynentalizm)

The second axis, which explains about 18% general variability, is the most positively correlated with temperature (T) and the most negatively with continentality (K) and moisture (F) indices.

Figure 2 shows a clear separation of phytosociological relevés of *Caricetum gracilis* from other communities. The *Phalaridetum arundinac*eae and *Phragmitetum australis* associations are similarly linked with the first axis, with the former community predominantly occurring in more humid habitats. *Phalaridetum arundinaceae* tends to prefer warmer conditions. The third distinguishable group consists of *Glycerietum maximae* with exception of one point. The vegetation cover of the analysed plant communities is stable, which is confirmed by the similar areas covered by phytosociological relevés made in 1973 and 2014. The *Glycerietum maximae* association is an exception where one point is slightly shifted towards the centre of the coordinate system so its value is smaller (Fig. 2).

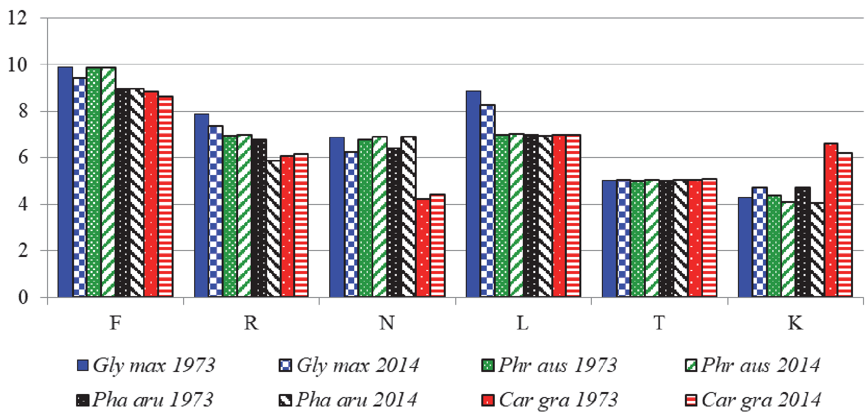

Fig. 3. Changes of Ellenberg's indicators mean values of rush communities (explanations like in Fig. 2)
Rys. 3. Zmiany średnich wartości wskaźników Ellenberga zbiorowisk szuwarowych (objaśnienia jak na rysunku 2)

The values of the indices according to Ellenberg et al. (1992) confirm that these are rush communities sharing similar habitat and climate requirements. The largest differences concerned the lowest nitrogen content in the *Caricetum gracilis* association, the highest light index for

Glycerietum maximae and continentality index for *C. gracilis* as well as a higher moisture index for *P. australis* and *G. maximae*. A comparison of 1973 and 2014 does not show considerable changes in the index values. Lower values were usually observed, particularly with regard to habitat indices but it was not a rule (Fig. 3). Similar values of edaphic indices for communities under study are provided by Warda & Stamirowska-Krzaczek (2009) for the Wieprz valley. Lower values of the moisture indices were recorded, which could result from lower precipitation volumes in recent years, limiting the occurrence of flooding with flood water in the Bystra valley.

Studies conducted in 2014 confirmed the occurrence of the same plant associations as in 1973 even though some changes did occur and the communities had a more pronounced mosaic, often transitional, character. Similarly to 1973, the *Caricetum gracilis* association was predominant in 2014: 60% of its patches were preserved in the original shape. In some systematically cut patches, a greater abundance of species from the *Molinietalia* order was observed (Fig. 1). The other patches transformed into communities of the *Alnion glutinosae* alliance (17%) with the predominant *Alnus glutinosa,* or *Phragmitetum australis* reed rush (15%; Table 2). In both cases, the changes resulted from the abandonment. In the former case, the patches were located closer to the river and had a high share of *Alnus glutinosa* and species from the genus *Salix*. In the latter case, the patches bordered with reed rushes; it must be stressed that *Phragmites australis* is an expansive species, particularly when not cut (Kamiński 2004, Kryszak et al. 2006, Kulik 2014, Stypiński & Grobelna 2000, Warda & Stamirowska-Krzaczek 2009). Some patches transformed into *Phalaridetum arundinaceae* rushes (4%). In 2014, there were more patches from the *Phalaridetum arundinaceae* association (Fig. 1), which also inhabited areas where *Glycerietum maximae* formerly occurred. The persistence of this association and its range depend on the systematic flooding in river valleys (Czyż et al. 2012, Wyłupek et al. 2015). Limited flooding accompanied by the delivery of sediments and periodic drying was conducive to the development of *Phalaridetum arundinaceae*, with the participation of species from the *Molinio-Arrhenatheretea* class (Table 1-2).

The reed rushes where 67% of the patches survived in unchanged form also showed a high level of stability. A smaller part of the drying, systematically cut habitats morphed into wet meadows representing the *Molinio-Arrhenatheretea* class (16.5%) while the patches located near the river changed into communities with the predominance of the common alder due to the lack of cutting. The process of secondary succession was also observed in the case of the *Phalaridetum arundinaceae* association (50% of the patches) and *Glycerietum maximae* (25%; Table 2). Under conditions of discontinued management of the rushes, they morph into forest communities over a longer period (Denisiuk 1980).

Table 2. Directions of changes of the *Phragmitetea* class communities
Tabela 2. Kierunki zmian zbiorowisk klasy *Phragmitetea*

Patches of communities in particular years (based on number of relevés)	
1973	2014
Ass. *Glycerietum maximae* (100%)	Ass. *Glycerietum maximae* (25%) Ass. *Phalaridetum arundinaceae* (25%) GrAss. *Alnion glutinosae* (25%) Ass. *Caricetum gracilis* (12.5%) Ass. *Phragmitetum australis* (12.5%)
Ass. *Phragmitetum australis* (100%)	Ass. *Phragmitetum australis* (67%) Cl. *Molinio-Arrhenatheretea* (16.5%) GrAss. *Alnion glutinosae* (16.5%)
Ass. *Caricetum gracilis* (100%)	Ass. *Caricetum gracilis* (60%) GrAss. *Alnion glutinosae* (17%) Ass. *Phragmitetum australis* (15%) Cl. *Molinio-Arrhenatheretea* (4%) Ass. *Phalaridetum arundinaceae* (4%)
Ass. *Phalaridetum arundinaceae* (100%)	Ass. *Phalaridetum arundinaceae* (25%) GrAss. *Alnion glutinosae* (50%) Cl. *Molinio-Arrhenatheretea* (25%)

The changes of plant communities from the *Phragmitetea* class were caused by habitat changes that influenced the occurrence of characteristic species. In the period analysed (1973-2014), a reduced floristic diversity was observed in the *Caricetum gracilis* association (on average 16 species in 1973 and 14 in 2014) and *Phragmitetum australis* association (9 and 8 respectively) and increased diversity for *Phalaridetum arundinaceae* (9 and 10 respectively) and *Glycerietum maximae* (9 and

14 respectively). In 1973, a greater share of species of the *Molinio-Arrhenatheretea* class, particularly the *Calthion* alliance, was observed in the *Caricetum gracilis* association (Table 1). The reduced number of species, particularly low one such as *Caltha palustris*, *Myosotis palustris*, *Trifolium hybridum*, or *Lychnis flos-cuculi*, was mostly caused by the abandonment, which led to the dominance of one characteristic species. Under conditions of management cessation, primary succession and return to floristically poor typical sedge communities occurs (Denisiuk 1980). On the other hand, there was an increased frequency of tall species such as *Cirsium rivulare*, *Filipendula ulmaria*, *Deschampsia caespitosa*, or *Lysimachia vulgaris*, which can indicate the usage extensification or abandonment (Grzywna & Urban 2008, Kostrakiewicz-Gierałt 2014, Kryszak et al. 2006). Similar tendencies were observed in the case of reed rushes where reduced diversity was caused by the disappearance of low species such as *Eleocharis palustris*, or *Rorippa amphibia*, characteristic of the *Phragmitetea* class (Table 1). This is confirmed by the results of other studies (Kamiński 2004, Kryszak et al. 2006, Kulik 2018).

An increase in floristic diversity in the other two associations was mainly linked with the greater number of characteristic species of the *Molinio-Arrhenatheretea* class (Table 1) and resulted from systematic cutting, which enables better growth and development of low species in particular (Kulik et al. 2017). However, when systematically cut, the *Phalaridetum arundinaceae* patches can have a much greater number of species (Szydłowska 2010, Wyłupek et al. 2015). Investigations conducted at the same sites (complexes) in different periods enable a more precise determination of the rate of changes in the species composition and the directions of the succession of communities depending on the changing habitat conditions or human activity (Dzwonko 2007).

The rushes from the *Phragmitetea* class were characterised by the dominance of a characteristic species, which is manifested in a smaller floristic diversity but, at the same time, a greater resistance of these communities to anthropogenic pressure (Kryszak et al. 2006). The plant communities of this class are usually of low fodder value but of high significance for the preservation of biodiversity, particularly as habitats for water and marsh birds (Grzelak 2004, Grzelak et al. 2015, Jonsson & Malmqvist 2000, Riis & Biggs 2003).

4. Conclusions

The *Caricetum gracilis* association (57% of the patches) was the dominant plant community from the *Phragmitetea* class in the valley of the Bystra river in 1973 and 2014. The other communities were *Phragmitetum australis*, *Glycerietum maximae* and *Phalaridetum arundinaceae*.

The plant communities from the *Phragmitetea* class reed communities were exposed to small anthropopressure so most of the patches of the analysed associations in the Bystra valley survived in unchanged form for 41 years.

Most changes in the vegetation cover of the rush communities resulted from the abandonment, which first leads to reduced floristic diversity manifested in the dominance of characteristic species and disappearance of low plants. In the second stage, secondary succession can occur, manifested in a greater abundance of shrubs and trees, which was observed after 41 years in the Bystra valley as communities of the *Alnion glutinosae* alliance.

Other changes in the plant communities occurred as a result of changes in habitat conditions (lower values of Ellenberg's indices) and systematic management, which led to the more frequent occurrence of species from the *Molinio-Arrhenatheretea* class.

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Zmiany roślinności z klasy *Phragmitetea* w dolinie Bystrej, wschodnia Polska

Streszczenie

Celem badań była ocena zmian roślinności z klasy *Phragmitetea* w dolinie rzeki Bystrej we wschodniej Polsce po 41 latach, kierunków sukcesji w zbiorowiskach roślinnych oraz analiza zmian na podstawie średnich wartości liczb Ellenberga obliczonych dla poszczególnych zbiorowisk szuwarowych. Badania zostały przeprowadzone w latach 1973 i 2014 w dolinie rzeki Bystrej, na trwałych użytkach zielonych o powierzchni około 30 ha, należących do rolników z następujących miejscowości: Nałęczów (2,5 ha), Łąki (2,7 ha), Wąwolnica (4,9 ha), Mareczki (3,0 ha), Rogalów (2,3 ha), Zawada (1,6 ha), Bartłomiejowice (3,3 ha), Chmielnik (0,9 ha), Góra (1,1 ha), Szczuczki (1,4 ha), Łubki (2,4 ha) i Nowy Gaj (3,6). Rzeka Bystra wypływa w Czesławicach i płynie z kierunku wschodniego na zachód, wpadając do Wisły w Bochotnicy. Zasilana jest kilkoma strumieniami, z których największy to rzeka Czerka. Ujścia tych cieków oraz liczne źródliska tworzą rozlewiska, w których występują zbiorowiska szuwarowe z klasy *Phragmitetea*. Metodą Braun-Blanqueta (1964) wykonano 44 zdjęcia fitosocjologiczne w 1973 roku i 41 – w 2014. Zmienność florystyczną w okresie 41 lat określono na podstawie struktury fitosocjologicznej i średniej liczby gatunków występujących w poszczególnych zdjęciach badanej fitocenozy. Zmiany warunków klimatycznych (L – światło, T – temperatura, K – kontynentalizm) i edaficznych (F – wilgotność, R – kwasowość, N – zawartość azotu) oceniono posługując się ekologicznymi liczbami wskaźnikowymi Ellenberga i in. (1992). Dominującym zbiorowiskiem roślinnym z klasy *Phragmitetea* w dolinie rzeki Bystrej w latach 1973 i 2014 był zespół *Caricetum gracilis* (57% płatów). Do pozostałych zbiorowisk należały *Phragmitetum australis*, *Glycerietum maximae* i *Phalaridetum arundinaceae*. Zbiorowiska roślinne z klasy *Phragmitetea* charakteryzują się dużą odpornością na antropopresję, ponieważ większość płatów analizowanych zespołów w dolinie Bystrej przetrwało w niezmienionej formie przez 41 lat. Większość zmian szaty roślinnej zbiorowisk szuwarowych spowodowana była zaniechaniem użytkowania, które w pierwszej kolejności prowadzi do zmniejszenia różnorodności florystycznej, przejawiającej się dominacją gatunku charakterystycznego i ustępowaniem niskich roślin. W kolejnym etapie może nastąpić sukcesja wtórna, której wyrazem jest większy udział krzewów i drzew, co zaobserwowano po 41 latach w dolinie Bystrej w postaci zbiorowisk związku *Alnion glutinosae*. Pozostałe przekształcenia zbiorowisk roślinnych nastąpiły w wyniku zmian warunków siedliskowych (zmniejszenie wartości wskaźników Ellenberga) oraz systematycznego użytkowania, co wpłynęło na częstsze występowanie gatunków z klasy *Molinio-Arrhenatheretea*.

Abstract

The aim of the study was to analyse the vegetation changes of the *Phragmitetea* class in the valley of the Bystra river in Eastern Poland after a period of 41 years, identify the direction of plant communities succession, and to analysis of changes based on the average values of Ellenberg's indicators calculated for particular reed communities. The studies were conducted in the years 1973 and 2014 in the valley of the Bystra river, on grasslands of an area of approx. 30 ha belonging to farmers from the following localities: Nałęczów (2.5 ha), Łąki (2.7 ha), Wąwolnica (4.9 ha), Mareczki (3.0 ha), Rogalów (2.3 ha), Zawada (1.6 ha), Bartłomiejowice (3.3 ha), Chmielnik (0.9 ha), Góra (1.1 ha), Szczuczki (1.4 ha), Łubki (2.4 ha) and Nowy Gaj (3.6). The Bystra river (Eastern Poland) starts in Czesławice and flows from the east to the west, emptying into the Vistula at Bochotnica. It is fed by several streams, the largest of which is the Czerka river. The mouths of these streams and the numerous springs form pools of stagnant water where rush communities of the *Phragmitetea* class occur. 44 phytosociological relevés were performed in 1973 and 41 in 2014 according to the Braun-Blanquet (1964) method. The floristic diversity after a period of 41 years was identified based on the phytosociological structure and mean number of species in the particular relevés of the phytocoenoses under study. Changes of the climatic (L – light, T – temperature, K – continentality) and edaphic (F – moisture, R – reaction, N – nitrogen content) conditions were assessed using ecological indicator values by Ellenberg et al. (1992). The *Caricetum gracilis* association (57% of the patches) was the dominant plant community from the *Phragmitetea* class in the valley of the Bystra river in 1973 and 2014. The other communities included *Phragmitetum australis*, *Glycerietum maximae* and *Phalaridetum arundinaceae*. The plant communities from the *Phragmitetea* class are characterised by a high resistance to anthropogenic pressure because most of the patches of the analysed associations in the Bystra valley survived in unchanged form for 41 years. Most changes in the vegetation cover of the rush communities resulted from the abandonment, which first leads to reduced floristic diversity manifested in the dominance of characteristic species and disappearance of low plants. In the second stage, secondary succession can occur, manifested in a greater abundance of shrubs and trees, which was observed after 41 years in the Bystra valley in the form of communities of the *Alnion glutinosae* alliance. Other changes in the plant communities occurred as a result of changes in habitat conditions (lower values of Ellenberg's indices) and systematic utilisation, which led to the more frequent occurrence of species from the *Molinio-Arrhenatheretea* class.

Słowa kluczowe:
wskaźniki Ellenberga, zbiorowiska szuwarowe, przekształcenia roślinności

Keywords:
Ellenberg's indicators, rush communities, vegetation transformation