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Monitoring the diversity of psammophilous grassland communities in the Kózki Nature Reserve under grazing and non-grazing conditions

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Abstract

The objective of the study was to assess the changes in vegetation and turf cover of psammophilous grasslands in the Kózki Nature Reserve under grazing and non-grazing conditions. The investigations were conducted in the years 2010–2013 in southern part of the Kózki Nature Reserve, in the Podlaski Przełom Bugu (the Podlasie Bug Gorge) Landscape Park where sheep of the native breed Świniarka graze as part of the agri-environmental project "Preservation of endangered genetic animal resources in agriculture". The pasture area is a mosaic of sandy grasslands of the *Koelerio glaucae-Corynephoretea canescentis* class and meadow communities of the *Molinio-Arrhenatheretea* class. The turf cover of the study areas varied depending on the type of phytocoenoses and on grazing the sward by sheep or the cessation of its use. Significantly greatest turf cover was determined for communities with species ChAll. *Vicio lathyroidis-Potentillion argenteae* involving species ChCl. *Molinio-Arrhenatheretea* and dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*, community with *Calamagrostis epigejos* and with *Poa pratensis*. Significantly smallest turf cover was observed for the *Spergulo-Corynephoretum* association where grazing by the Świniarka sheep led to successive reduction of the vegetation cover in the study period. Monitoring of the number of trees and shrubs indicated that all species of this group of plants, up to the height of 100 cm, were nibbled or damaged by sheep during the grazing. Therefore, sheep of the Świniarka breed can be used in the protection of psammophilous grasslands because they hinder the secondary succession of tree and shrub vegetation.

Key words: *grazing, psammophilous grasslands, sheep of the Świniarka breed*

INTRODUCTION

All European dry grasslands can be characterized from a hydrological point of view as infiltration areas, fed by rainwater. Thermophilous inland grasslands of the *Koelerio glaucae-Corynephoretea canescentis* class constitute a habitat for many rare and endangered plant and invertebrate species. They are priority natural habitats at European level listed in Annex I of the Habitat Directive. Species listed in Annex II of the Habitat Directive also occur there. These valuable habitats are threatened by both the cessation and intensification of their use *i.e.* by fertilisation and overgrazing that may mechanically damage the vegetation cover. As a result of these processes, psammophilous grasslands disappear together with valuable fauna and flora species [ZARZYCKI, MISZTAL 2010; FAUST *et al.* 2011], which necessitates their protection, through *e.g.* the promotion of their extensive use [CEYNOWA-GIEŁDON 1986; KUJAWA-PAWLACZYK 2004; WARDA, KULIK 2012]. One of the protected areas featuring valuable patches of psammophilous grasslands is the Kózki Nature Reserve in the "Podlaski Przełom Bugu" Landscape Park located within the Natura 2000 area "Ostoja Nadbużańska" (PLH140011). The Bug River, a left-hand tributary of the Narew River, is one of the best preserved and largest lowland rivers in Poland and is among the least transformed large rivers in Europe [SIENKIEWICZ-PADEREWSKA 2010]. Located by the Bug River in northern part of the Sarnaki municipality and covering an area of 82.1 ha, the Kózki Nature Reserve is a habitat for many valuable fauna and flora species. A specific feature of the landscape are patches of psammophilous grasslands formed from sediments transported by the river and enriched with single specimens or small groups of *Juniperus communis*. Continuous grasslands forming the so-called grey dunes and white dunes, covered by tufts of sparse vegetation with vast patches of bare sand are characteristic for the area [DOMBROWSKI, WERESZCZYŃSKA 1991; MARCINIUK 2009]. In the late 1980s and early 1990s, sandy shoals formed by the sand material accumulated by the Bug River were still a characteristic landscape feature. This area was grazed before the establishment of the nature reserve, but afterwards the agricultural use was discontinued, which was one of the reasons behind secondary succession in the psammophilous grassland communities and their transformation to compact shrub growth and, finally, forest communities. Dead, non-decomposed organic matter accumulates on grasslands and the soil is subject to gradual shading. Such conditions are conducive to the appearance of seedlings of trees and shrubs that overshadow the grasslands and cause the recession of extremely xeric and light-loving species that give way to meadow species. This is evidenced by changes in the population of the dominant bird species that are the best indicators of habitat changes [GRZYWACZEWSKI *et al*. 2012]. In the late 1980s and early 1990s, the Northern Lapwing (*Vanellus vanellus*), Common Redshank (*Tringa totanus*) and Eurasian Skylark (*Alauda arvensis*) were among the characteristic meadow and pasture species [DOMBROWSKI, WERESZCZYŃSKA 1991]. Habitat changes include also the reduced biological diversity and changes of the chemical condition of the soil [GRUSZECKI *et al*. 2011].

A natural and effective means of preventing such processes is animal grazing that limits the growth of weeds and stops secondary succession. Small ruminants, particularly sheep, are the best adapted animals to forage on low-productive xerophilous grasslands [FAUST *et al*. 2011; HELLSTRÖM *et al*. 2003; SCHWABE, KRATOCHWIL 2004; SKRIJKA 1984; STROH *et al*. 2002; WARDA, KULIK 2012; WARDA, ROGALSKI 2004]. In recent years, old breeds of primitive ruminants have very often been used for this purpose, which preserves the endangered genetic animals resources in agriculture and the environmentally valuable habitats. The native Świniarka breed of sheep is among these disappearing species. It is the most primitive sheep breed in Poland [GRUSZECKI *et al*. 2011]. Investigations conducted at the Kózki Nature Reserve were part of an interdisciplinary project "Active protection of selected Natura 2000 habitats with the use of native sheep breed". The objective of the study was to assess changes in the vegetation and turf cover of psammophilous grasslands in the valley of the Bug River under grazing and non-grazing conditions with the use of sheep of the Świniarka breed.

MATERIALS AND METHODS

The investigations were conducted in the years 2010–2013 in the Kózki Nature Reserve (52°21' 42.54″ N 22°51'39.61″ E), covering an area of 82.1 ha and located in the northern part of the Sarnaki municipality (Mazowieckie Province), in the "Podlaski Przełom Bugu" Landscape Park (Fig. 1). The name "Kózki" originates from the same-named village bordering the reserve. The studies were concentrated on the southern part of the grasslands separated from the northern part by an old riverbed of the Bug River. The area of about 15 ha, which belongs to an individual farmer, is a ground for sheep of the native Świniarka continuously grazed as part of package 7 of the agri-environmental scheme "Preservation of endangered genetic animal resources in agriculture". Stocking density in particular years was 90–110 sheep in 2010, 110–157 in 2011, 110–120 in 2012 and 120 sheep in 2013.

Fig. 1. Localization of the Kózki Nature Reserve; source: own elaboration

The vegetation cover in the Kózki Nature Reserve was studied within homogeneous patches. Six permanent 20 m x 10 m tracts were designated within the uniform types of phytocoenoses (Tab. 1). Each large tract of land was divided into two parts, 100 m^2 each (sheep grazed on one while the other was unused). In each tract, wooden stakes were used to mark

Table 1. Characteristics of the vegetation

Plot	Name of communities
A	community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* Brzeg in Brzeg et M.Wojt. 1996 involving species ChCl. *Molinio-Arrhenatheretea* R.Tx. 1937
B	community dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* Klika in Klika et Novak 1941 involving species ChCl. *Molinio-Arrhenatheretea* R.Tx. 1937
C	Ass. *Spergulo-Corynephoretum* (R.Tx. 1928) Libb. 1933
D	community with the domination of *Calamagrostis epigejos* (Ass. *Corynephoro-Silenetum tataricae* Libb. 1931)
E	community with *Poa pratensis* involving species ChCl. *Molinio-Arrhenatheretea* R.Tx. 1937
F	community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* Brzeg in Brzeg et M.Wojt. 1996 dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* Klika in Klika et Novak 1941

Source: own study

Table 3. Change in the number of trees and shrubs in the studied plots

Plot	Type of use	Number of specimens (high)			
		∑	Spring 2010	∑	Spring 2013
A	1	32	*Prunus spinosa* 30 (20–80 cm); *Pyrus pyraster* 1 (>200 cm); *Salix alba* 1 (80 cm)	14	*Alnus glutinosa* 11 (5–15 cm); *Prunus spinosa* 2 (30–40 cm); *Pyrus pyraster* 1 (>200 cm)
	2	0	–	195	*Alnus glutinosa* 192 (10–130 cm); *Quercus robur* 1 (18 cm); *Pinus sylvestris* 1 (17 cm); *Juniperus communis* 1 (25 cm)
B	1	6	*Juniperus communis* 4 (40–200 cm); *Padus avium* 1 (40 cm); *Rosa canina* 1 (30 cm)	3	*Juniperus communis* 3 (>200 cm)
	2	2	*Juniperus communis* 2 (>200 cm)	2	*Juniperus communis* 2 (>200 cm)
C	1	0	–	0	–
	2	0	–	0	–
D	1	0	–	0	–
	2	0	–	0	–
E	1	5	*Alnus glutinosa* 2 (30–40 cm); *Crataegus monogyna* 1 (40 cm); *Padus avium* 1 (100 cm); *Prunus spinosa* 1 (80 cm)	2	*Padus avium* 1 (120 cm); *Prunus spinosa* 1 (100 cm)
	2	2	*Prunus spinosa* 2 (80–100 cm)	2	*Prunus spinosa* 2 (90–110 cm)
F	1	2	*Quercus robur* 2 (10–30 cm)	0	–
	2	1	*Juniperus communis* 1 (>200 cm)	1	*Juniperus communis* 1 (>200 cm)

Explanations: 1 – grazed by sheep; 2 – non-grazed (abandoned grassland); A – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* involving species ChCl. *Molinio-Arrhenatheretea*; B – community dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*; C – Ass. *Spergulo-Corynephoretum*; D – community with the domination of *Calamagrostis epigejos* (Ass. *Corynephoro-Silenetum tataricae*); E – community with *Poa pratensis* involving species ChCl. *Molinio-Arrhenatheretea*; F – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis*.
Source: own study

out four permanent plots (0.5 m x 0.5 m) for a detailed monitoring of the turf cover and share of individual species in the vegetation cover. The monitoring was conducted every year on two dates: before (in the spring) and after the grazing (in the autumn). The vegetation and turf cover was investigated according to quadrat method [WEAVER 1918] with a square frame $0.5 \times 0.5 = 0.25$ m^2. In large tracts (100 m^2) the number of trees and shrubs was also monitored (Tab. 3). The turf cover data (in four repetitions) were processed statistically using the analysis of variance followed by Tukey's test. The nomenclature of vascular plants was given according to MIREK *et al*. [2002] while that of mosses – according to OCHYRA *et al*. [2003]. The types of plant communities on large tracts was assessed using the Braun-Blanquet method and described according to MATUSZKIEWICZ [2008].

RESULTS AND DISCUSSION

Performed study showed a significant impact of grazing on grassland vegetation. The turf cover of the areas under study depended on the year, type of phytocoenosis and type of use. Significant changes were observed only after the first year of investigation (2010) when the most extensive vegetation cover (mean 92.9%) was recorded, regardless of the phytocoenosis. Significantly lower turf cover was recorded in the spring of the following years (2011 – 89.7%; 2012 – 87.9%; 2013 – 87.9%) (Fig. 2). The vegetation structure and cover and the persistence of individual species on psammophilous grassland is regulated by the magnitude of climatic stress in particular years [DANIELS *et al*. 2008]. Significantly lower turf cover

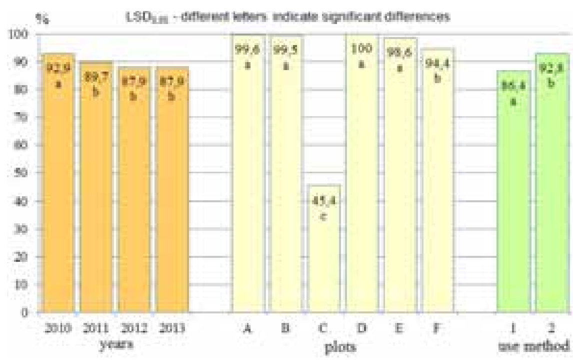

Fig. 2. Mean spring turf cover of the plots in relation to the years, phytocenosis and type of use; 1 – grazed by sheep; 2 – non-grazed (abandoned grassland); A – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* involving species ChCl. *Molinio-Arrhenatheretea*; B – community dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*; C – Ass. *Spergulo-Corynephoretum*; D – community with the domination of *Calamagrostis epigejos* (Ass. *Corynephoro-Silenetum tataricae*); E – community with *Poa pratensis* involving species ChCl. *Molinio-Arrhenatheretea*; F – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis*; source: own study

was recorded on grazed grassland (86.4%) compared to non-grazed area (92.8%; Fig. 2). This was probably caused by grazing pressure resulting from a too high stocking rate on the pasture [DANIELS *et al*. 2008; KULIK 2007]. Continuous grazing leads to inefficient pasture utilisation because some areas are intensively grazed while other areas may be used only for foraging the sheep. Regardless of the year and sheep grazing, the analysed phytocoenosis can be divided into three groups. Significantly greatest turf cover was determined for the following grasslands: A – *Vicio lathyroidis-Potentillion argenteae* community (mean 99.6%), B – *Koelerio glaucae-Corynephoretea canescentis* community (mean 99.5%), D – community with *Calamagrostis epigejos* (mean 100%) and E – community with *Poa pratensis* (mean 98.6%). These communities were also characterised by a relatively high productivity in comparison with other combinations [WARDA *et al*. 2011]. Significantly smaller turf cover was observed in the psammophilous grassland (F) – a more compact and floristically richer *Vicio lathyroidis-Potentillion argenteae* community dominated by species of *Koelerio glaucae-Corynephoretea canescentis* (mean 94.4%). Significantly smallest turf cover was observed in the grassland C – *Spergulo-Corynephoretum* association (mean 45.4%). Grazing by Świniarka sheep significantly reduced the turf cover (mean 86.4%) in comparison with non-grazed grasslands (mean 92.8%). The greatest impact of sheep grazing was observed in the sparse psammophilous grassland (C) where the mean vegetation cover was successively decreasing in the years 2010–2013 (63.8% > 33.8% > 35.0% > 18.8% > 6.5% > 2.8% > 5.0%, respectively, Fig. 3). In the last year of the study, small regeneration of the vegetation cover was observed. In 2010, two areas with the largest turf cover (about 65%) were selected in the psammophilous grassland. The size of bare areas usually increases as a result of extreme climate conditions like summer droughts or frosty, snowless winters that cause the disappearance of particular species from the sward [WARDA 1997; KULIK 2007]. Grazing is also a factor influencing the turf cover and persistence of individual species in the sward of pastures [KULIK 2007] and it turned out to be very significant in the case of the sparse psammophilous grassland. While moving across the sandy surfaces, sheep damaged the delicate *Cladonia mitis* lichens and tore out tufts of *Corynephorus canescens* with their hoofs. Therefore, when planning pasturage on grasslands of this type, it is important to select animals appropriate for the production potential of a pasture, or to secure the bare dune parts of the grasslands against unnecessary foraging by sheep. Other low-productive grasslands, with a better turf cover [KUJAWA-PAWLACZYK 2004; WARDA, KULIK 2012; WYSOCKI, SIKORSKI 2009], can be grazed by the Świniarka sheep that are best adapted to collecting forage from such grasslands. However, grazing by sheep with low stocking rate is often insufficient to prevent adverse successional vegetation change [STROH *et al*. 2002]. The turf cover of unused grassland, on the other hand, was similar to the initial state, ranging from 57.5 to 67.5% in the study years (Fig. 3). A decrease in the turf cover during the study period was also observed on grazed psammophilous grassland (F), floristically richer, particularly in the initial period of grazing (until the autumn of 2011). From the spring 2012, the sward was regenerating and on the last assessment date, the turf cover was similar to the initial state (Fig. 3). This resulted from a smaller pressure on this part of the pasture. *Niphotrichum canescens* moss had the greatest contribution to the increased vegetation cover (Tab. 2).

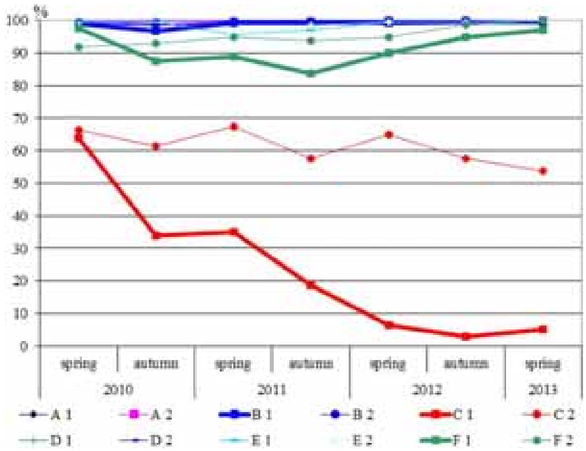

Fig. 3. Changes of the turf cover in the study years; 1 – grazed by sheep; 2 – non-grazed (abandoned grassland); A – community with species ChAll. *Vicio lathyroidis--Potentillion argenteae* involving species ChCl. *Molinio--Arrhenatheretea*; B – community dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*; C – Ass. *Spergulo-Corynephoretum*; D – community with the domination of *Calamagrostis epigejos* (Ass. *Corynephoro--Silenetum tataricae*); E – community with *Poa pratensis* involving species ChCl. *Molinio-Arrhenatheretea*; F – community with species ChAll. *Vicio lathyroidis--Potentillion argenteae* dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis*; source: own study

Species composition of the analysed phytocoenoses changed depending on the type of use in the study period. The dominant species in the sward of grassland A, both grazed and non-grazed, were: *Carex praecox, Hieracium pilosella, Anthoxantum odoratum, Luzula campestris* and *Danthonia decumbens*. Moreover, the non-grazed grassland showed a considerable share of the *Polytrichum juniperinum* moss that increased its share in the study period (from 1.3 to 12.4 %), similarly to the moss of the *Brachytecium* sp. genus (Tab. 2). The coverage of *Luzula campestris* increased in the sward of grazed grassland, but it was reduced in non-grazed grassland. Thirty three plant species were identified in the grazed part and 35 species in the non-grazed part of the study areas (a total of 1 m^2 in four repetitions). Grassland B grazed by the Świniarka sheep was characterised by the predomi-

Table 2. Changes in the composition of sward species in the study period (%)

Plot	Dominant species	Mean	2010		2011		2012		2013
			s	a	s	a	s	a	s
1	2	3	4	5	6	7	8	9	10
A1	*Carex praecox*	18.0	16.6	18.3	21.5	19.9	15.9	17.6	16.3
	Hieracium pilosella	17.0	14.5	13.0	18.1	18.0	21.4	16.3	17.8
	Anthoxantum odoratum	14.6	15.0	15.4	18.6	17.0	14.0	10.8	11.3
	Luzula campestris	10.8	9.9	10.6	12.4	11.3	8.6	9.5	13.5
	Danthonia decumbens	5.2	5.5	5.5	6.6	6.4	3.8	4.1	4.6
	Others less than 5%: *Brachytecium sp. > Plantago lanceolata > Hypochaeris radicata > Thymus serpyllum > Briza media > Carex hirta > Berteroa incana > Cladonia mitis > Achillea millefolium > Polytrichum juniperinum > Armeria maritima > Rumex acetosella > Elymus repens > Sedum acre > Myosotis arvensis > Saxifraga granulata > Helichrysum arenarium > Veronica chamaedrys > Alnus glutinosa > Potentilla arenaria > Equisetum arvense > Hypericum perforatum > Medicago lupulina > Phleum pratense > Potentilla anserine > Prunus spinosa > Conyza canadensis > Jasione montana*								
A2	*Luzula campestris*	17.5	20.9	19.6	24.3	22.5	14.9	11.5	8.5
	Anthoxantum odoratum	12.1	17.4	19.0	11.0	10.5	12.3	9.4	5.3
	Hieracium pilosella	11.2	9.3	9.5	10.1	8.6	13.0	13.4	14.5
	Danthonia decumbens	8.2	9.1	8.8	9.6	8.9	8.9	7.5	4.9
	Carex praecox	6.3	7.6	7.9	10.3	7.1	4.9	3.4	3.0
	Polytrichum juniperinum	5.0	1.3	1.3	0.8	2.8	7.3	9.0	12.4
	Others less than 5%: *Plantago lanceolata > Carex hirta > Briza media > Cladonia mitis > Nardus stricta > Brachytecium sp. > Rumex acetosella > Festuca rubra > Armeria maritima > Agrostis capillaris > Potentilla arenaria, Thymus serpyllum > Alnus glutinosae > Achillea millefolium > Niphotrichum canescens > Jasione montana > Hypochaeris radicata > Helichrysum arenarium > Myosotis arvensis > Saxifraga granulata > Trifolium dubium > Veronica chamaedrys > Berteroa incana > Holcus lanatus > Hypericum perforatum > Potentilla anserina > Trifolium arvense > Equisetum arvense > Sedum acre*								
B1	*Carex praecox*	18.8	16.4	16.1	25.3	21.9	17.5	17.5	16.6
	Cladonia mitis	18.7	22.4	19.9	19.6	18.3	23.3	13.9	13.3
	Anthoxantum odoratum	18.5	16.4	16.8	23.4	23.4	20.4	15.1	14
	Thymus serpyllum	11.2	7.1	7.1	5.8	6.8	12.9	19.5	19.3
	Hieracium pilosella	7.0	6.5	6.6	4.1	6.9	4.6	9.8	10.8
	Potentilla arenaria	6.8	5.6	5.6	7.4	6.0	8.6	7.1	7.0
	Achillea millefolium	6.5	9.3	9.3	5.0	4.3	3.9	6.1	7.3
	Others less than 5%: *Equisetum arvense > Rumex acetosella > Polytrichum juniperinum > Niphotrichum canescens > Sedum acre > Elymus repens > Briza media > Berteroa incana > Holcus lanatus > Hypochaeris radicata > Carex hirta*								
B2	*Cladonia mitis*	28.8	31.6	30.8	25.4	25.3	27.1	30.8	30.4
	Anthoxantum odoratum	21.6	21.8	20.5	32.5	28.1	18.3	14.5	15.3
	Achillea millefolium	9.4	11.4	11.4	8.5	6.3	6.3	10.1	11.5
	Potentilla arenaria	9.4	10.4	10.4	9.8	9.5	5.4	11.0	9.0
	Thymus serpyllum	7.7	2.8	2.8	3.8	5.8	15.0	12.0	11.9
	Carex praecox	7.3	8.4	9.5	8.0	6.5	8.3	5.0	5.3
	Hieracium pilosella	7.3	2.0	2.0	4.0	9.0	13.3	10.5	10.5
	Others less than 5%: *Polytrichum juniperinum > Equisetum arvense > Rumex acetosella > Niphotrichum canescens > Elymus repens > Phleum pratense > Sedum acre > Helichrysum arenarium > Hypochaeris radicata > Poa pratensis*								
C1	*Cladonia mitis*	17.0	45.3	28.0	28.9	13.6	1.6	0.5	1.0
	Corynephorus canescens	4.2	15.3	5.3	0.5	–	4.5	2.0	1.6
	Others less than 5%: *Spergula morisonii > Hieracium pilosella > Agrostis vinealis > Niphotrichum canescens*								
C2	*Cladonia mitis*	47.8	40.6	48.4	50.8	46.5	53.4	52.4	42.5
	Corynephorus canescens	9.6	17.1	10.4	11.6	8.1	11.3	4.4	4.4
	Others less than 5%: *Spergula morisonii > Hieracium pilosella > Agrostis vinealis > Niphotrichum canescens > Helichrysum arenarium*								
D1	*Calamagrostis epigeios*	95.3	93.0	93.0	92.6	92.6	98.8	98.8	98.3
	Carex praecox	3.0	4.5	4.5	4.6	4.6	0.8	0.8	1.3
	Carex hirta	1.7	2.5	2.5	2.8	2.8	0.5	0.5	0.5
D2	*Calamagrostis epigeios*	97.1	91.0	91.0	99.0	99.0	100	100	100
	Carex praecox	1.8	5.8	5.8	0.4	0.4	–	–	–
	Carex hirta	1.1	3.3	3.3	0.6	0.6	–	–	–
E1	*Poa pratensis*	20.1	22.0	21.8	15.6	15.4	16.6	31.6	17.9
	Veronica chamaedrys	17.0	24.4	25.0	17.9	18.6	14.8	6.8	11.3
	Potentilla anserina	15.9	8.6	8.5	19.1	19.1	11.5	21.9	22.8
	Carex hirta	8.5	7.3	7.3	10.0	10.3	7.5	8.9	8.5
	Ranunculus acris	5.3	4.3	4.3	7.4	7.4	5.0	2.8	5.6
	Festuca pratensis	5.1	9.4	9.8	3.4	3.6	4.1	2.8	2.5

cont. tab. 2

1	2	3	4	5	6	7	8	9	10
E1	Others less than 5%: *Avenula pubescens > Equisetum palustre > Phleum pratense > Festuca rubra > Potentilla reptans > Agrostis stolonifera > Carex praecox > Elymus repens > Galium mollugo > Galium verum > Stellaria graminea > Myosotis arvensis > Plantago major > Ranunculus repens > Rumex acetosella > Achillea millefolium > Galium aparine > Glechoma hederacea > Dianthus deltoides*								
E2	*Poa pratensis*	20.0	30.0	28.8	21.2	21.2	8.9	19.7	9.9
	Potentilla anserina	15.0	9.4	9.3	15.6	15.6	18.2	20.7	16.4
	Veronica chamaedrys	14.9	24.4	22.1	13.8	13.3	15.2	4.7	10.8
	Festuca pratensis	9.9	10.2	8.4	9.0	10.2	9.0	13.6	9.1
	Carex hirta	7.8	5.4	5.4	8.0	8.4	7.8	6.9	12.4
	Phleum pratense	6.2	2.7	2.5	9.9	9.8	6.6	5.2	7.0
	Ranunculus acris	5.3	–	–	4.6	4.6	9	7.6	11.5
	Others less than 5%: *Potentilla reptans > Avenula pubescens > Equisetum palustre > Galium mollugo > Festuca rubra > Alopecurus pratensis > Elymus repens > Deschampsia caespitosa > Carex praecox > Prunus spinosa > Agrostis stolonifera > Glechoma hederacea > Galium verum > Achillea millefolium > Rumex acetosella > Ranunculus repens > Vicia sepium > Viola tricolor*								
F1	*Niphotrichum canescens*	25.7	23.8	30.2	29.1	25	15.6	23.4	33.1
	Corynephorus canescens	12.2	5.5	21.9	5.5	18.6	20.7	2.5	10.8
	Carex praecox	11.1	6.3	3.5	16.8	5.8	17.8	15.7	11.5
	Cladonia mitis	7.4	7.1	11.9	8.3	7.9	4.9	6.1	5.3
	Thymus serpyllum	5.6	1.8	3.8	3.0	2.7	10.8	15.3	1.8
	Others less than 5%: *Helichrysum arenarium > Anthoxantum odoratum > Sedum acre > Potentilla arenaria > Hieracium pilosella > Polytrichum piliferum > Equisetum arvense > Poa pratensis > Carex hirta > Rumex acetosella > Elymus repens > Hypochaeris radicata > Veronica verna > Festuca rubra > Jasione montana > Myosotis arvensis > Scleranthus polycarpos > Vicia hirsuta*								
F2	*Niphotrichum canescens*	35.6	14.3	37.0	30.8	31.5	37.4	47.6	50.7
	Carex praecox	12.4	15.0	5.2	14.3	14.9	14.2	11.6	11.3
	Corynephorus canescens	10.5	12.7	15.4	16.6	13.8	5.0	4.2	5.7
	Cladonia mitis	8.1	6.3	14.7	5.9	6.6	5.3	12.9	5.0
	Others less than 5%:*Polytrichum piliferum > Potentilla arenaria > Helichrysum arenarium > Thymus serpyllum > Hieracium pilosella > Scleranthus polycarpos > Equisetum arvense > Sedum acre > Anthoxantum odoratum > Hypochaeris radicata > Berteroa incana > Carex hirta > Spergula morisonii > Myosotis arvensis > Conyza canadensis > Jasione montana > Veronica verna > Rumex acetosella*								

Explanations: s – spring; a – autumn; 1 – grazed by sheep; 2 – non-grazed (abandoned grassland); A – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* involving species ChCl. *Molinio-Arrhenatheretea*; B – community dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*; C – Ass. *Spergulo-Corynephoretum*; D – community with the domination of *Calamagrostis epigejos* (Ass. *Corynephoro-Silenetum tataricae*); E – community with *Poa pratensis* involving species ChCl. *Molinio-Arrhenatheretea*; F – community with species ChAll. *Vicio lathyroidis-Potentillion argenteae* dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis*.
Source: own study.

nance of *Carex praecox, Cladonia mitis, Anthoxantum odoratum, Thymus serpyllum, Hieracium pilosella, Potentilla arenaria* and *Achillea millefolium*. The same species, but in different proportions, dominated in the non-grazed part. In the sward of the pasture, a smaller percentage share of *Cladonia mitis* was observed; its fragile thallus was susceptible to trampling by sheep. The grazed grassland comprised 18 plant species while the non-grazed – 17 species. The sparse psammophilous grassland *Spergulo-Corynephoretum* (C) consisted of seven species, among which *Cladonia mitis* and *Corynephorus canescens* predominated. *Spergula morisonii* and *Hieracium pilosella* were less numerous (Tab. 2). This grassland was characterised by the smallest vegetation cover and by sandy places devoid of turf. Its grazing caused a reduced coverage by all species and increased the size of bare areas. The coverage by the dominant species *Cladonia mitis* decreased from 45.3 to 1.0%. The community with *Calamagrostis epigejos* (D) was the poorest in floristic terms. There was a small percentage of *Carex praecox* and *C. hirta* in its sward (Tab. 2), but these species persisted only in the grazed part. Results of other authors confirmed that sheep grazing reduced the coverage of *Calamagrostis epigejos* and enhanced the habitat-typical phytodiversity [EICHBERG *et al*. 2007; SÜSS *et al*. 2004; SÜSS, SCHWABE 2007]. The lack of grazing resulted in the displacement of these species by the tall *C. epigejos* grass in the sward. It was probably a poor form of the *Corynephoro-Silenetum tataricae* association even though nine plant species were identified in the entire patch. Typical patches of this association occur in the northern part of the Kózki Nature Reserve, where the characteristic *Silene tatarica* or distinguishing species *Petasites spurius* occur. The community with *Poa pratensis* (E) comprised 25 plant species, both in the grazed and non-grazed areas. *Poa pratensis, Veronica chamaedrys* and *Potentilla anserina* dominated in both. The grassland was mainly covered by the characteristic species of the *Molinio-Arrhenatheretea* class (*Alopecurus pratensis, Avenula pubescens, Festuca pratensis, F. rubra, Phleum pratense, Poa pratensis, Ranunculus acris*) and of the low, periodically flooded or waterlogged grasslands of the *Trifolio fragiferae-Agrostietalia stoloniferae* order (*Ranuncu-*

lus repens, Carex hirta, Potentilla reptans, Agrostis stolonifera, Elymus repens, Potentilla anserina). The species composition was similar, only the percentage share of particular species in the sward was changing. Grazing stimulated the persistence of *Poa pratensis* as a typical pasture species [WARDA 2006], while under non-grazing conditions an increasing share of tall grass species such as *Festuca pratensis* or *Phleum pratense* was recorded (Tab. 2). Non-grazed grasslands are often dominated by tall grasses or perennial species [NOY-MEIR *et al.* 1989]. In threatened sand ecosystems grazing by sheep is an appropriate way to ensure vegetation dynamics due to intermediate disturbances and prevent grass encroachment or counteract ruderalisation (SCHWABE, KRATOCHWIL 2004; STROH *et al*. 2002). The psammophilous grassland community of *Vicio lathyroidis-Potentillion argenteae* – F) featured 22–23 plant species, among which *Niphotrichum canescens, Corynephorus canescens, Carex praecox, Cladonia mitis* and *Thymus serpyllum* had greatest percentage shares (Tab. 2). Species composition of this grassland did not vary in relation to the type of use. *Thymus serpyllum* had a greater share in the grazed sward.

Generally, grazed grasslands were characterized by the greatest biodiversity compared to non-grazed ones. In later successional stages, however, grazing has often significant, positive influence on the site-specific diversity of grasslands, including sandy grasslands [HELLSTRÖM *et al*. 2003; SÜSS, SCHWABE 2007]. It should be noted that in the large areas (100 m^2), more species were identified (A – 42, B – 30, C – 10, D – 9, E – 33 and F – 30), while the entire study area was characterised by an even greater floristic diversity [WARDA, KULIK 2012].

In the large fields, the number of trees and shrubs in the sward of grasslands A, B, E and F was also monitored. These plants were not found in the sward of the sparse psammophilous grassland C and in the sward with the predominance of *Calamagrostis epigejos* D (Tab. 3). Ten shrub and tree species (*Alnus glutinosa, Crataegus monogyna, Juniperus communis, Padus avium, Pinus sylvestris, Prunus spinosa, Pyrus pyraster*, *Quercus robur, Rosa canina* and *Salix alba*) occurred in the study areas. Their height ranged from 5 to about 250 cm (Tab. 3). The most numerous species was *Alnus glutinosae* that occurred mainly in grassland A located close to the forest where this tree predominated (the *Alnetea glutinosae* class). In the fourth year of study, 192 specimens of this species were identified under non-grazing conditions; their height varied from 10 to 130 cm (Tab. 3). In the grazed part of this grassland, 11 specimens of this species were found, their height reaching 15 cm. It should also be mentioned that this species was not recorded in 2012. In the spring of 2010, specimens of *Prunus spinosa* were very numerous (30), but three years later only two specimens of this species were identified in the grazed part (Tab. 3). Furthermore, *Salix alba*, *Padus avium*, *Rosa canina*, *Crataegus monogyna* and *Quercus robur* were among the species that occurred in the pasture sward in 2010 but were not recorded in 2013 (Tab. 3). These plants, up to the height of 100 cm, were nibbled or damaged by sheep during the grazing. Sheep also grazed specimens of *Juniperus communis* having a similar height (Tab. 3). The target communities of dry grasslands need management to prevent succession towards a community dominated by just a few herbaceous species that later becomes shrubland, woodland or forest [STROH *et al*. 2002]. This shows that sheep of the Świniarka breed can be used in the protection of psammophilous grasslands because they hinder the secondary succession of tree and shrub vegetation. It should be noted that the secondary succession results in changes in the dominant bird species in Kózki Nature Reserve [GRZYWACZEWSKI *et al*. 2012]. Various management methods, for instance mowing, mulching, burning or grazing, have been discussed for low-productive ecosystems [MOOG *et al*. 2002]. Sheep grazing has turned out to be an adequate conservation tool in inland sand ecosystems [FAUST *et al*. 2011; HELLSTRÖM *et al*. 2003; NAMURA-OCHALSKA 2004; SCHWABE, KRATOCHWIL 2004; STROH *et al*. 2002; WARDA, KULIK 2012].

CONCLUSIONS

1. The turf cover of the grassland under study depended on the year, type of phytocoenosis and type of use. Significantly greatest turf cover was determined for communities with species ChAll. *Vicio lathyroidis-Potentillion argenteae* involving species ChCl. *Molinio-Arrhenatheretea* and dominated by species ChCl. *Koelerio glaucae-Corynephoretea canescentis* involving species ChCl. *Molinio-Arrhenatheretea*, community with *Calamagrostis epigejos*as and with *Poa pratensis*. Significantly smallest turf cover was observed for the *Spergulo-Corynephoretum* association where grazing by Świniarka sheep led to successive reduction of the vegetation cover in the study years.

2. The greatest share in turf cover had species of the *Koelerio glaucae-Corynephoretea canescentis* class (*Carex praecox, Cladonia mitis, Calamagrostis epigejos, Corynephorus canescens, Anthoxantum odoratum, Luzula campestris,Thymus serpyllum*) and meadow communities of the *Molinio-Arrhenatheretea* class (*Poa pratensis, Potentilla anserina, Achillea millefolium*) and of other classes (*Hieracium pilosella, Danthonia decumbens, Potentilla arenaria, Veronica chamaedrys* and *Niphotrichum canescens*).

3. Grazing by the Świniarka sheep influenced the percentage share of particular species but species composition was similar, compared to non-grazed sward.

4. Monitoring of the number of trees and shrubs indicated that all species of this group of plants, up to the height of 100 cm, were nibbled or damaged by sheep during the grazing. This shows that sheep of the Świniarka breed can be used in the protection of

psammophilous grasslands because they hinder the succession of secondary tree and shrub vegetation. Świniarka sheep grazed *Alnus glutinosa, Crataegus monogyna, Juniperus communis, Padus avium, Pinus sylvestris, Prunus spinosa, Pyrus pyraster*, *Quercus robur, Rosa canina* and *Salix alba*.

5. When planning the grazing on psammophilous grasslands it is important to select animals appropriate for the production potential of a pasture, or to secure the bare dune parts of the grasslands against unnecessary foraging by sheep. Other dry grasslands with a better turf cover can be grazed by the Świniarka sheep that are best adapted to collecting forage from such grasslands. Currently, more and more attention is paid to the use of old breeds of primitive ruminants in order to preserve the endangered genetic animals resources in agriculture and the environmentally valuable (for plants and bird species) habitats.

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Monitoring zróżnicowania zbiorowisk roślinnych muraw napiaskowych w rezerwacie przyrody Kózki w warunkach prowadzenia i zaniechania wypasu

STRESZCZENIE

Słowa kluczowe: *murawy napiaskowe, owce rasy świniarka, wypas*

Celem badań była ocena zmian szaty roślinnej i zadarnienia powierzchni muraw w rezerwacie przyrody „Kózki" w warunkach prowadzenia i zaniechania wypasu. Badania przeprowadzono w latach 2010–2013, w południowej części rezerwatu, w granicach Parku Krajobrazowego „Podlaski Przełom Bugu". Na tym obszarze prowadzony jest wypas owiec rodzimej rasy świniarka w ramach realizacji 7. pakietu programu rolnośrodowiskowego „Zachowanie zagrożonych zasobów genetycznych zwierząt w rolnictwie". Teren objęty wypasem stanowi mozaikę muraw napiaskowych klasy *Koelerio glaucae-Corynephoretea canescentis* i zbiorowisk łąkowych klasy *Molinio-Arrhenatheretea*. Zadarnienie badanych powierzchni było zróżnicowane w zależności od typu porastających je fitocenoz oraz spasania runi przez owce lub pozostawienia jej bez użytkowania. Istotnie największym zadarnieniem charakteryzowały się murawy związku *Vicio lathyroidis-Potentillion argenteae,* z klasy *Koelerio glaucae-Corynephoretea canescentis* oraz zbiorowisko z *Calamagrostis epigejos* i zbiorowisko z *Poa pratensis*. Natomiast istotnie najmniejszym pokryciem powierzchni odznaczał się zespół *Spergulo-Corynephoretum*, gdzie prowadzony wypas owiec rasy świniarka wpływał na sukcesywne zmniejszanie się pokrycia powierzchni przez roślinność w latach badań. Monitoring liczebności drzew i krzewów wykazał, że wszystkie gatunki tej grupy roślin o wysokości do 100 cm były przygryzane lub niszczone przez owce podczas wypasu. Świadczy to o możliwości wykorzystywania owiec rasy świniarka do czynnej ochrony muraw napiaskowych z uwagi na hamowanie sukcesji wtórnej roślinności drzewiasto-krzewiastej.