THE EFFECT OF RESTORATION AND DRAINAGE ON THE BOTANICAL COMPOSITION OF HUMID MARSH THISTLE MEADOWS UNDER DIFFERENT MANAGEMENT SYSTEMS*

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We evaluated the effect of previous drainage and restoration on the present botanical composition of humid marsh thistle meadows of the Association *Angelico-Cirsietum palustris* (the area of the Crystalline complex, Vysočina Region, Czech Republic) in relation to different methods of management (one-cut, two-cut and no-cut treatments). The multivariate analysis of data was done by the Canoco 4.5 software (direct redundancy analysis RDA). Three localities were assessed: 1) undrained locality with grassland corresponding to the site conditions (L1), 2) restored locality with drainage system (out of operation for the last five years, L2), 3) restored locality, the drainage system was used for water retardation (out of operation for the last five years, L3). Locality influences the variability of botanical composition to the greatest extent (its effect explained 35.8% of variability in tested data). The elevation of groundwater level as a result of the drainage system choking markedly increased the number of species (including indicator ones) in L2. From point of view of the species number and grassland composition two-cut management is the best, while one-cut management is an acceptable compromise. The effect of grassland management on botanical composition explained 23.3% of species variability. The no-cut treatment has a different effect on the spread of species compared to cut treatments. No-cut and two-cut treatments (highly competitive species and support to species diversity, respectively) contribute to the greatest differentiation of the species composition. The species were not found to be markedly related to one-cut management.

grassland; *Angelico-Cirsietum palustris*; floodplain area; water regime; management; botanical composition

INTRODUCTION

In the sixties to the eighties of the 20th century approximately 1 000 000 ha of agricultural land, i.e. 25% of agricultural land, were drained in the Czech Republic, what brought about negative impacts on the landscape equilibrium, besides positive effects from the human aspect. Drainage was carried out for the purposes of agricultural production intensification, to make fields accessible to farm machinery and/or to compensate the loss of arable land as a result of its reallocation to non-agricultural use. Drained plots were mostly converted to arable land or they were restored and grasslands were established that were intensively used for agricultural purposes. Rich-in-species, humid and wet meadows connected particularly with river floodplains and lake banks (Joyce, Wade, 1998) were afflicted by these measures to the greatest extent. Drainage and restoration with subsequent intensive use were marked negative interventions in their species diversity and deterioration of the non-production functions (water conservation, anti-erosion effects, water retention in floodplains). But the other extreme, i.e. leaving the grassland as derelict land, may have the same impacts (Straškrabová, Prach, 1998). The restoration of species diversity of abandoned floodplains in undrained localities by the introduction of regular management is relatively fast and successful if they are in contact with managed grasslands in the proximity and/or thanks to a sufficiently large seed bank in the soil (Straškrabová, Prach, 1998; Grootjans et al., 2002). The restoration of species richness on drained intensively used grasslands is however more difficult because the disturbance of the soil seed bank diminishes a possibility of successful restoration (Bekker et al., 1997; Grootjans et al., 2002). Rosenthal (2003) stated that another condition of restoration of such ecosystems was to what extent the original abiotic conditions were re-established (water regime, nutrient amount in the soil). But it does not imply that a reduction in management intensity and an increase in the groundwater level will lead to an automatic return of the original community and species diversity; a new "atypical" plant community will be developed. Species with low vulnerability (higher resistance to disturbed living conditions, wider site amplitude) penetrate back to the ecosystem faster than species with higher vulnerability (rare species).

In this study, the attention was focused on humid marsh thistle meadows (Assoc. *Angelico-Cirsietum palustris*) that belong to the types of grasslands frequently endangered by drainage, doses of industrial fertilisers and/or abandonment of lands followed by the overgrowing with tall broadleaved herbaceous plants (Petříček et al., 1999; Chytrý et al., 2001). The objective of this study is to determine how restoration and drainage (with potential retardation of drainage water) performed in the past influence the present botanical composition of grassland with different management compared to the original grassland.

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Table 1. Characteristics of Velký Rybník localities

Locality	Average GWL (incl. min. and max. values) in growing seasons (m)						Drainage in 1986–1988	Restoration in 1988
	1996–2000			2001–2005				
	Avg.	Min.	Max.	Avg.	Min.	Max.		
1	0.59	0.33	0.82	0.58	0.29	0.85	No	No
2	0.80	0.48	0.98	0.54	0.22	0.83	Yes	Yes
3	0.47	0.24	0.68	0.44	0.17	0.66	Yes	Yes

MATERIALS AND METHODS

An experimental object is situated in three meadow localities near the municipality of Velký Rybník (Vysočina Administrative Region, 49° 30′ N lat., 15° 18′ E long.). The long-term precipitation amount over the period 1951–2000 for Pelhřimov and Humpolec Stations of the Czech Hydrometeorological Institute is 660 and 666 mm, respectively, and 425 and 415 mm in the growing season. Average air temperature (Přibyslav, 1951–2000) is 6.7 °C, and 12.8 °C in the growing season. It is a potato production area (B3, Němec, 2001), at a height of 506–513 m above sea level. Two localities (L1 and L2) are situated in the floodplain of the Jankovský stream and the third locality (L3) lies in the floodplain of the Kopaninský stream, ca. 1000 m from each other; the soil type is gleyic Fluvisol (L1, L2) or modal Gleysol (L3), and in terms of the soil texture it is sandy-loam to loamy soil. Both soil types are adjoined onto a gravel to gravel-sand terrace at a depth of 0.8–1.0 m. The parent rock is cordieritic paragneiss. Water regimes of these localities are different (Table 1): L1 is without drainage, with natural grassland, waterlogged with surface water from near springs. The groundwater level (GWL) in L1 fluctuates according to a discharge in the brook and precipitation. Localities L2 and L3 were drained in 1986–1988 by systematic drainage where regulation and in L3 retardation of drainage water could be used (Kvítek, 1992). In 1988 grassland restoration was done in these localities, i.e. after preceding soil preparation, NPK fertilisation and liming the grassland was established by undersowing in oats as a cover crop for green forage (*Trifolium repens*, *Phleum pratense*, *Festuca pratensis*, *Festuca rubra*, *Poa pratensis*, *Alopecurus pratensis*). Before the trial was established (before 1990), L1 was cut from time to time, mostly once a year. As a consequence of water accumulation due to the choked drainage system GWL has been increasing in L2 and L3 since 2002 to exceed the level in L1 (Table 1).

Table 2 shows the history of management and fertilisation of experimental localities.

In each of the three localities there are 9 plots (each treatment, i.e. no cut, one cut and two cuts, has three replications), the size of experimental plots is 15 m^2.

The phytocoenological classification of the grasslands is as follows (Blažková, 2001, unpubl.):

L1: Class *Molinio-Arrhenatheretea*, Order *Molinietalia*, Alliance *Calthion,* Association *Angelico-Cirsietum palustris* (i.e. angelica meadow with marsh thistle), that means the grassland indicates marsh thistle meadows of sub-mountainous locations, rather acid, on poor-in-nutrient soils, groundwater or spring water and gleyification in the upper layers of the soil profile.

Table 2. History of management and fertilisation of experimental localities 1–3 in Velký Rybník

Period	Treatments	Fertilisation (kg.ha^{-1})
1990–1992	Three cuts everywhere	0, 50, 100 N + P, K
1993–1997	No cut	0
	One cut	0, 25, 50 N + P
	Two cuts	0, 50, 75 N + P
1998–2005	No cut	0
	One cut	0
	Two cuts	0

L2: Class *Molinio-Arrhenatheretea*, Order *Arrhenatheretalia*, Alliance *Arrhenatherion*, Association *Angelico-Cirsietum palustris* – drier form, in transition to Association *Trifolio-Festucetum rubrae*. Alliance *Calthion* before drainage.

L3: Assoc. *Angelico-Cirsietum palustris*, the most humid form.

A multivariate analysis of data was done by the Canoco 4.5 software (Ter Braak, Šmilauer, 2002). Direct redundancy analysis RDA was used where independent variables of environment and linear responses of the species to environmental gradients were included (except the management x locality interaction where canonical correspondence analysis CCA was applied). Localities with different water regimes, management and the interactions management x locality and management x time were chosen as independent variables. The identification of the pure effect of independent variables on botanical composition was tested on the basis of hypotheses (Table 3) by means of appropriately determined permutation tests with the set *P*-value 0.05 that excluded the effect of variables uninteresting for the given hypothesis, the so called covariates. Biplot ordination diagrams created in CANODRAW programme (Ter Braak, Šmilauer, 2002) were used for the graphical visualisation of results. The species that proved the effect of the explanatory variable in a negligible way were masked in diagrams.

Data on the degree of coverage of the particular species in per cent were acquired from the whole experimental plots by the method of projective reduced dominance. With regard to the diverse and complicated history of localities (Table 2) the last five-year series of data (2001–2005) was chosen for common analyses of all three lo-

Table 3. Results of the tested hypotheses by RDA (Velký Rybník 2001–2005, H4 – 1994–2005)

Code	Tested hypothesis	Explanatory variables	Covariates	% axes 1+2	*F*-ratio	*P*-value
H1	Does locality influence botanical composition?	Locality	Year, management	35.8	35.92	0.002
H2	How is botanical composition influenced by different management?	Management	Year, locality	23.3	19.58	0.002
H3	Does the influence of management on botanical composition depend on locality?	Locality x management	Locality, management, year	27.1	11.62	0.002
H4	How is botanical composition in L1 influenced by different management in the course of time?	Time x management	Time, management, codes of plots	10.5	5.65	0.002

% axes 1+2 = % of the species variability explained by the first two canonical axes; *F*-ratio = statistics for the test on the trace (all axes); *P*-value = the value of probability of non-existence of the relation defined by a hypothesis (calculated by 499 Monte-Carlo permutation tests)

calities, when the long-term influence of the tested explanatory variables markedly differentiated botanical composition. As the influence of different management on botanical composition was evident already at the beginning of the chosen period (2001), it was not possible to analyse the influence of the management x time interaction because variability explainable by this interaction was negligible (i.e. insignificant). Such an analysis was done in L1 for all available data (1994–2005).

To evaluate statistically significant differences in the number of species between management treatments and localities the significance level $\alpha = 0.05$ was set in the framework of one-way classification of ANOVA, and Scheffe's test of simultaneous comparison was used in Statgraphics 5 Plus software.

RESULTS AND DISCUSSION

The tested hypotheses shown in Table 3 indicate a significant effect of explanatory variables on botanical composition in all treatments. The relationship between the species and the explanatory variable can be determined in RDA by perpendicular projection of the end point of the species arrow onto the connecting line of the explanatory variable with the intersection point of the axes. The longer the distance from the intersection point of the axes, the higher the correlation of the species with the given variable. The species pointing in an opposite direction to the connecting line of the explanatory variable and the intersection point of the axes are in negative correlation with the variable.

In 2001–2005 the highest (statistically significant) effect on botanical composition was found for a different locality differing in GWL, method of grassland establishment in 1988 and/or soil type (Fig. 1); its effect explained 35.8% of variability in tested data on the degree of species coverage. The highest number of botanical species is related with L1 without restoration and drainage. Fig. 1 shows that the occurrence of *Agrostis capillaris* and *Holcus lanatus* is in negative correlation with L3 (the most humid locality). This result is consistent with the findings of Straškrabová and Prach (1998), who stated that *Holcus lanatus* and *Festuca rubra* were the species typical of drier parts of alluvial meadows. Grevilliot and Muller (2001) concluded that floristic diversity was mostly influenced by fluctuations of the water regime and cultural practices.

The effect of grassland management on botanical composition explained 23.3% of variability of the given set. Fig. 2 documents that the effect of no-cut treatment on botanical composition is markedly different from the effect of management. Significant differences in botanical composition were determined between all treatments. The highest number of species (especially dicotyledonous ones) is related with two-cut treatment. The occurrence of some species is in negative correlation with no-cut treatment (*Rumex acetosa*, *Sanguisorba officinalis*, *Alchemilla vulgaris*, *Cirsium palustre*, *Agrostis capillaris*, *Poa pratensis*, *Cardamine pratensis*, *Veronica chamaedrys*). It means that these species are suppressed as a result of no-cut treatment, and on the other hand, their occurrence is supported by cutting (regardless of its frequency). Rosenthal (2003) stated that *Sanguisorba officinalis* was a species typical of grasslands under extensive management along large valleys of brooks and rivers. None of the identified species is quite explicitly related with one-cut treatment. Conditions on uncut plots are favourable for highly competitive species such as *Phalaris arundinacea*, *Calamagrostis epigeios*, *Urtica dioica*, *Filipendula ulmaria*, *Alnus glutinosa* as well as *Galeopsis bifida* (an annual herbaceous plant germinating well on dead plant residues) and *Ranunculus auricomus* (a species of humid forest sites). Joyce and Wade (1998) also reported that robust highly competitive species, such as *Phalaris arundinacea*, *Rumex* sp. and *Urtica dioica* preferred unmanaged wet meadows. *Filipendula ulmaria* is supported by an increased supply of nutrients to floodplain areas by agricultural pollution of shallow groundwater (Truus, Tõnisson, 1998). Chytrý et al. (2001) stated that the occurrence of *Carex brizoides* was related with unmanaged and/or from time to time cut humid meadows. Straškrabová and Prach (1998) considered *Alopecurus pratensis*, *Deschampsia caespitosa*, *Poa* sp., and *Ranunculus repens* as the species characteristic of regular management. Joyce (1998) stated that *Poa trivialis* and *Cardamine pratensis* used mainly the time before cutting for their spread (i.e. they were suppressed by cutting).

Our results are consistent with the findings of e.g. Harmens et al. (2004) and Hansson, Fogelfors (2000), who considered cutting as an appropriate method of the stimulation of plant diversity by increasing the

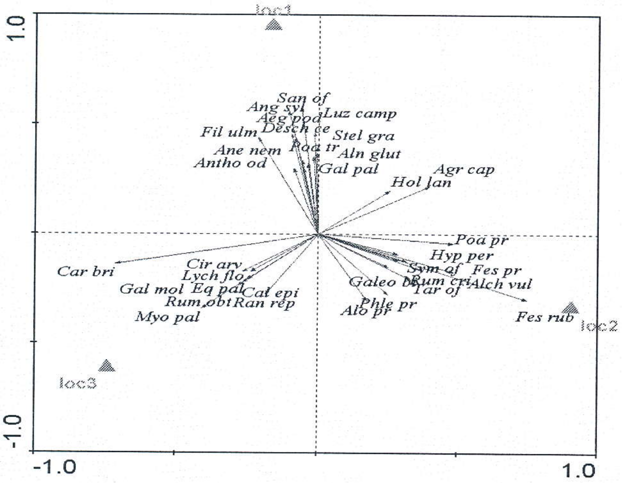

Fig. 1. The effect of locality on botanical composition (H1 in Table 3), Velký Rybník 2001–2005
Explanatory note to abbreviations of the species in all diagrams see Table 5

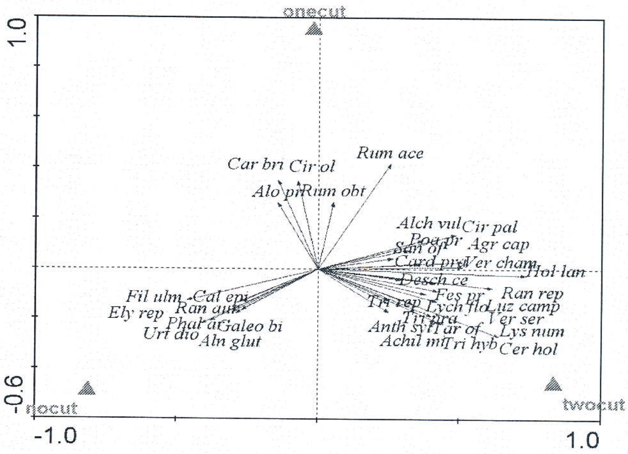

Fig. 2. The effects of management on botanical composition (H2 in Table 3), Velký Rybník 2001–2005

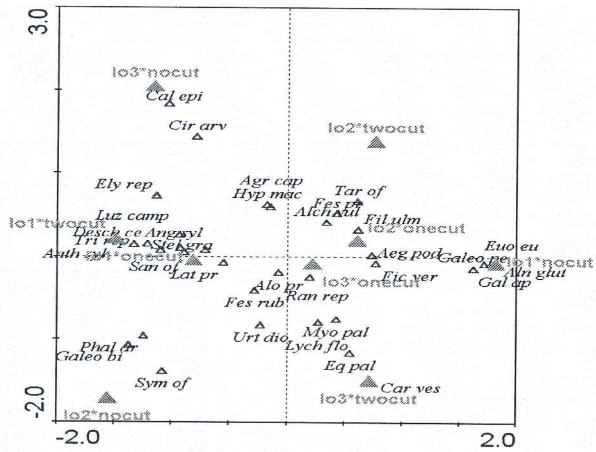

Fig. 3. The effect of the management x locality interaction on botanical composition (H3 in Table 3), Velký Rybník 2001–2005

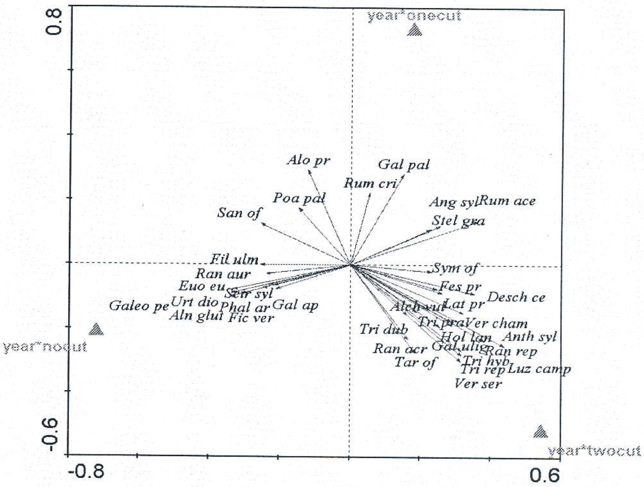

Fig. 4. The effect of the management x time interaction in locality 1 (H4 in Table 3), Velký Rybník 1994–2005

number of dicotyledonous plants and for the maintenance of species richness. Loiseau et al. (1998) and Grevilliot, Muller (2001) described the adverse effect of management extensification (reduction in the number of cuts) on botanical composition that leads to lower species richness because highly competitive species are stimulated by such treatment. Pykala et al. (2005) and Kahmen et al. (2002) confirmed generally well-known negative impacts of the absence of cutting on botanical composition.

Fig. 3 illustrates the unimodal (bell-shaped) type of species behaviour for the management x locality interaction. The occurrence of the given species decreases evenly to all directions with a distance from the point designating its name. Obviously, the management treatments (one cut and two cuts) in L1 have a similar effect on the spread of species and their occurrence is in negative correlation with no-cut treatment (occurrence of *Alnus glutinosa*). It follows from this fact that even one cut a year may markedly improve the species diversity compared to uncut grassland. It is also evident that the species occurrence given by a certain method of management is related to locality. Fig. 3 also shows that the spread of species in one-cut treatments of restored localities is similar.

The differentiation of botanical composition in relation to the management x year interaction is marked mainly in two-cut and no-cut treatment (Fig. 4). The highest number of species related to the management in time is spread in two-cut treatment. It means that these two methods (two-cut and no-cut variant) may change the botanical composition in the course of time to the greatest extent, let it be positively or negatively from the aspect of species diversity. The species *Rumex acetosa*, *Stellaria graminea*, and *Angelica sylvestris* are suppressed in time by the absence of cutting.

Applying the analysis of variance (ANOVA) the method of management and locality were found to have a significant effect on the number of species occurring in

Table 4. Number of species in 2001 and 2005 in the particular treatments and localities, Velký Rybník

Treatment/Locality	No-cut		One-cut		Two-cuts	
	2001	2005	2001	2005	2001	2005
L1	16.0	21.3	22.7	29.7	28.3	34.0
L2	14.0	23.7	21.7	30.0	20.0	28.7
L3	15.7	15.3	20.0	23.7	27.0	29.7

Table 5. The occurrence of indicator species of the association *Angelico-Cirsietum palustris,* Velký Rybník 2005

Locality 1			Locality 2			Locality 3		
No-cut	One-cut	Two-cuts	No-cut	One-cut	Two-cuts	No-cut	One-cut	Two-cuts
		Agr can						
Alo pr	*Alo pr*	*Alo pr*	*Alo pr*	*Alo pr*	*Alo pr*	*Alo pr*	*Alo pr*	*Alo pr*
Ang syl	*Ang syl*	*Ang syl*						
	Antho od	*Antho od*						
				Card pra	*Card pra*		*Card pra*	
Cir pal	*Cir pal*	*Cir pal*	*Cir pal*	*Cir pal*	*Cir pal*		*Cir pal*	*Cir pal*
Desch ces	*Desch ces*	*Desch ces*						
						Eq pal	*Eq pal*	*Eq pal*
	Fes pr	*Fes pr*		*Fes pr*	*Fes pr*		*Fes pr*	*Fes pr*
	Fes rub	*Fes rub*	*Fes rub*	*Fes rub*	*Fes rub*	*Fes rub*	*Fes rub*	*Fes rub*
Fil ulm	*Fil ulm*	*Fil ulm*	*Fil ulm*	*Fil ulm*	*Fil ulm*	*Fil ulm*	*Fil ulm*	*Fil ulm*
Gal ulig	*Gal ulig*	*Gal ulig*	*Gal ulig*	*Gal ulig*	*Gal ulig*	*Gal ulig*	*Gal ulig*	*Gal ulig*
Hol lan	*Hol lan*	*Hol lan*	*Hol lan*	*Hol lan*	*Hol lan*		*Hol lan*	*Hol lan*
								Jun ef
Lat pr	*Lat pr*	*Lat pr*	*Lat pr*	*Lat pr*	*Lat pr*	*Lat pr*	*Lat pr*	*Lat pr*
	Luz camp	*Luz camp*		*Luz camp*	*Luz camp*		*Luz camp*	
Lych flos	*Lych flos*	*Lych flos*	*Lych flos*		*Lych flos*	*Lych flos*		
Poa pal	*Poa pal*	*Poa pal*	*Poa pal*					
	Poa pr	*Poa pr*	*Poa pr*	*Poa pr*	*Poa pr*	*Poa pr*	*Poa pr*	*Poa pr*
Poa tr	*Poa tr*	*Poa tr*	*Poa tr*	*Poa tr*	*Poa tr*	*Poa tr*	*Poa tr*	*Poa tr*
	Ran acr			*Ran acr*				
Ran aur	*Ran aur*		*Ran aur*	*Ran aur*	*Ran aur*	*Ran aur*	*Ran aur*	*Ran aur*
Rum ace	*Rum ace*	*Rum ace*	*Rum ace*	*Rum ace*	*Rum ace*	*Rum ace*	*Rum ace*	*Rum ace*

Explanatory note: *Aeg pod* – *Aegopodium podagraria*, *Agr can* – *Agrostis canina*, *Agr cap* – *Agrostis capillaris*, *Achil mil* – *Achillea millefolium*, *Alch vul* – *Alchemilla vulgaris*, *Aln glut* – *Alnus glutinosa*, *Alo pr* – *Alopecurus pratensis*, *Ane nem* – *Anemone nemorosa*, *Ang syl* – *Angelica sylvestris*, *Anth syl* – *Anthriscus sylvestris*, *Antho od* – *Anthoxanthum odoratum*, *Cal epi* – *Calamagrostis epigeios*, *Car bri* – *Carex brizoides*, *Car ves* – *Carex vesicaria*, *Card pra* – *Cardamine pratensis*, *Cer hol* – *Cerastium holosteoides*, *Cir arv* – *Cirsium arvense*, *Cir ol* – *Cirsium oleraceum*, *Cir pal* – *Cirsium palustre*, *Desch ce* – *Deschampsia caespitosa*, *Eq pal* – *Equisetum palustre*, *Ely rep* – *Elytrigia repens*, *Euo eu* – *Euonymus europaea*, *Fes pr* – *Festuca pratensis*, *Fes rub* – *Festuca rubra*, *Fic ver* – *Ficaria verna*, *Fil ulm* – *Filipendula ulmaria*, *Galeo bi* – *Galeopsis bifida*, *Galeo pe* – *Galeopsis pernhofferi*, *Gal ap* – *Galium aparine*, *Gal mol* – *Galium mollugo*, *Gal pal* – *Galium palustre*, *Gal ulig* – *Galium uliginosum*, *Hol lan* – *Holcus lanatus*, *Hyp mac* – *Hypericum maculatum*, *Hyp per* –*Hypericum perforatum*, *Jun ef* – *Juncus effusus*, *Lat pr* – *Lathyrus pratensis*, *Luz camp* – *Luzula campestris*, *Lych flo* – *Lychnis flos cuculi*, *Lys num* – *Lysimachia numularia*, *Myo pal* – *Myosotis palustris*, *Phal ar* – *Phalaris arundinacea*, *Phle pr* – *Phleum pratense*, *Poa pal* – *Poa palustris*, *Poa pr* – *Poa pratensis*, *Poa tr* – *Poa trivialis*, *Ran acr* – *Ranunculus acris*, *Ran aur* – *Ranunculus auricomus*, *Ran rep* – *Ranunculus repens*, *Rum ace* – *Rumex acetosa*, *Rum cri* – *Rumex crispus*, *Rum obt* – *Rumex obtusifolius*, *San of* – *Sanguisorba officinalis*, *Scir syl* – *Scirpus sylvaticus*, *Stel gra* – *Stellaria graminea*, *Sym of* – *Symphytum officinale*, *Tar of* – *Taraxacum officinale*, *Tri dub* – *Trifolium dubium*, *Tri hyb* – *Trifolium hybridum*, *Tri pra* – *Trifolium pratense*, *Tri rep* – *Trifolium repens*, *Urt dio* – *Urtica dioica*, *Ver cham* – *Veronica chamaedrys*, *Ver ser* – *Veronica serpyllifolia*

grassland in 2001–2005. The numbers of the species of particular treatments were proved to be statistically significantly different (no cut: 18.5; one cut: 24.5; two cuts: 29.4). Significant differences in the number of species were also determined between L1 (26.1) and L3 (22.5). There were on average 23.8 species in L2. The evaluation of statistical differences in the methods of management in the particular localities demonstrated significant differences between all treatments in L1 and L3, in L2 there was a difference between no-cut treatment on the one hand and one-cut and two-cut treatment on the other. In one-cut treatments of L1 and L2 and in two-cut treatments of L1 and L3 the number of species was almost identical (Table 4). In the same association in the Moravian-Silesian Beskids at an altitude of 470–920 m above sea level Balátová-Tuláčková (2000) reported 28–39 species (33 species at 470 m a.s.l. and 28 species at 490 m a.s.l.).

Table 4 shows that there was an increase in the number of species in all localities between the years 2001 and 2005; it is most markedly proved in L2 by the elevation of GWL due to the choked drainage system.

Table 5 documents that the highest number of indicator species (Rybníček et al., 1984; Balátová-Tuláčková, 2000; Chytrý et al., 2001) occurs in managed grasslands of L1. In all localities there exists a marked coincidence of the indicator species occurrence between one-cut and two-cut treatment. An increase in the number of indicator species between 2001 and 2005 was only small in L1 and L3 (by 1–3 species) while the number of indicator species in L2 was complemented markedly (by 3–6 species) as a result of influenced (increased) GWL. In the most humid locality L3 *Equisetum palustre* and *Juncus effusus* were spreading, which are indicator species with very high requirements for water, and which occur only in this locality. *Galium uliginosum* appeared at first in managed grasslands of L1 only, and it gradually (in 1–2 years) spread to other localities, and sporadically also to uncut grasslands. *Poa trivialis* spread in L2 and L3 with a similar time lag. *Festuca pratensis* appeared only on managed grasslands, always later than *Festuca rubra*, which occurs in all variants of management.

Two indicator species that are common in L1: *Angelica sylvestris* and *Agrostis canina* do not occur in restored localities.

The drainage system can markedly influence the water regime of the site in two ways in total: after its construction by a decrease in water storage in the soil, and after some time if it becomes choked, by an increase in the groundwater level compared to the original grassland. These are two reasons why it is necessary to pay great attention to the development of the botanical composition of grasslands in previously drained localities.

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DUFFKOVÁ, R. – LEXA, M. (Výzkumný ústav meliorací a ochrany půdy, v.v.i., Praha, Česká republika):

Vliv rekultivace a odvodnění na botanickou skladbu rozdílně využívaných vlhkých pcháčových luk.

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Odvodnění a rekultivace prováděné v minulosti v České republice z důvodu zvýšení intenzity zemědělské výroby často postihovaly druhově bohaté vlhké a mokré louky spjaté především s říčními nivami. Těmito zásahy byly výrazně oslabovány jejich mimoprodukční funkce.

V příspěvku je posuzován vliv předchozího odvodnění a rekultivace na současnou botanickou skladbu vlhkých pcháčových luk as. *Angelico-Cirsietum palustris* (oblast krystalinika, kraj Vysočina, nivní oblast, 506–513 m n. m., Česká republika) v závislosti na různém způsobu využití (varianta jednosečná, dvousečná, nesečená) ve srovnání s původním porostem. Byly hodnoceny tři lokality: 1) neodvodněná, s porostem odpovídajícím stanovištním podmínkám (L1), 2) rekultivovaná, s drenážním systémem (posledních pět let nefunkční, L2), 3) rekultivovaná, drenážní systém využit pro retardaci vody (posledních pět let nefunkční, L3). Analýza dat byla provedena mnohorozměrnou analýzou pomocí softwaru Canoco 4.5 . Byla použita přímá (kanonická) technika RDA (redundancy analysis).

Na variabilitu botanického složení nejvíce působí vliv lokality lišící se hladinou podzemní vody, způsobem založení, popř. půdním typem. Nejvíce botanických druhů je vázáno na nerekultivovanou a neodvodněnou L1. Zvyšováním hladiny podzemní vody v důsledku neprůchodnosti drenážního systému došlo na L2 k výraznému vzestupu počtu druhů (vč. indikačních). Pro pravidelnou údržbu je z hlediska počtu druhů i porostové skladby nejvhodnější dvousečné využití (nejvyšší druhová diverzita), přijatelným kompromisem je i jednosečné využití. Nesečení má odlišný vliv na šíření druhů než obhospodařování. Diferenciace druhového složení je nejvíce podporována nesečením (kompetičně silné druhy –*Phalaris arundinacea*, *Calamagrostis epigeios*, *Urtica dioica*, *Filipendula ulmaria*, *Alnus glutinosa*, dále *Galeopsis bifida* dobře klíčící na stařině a *Ranunculus auricomus*) a dvousečným využitím (podpora druhové diverzity). Nebyla zjištěna výrazná druhová závislost na jednosečném využití. Sečením byly podporovány (tzn. nesečením potlačovány) druhy *Angelica sylvestris*, *Rumex acetosa*, *Sanguisorba officinalis*, *Alchemilla vulgaris*, *Cirsium palustre*, *Agrostis capillaris*, *Poa pratensis*, *Cardamine pratensis*, *Veronica chamaedrys*, *Stellaria graminea*.

Nejvyšší počet indikačních druhů je na obhospodařovaných variantách L1. Na všech lokalitách existuje výrazná shoda ve výskytu indikačních druhů mezi jednosečnou a dvousečnou variantou. Na nejvlhčí variantě L3 dochází k rozšiřování *Equisetum palustre* a *Juncus effusus*, indikačních druhů s velmi vysokými nároky na vodu, naopak se zde nevyskytovaly *Agrostis capillaris* a *Holcus lanatus*.

Drenážní systém může výrazně změnit vodní režim stanoviště celkem dvakrát, a sice po jeho vybudování snížením zásoby vody v půdě a po čase, pokud dojde k jeho ucpání, naopak zvýšením hladiny podzemní vody ve srovnání s původním porostem.

travní porost; *Angelico-Cirsietum palustris*; nivní oblast; vodní režim; management; botanické složení

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