

An assessment of the natural value of selected meadow-pasture communities in the Middle Sudetes region

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Abstract: The paper presents an assessment of the natural values of grassland communities situated in the region of the Middle Sudetes in meso-regions of the Sowie, Kamienne and Wałbrzyskie Mountains. The study was carried out in the years 2009–2010 on utilised meadows and pastures. Two hundred and thirty two phytosociological relevés were made with the Braun-Blanquet method to estimate phytosociological affiliation of grassland communities. Moreover, species richness and the index of floristic diversity were calculated. Protected species were recorded and their risk categories were estimated.

The studies showed that grassland communities belonged to the class *Molinio-Arrhenatheretea*. Five phytosociological units in the rank of association or community with the dominating species were distinguished within this class: *Arrhenatheretum elatioris*, the community *Poa pratensis-Festuca rubra*, the community with *Agrostis capillaris*, the association *Lolio-Cynosuretum* and the community with *Alopecurus pratensis*. The distinguished grassland communities were characterised by relatively high species richness ranging from 57 species in the community with *Alopecurus pratensis* to 103 species in the community with *Agrostis capillaris* and by mean diversity indices H' ranging from 2.6 to 3.1. In part of analysed grasslands there were 10 strictly or partly protected species. Six of them: *Dactylorhiza maculata* (L.) Soó, *Gymnadenia conopsea* (L.) subsp. *conopsea* R. Br., *Trollius europaeus* L. s. str. *Dactylorhiza majalis* (Rchb.) P. F. Hunt & Summerh., *Colchicum autumnale* L. and *Platanthera bifolia* (L.) Rich belonged to endangered or rare species in Lower Silesia. The presence of protected and rare species in grasslands increases their natural value. Most valuable phytocoenoses classified as the association *Arrhenatheretum elatioris* and the community *Poa pratensis-Festuca rubra* are identifiers of valuable habitats protected within the Natura 2000 system. Obtained results indicate that the studied grassland communities are characterised by a high natural value.

Key words: *grasslands communities, natural value, protected and endangered plant species, rare, the Sudetes*

INTRODUCTION

Natural values of mountain grasslands are highly estimated by many authors (BIAŁA *et al.*, 2002; GRYNIA and KRYSZAK, 1999; KOSTUCH, 1995; ŻYSZKOWSKA, 2004; 2006). The grasslands are characterised by a high species richness and diversity and often host rare plant species. They are more diverse than lowland grasslands (TRZASKOŚ, 1998). Moreover, they occupy large parts of mountain landscape providing its mosaic character which is important for both aesthetic and protective reasons (FATYGA and NADOLNA, 2009; KOPEĆ 1995; WOLAŃSKI and TRĄBA, 2009).

Meadows and pastures play an important role in the land use structure in the Polish Sudetes. They occupy more than 50% of agricultural lands (A set of data..., 2008). After the system transformation, due to the decline of animal production profitability (FATYGA and PASZKIEWICZ-JASIŃSKA, 2009; NOWAKOWSKI, 2008) the region experienced unfavourable changes in the utilisation of agricultural lands. Large grassland areas were abandoned, forested or ploughed (FATYGA, 2009; NADOLNA, 2006). The changes resulted in the transformation of grass communities, which led to a decrease of their natural value or even to the disappearance of many valuable grasslands (DRADRACH *et al.*, 2007; KAĆKI, 2003; NADOLNA, 2005; NADOLNA *et al.*, 2008). EU support introduced since 2004 (direct subsidies, LFA and agro-environmental programmes) initiated the reuse of many grasslands which prevents from unfavourable changes and improves their species structure and diversity (FATYGA *et al.*, 2009; NADOLNA, 2009). That is why recognizing natural values of grasslands that occupy significant part of agricultural lands in mountain areas is so important.

The aim of this study was to assess the natural value of selected meadow and pasture communities situated in the Middle Sudetes.

MATERIALS AND METHODS

According to the physico-geographic division by KONDRACKI (2000), the study area is located in the Middle Sudetes region and encompasses three meso-regions: the Sowie, Kamienne and Wałbrzyskie Mts. In the Sowie Mts the studied grasslands were situated near Glinno, Jugowice and Walim, in the Kamienne Mts – in Sokołowsko and in the Wałbrzyskie Mts – in Lubiechów. With respect to climatic conditions (SCHMUCK, 1960) the Middle Sudetes area belongs to pluvio-thermal region of Wałbrzych. The region is characterised by severe climatic conditions and two elevation zones useful for agriculture – moderately warm zone b reaching 550 m a.s.l. (mean annual air temperature 6.1°C, mean annual precipitation 700 to 800 mm) and moderately cool zone c above 550 m a.s.l. considered less

useful for agriculture due to a lack of the thermal summer and a high sum of annual precipitation exceeding 800 mm.

Natural value was assessed based on the results from field studies carried out in June and July 2009 and 2010 on utilised meadows and pastures. During this period of time 232 phytosociological relevés, 25 m² each (FALIŃSKI, 2001) were made with the Braun-Blanquet method. Optically uniform plant patches situated in selected localities were the study sites. Collected material served for estimating phytosociological affiliation of grassland communities. Phytosociological relevés were entered to the TURBOVEG programme database. Then, they were analysed with the TWINSpan software which allowed to hierarchically classify the set of phytosociological relevés. Syntaxonomic groups and their characteristic species were adopted after MATUSZKIEWICZ (2007). Botanical nomenclature was used according to MIREK *et al.* (2002).

For the communities of estimated phytosociological affiliation species richness was determined and the Shannon-Wiener diversity index H' (KRYSZAK, 2001; MAGURRAN, 1996) was calculated. Strictly and partly protected species were recorded (Decree of the Minister of Environment of 9th July 2004...) and their risk category was estimated after Endangered vascular...(2003). Moreover, communities – identifiers of valuable protected habitats and other forms of nature protection were also indicated in the study area.

RESULTS

CHARACTERISTICS OF MEADOW-PASTURE COMMUNITIES

Field studies were carried out in grasslands situated from 300 to 500 m a.s.l. and from 500 to 1000 m a.s.l. and at slope inclinations less than 5° and between 5 and 10°. All plots were mown, grazed or both. Phytosociological studies were carried out in grasslands localised in habitats of various trophic and moisture conditions.

Five phytosociological units in the rank of association or community with the dominating species were distinguished upon the analysis of grassland communities (Tab. 1). All studied grasslands belonged to the class *Molinio-Arrhenatheretea*; communities within this class were grouped into two orders: *Arrhenatheretalia* and *Molinietalia*. The association *Arrhenatheretum elatioris*, the community *Poa pratensis-Festuca rubra*, the community with *Agrostis capillaris* and the association *Lolio-Cynosuretum* were found within the first order. Only one community with *Alopecurus pratensis* from the order *Molinietalia* was recorded.

The community *Poa pratensis-Festuca rubra* (tab. 1) was found in 2 sites in the Sowie Mts near Glinno. It was distinguished based on the presence of *Poa pratensis* L. s. str. and *Festuca rubra* L. s. str. The species characteristic for the al-

Table 1. Synthetic phytosociological table for grassland communities distinguished in the study area: 1 – *Arrhenatheretum elatioris*, 2 – community *Poa pratensis-Festuca rubra*, 3 – community with *Agrostis capillaris*, 4 – community with *Alopecurus pratensis*, 5 – *Lolio-Cynosuretum*

Syntaxon	1	2	3	4	5
Constancy (S)	S	S	S	S	S
Number of sites	2	9	5	3	2
1	2	3	4	5	6
Ch. <i>Poa pratensis-Festuca rubra</i>					
<i>Poa pratensis</i> L. s. str.		I			II
<i>Festuca rubra</i> L. s. str.		V			
Ch. <i>Arrhenatheretum elatioris</i>					
<i>Arrhenatherum elatius</i> (L.) P. Beauv. ex J. Presl & C. Presl	IV	IV	V	II	
<i>Geranium pratense</i> L.		I			II
D. community with <i>Agrostis capillaris</i>					
<i>Agrostis capillaris</i> L.		V	V		
D. community with <i>Alopecurus pratensis</i>					
<i>Alopecurus pratensis</i> L.				V	V
Ch. <i>Lolio-Cynosuretum</i>					
<i>Leontodon autumnalis</i> L.					II
<i>Trifolium repens</i> L.					V
<i>Lolium perenne</i> L.					I
Ch. <i>Cynosurion</i>					
<i>Cynosurus cristatus</i> L.					V
Ch. <i>Arrhenatherion</i>					
<i>Campanula patula</i> L. s. str.	II	V	V	II	II
<i>Galium mollugo</i> L. s. str.	IV	II	IV	II	I
<i>Crepis biennis</i> L.	I	II	I	III	
<i>Knautia arvensis</i> (L.) J. M. Coult	III	II	III		
<i>Tragopogon pratensis</i> L. s. str.	III	II	II		I
Ch. <i>Arrhenatheretalia</i>					
<i>Achillea millefolium</i> L. s. str.	IV	IV	IV	II	II
<i>Dactylis glomerata</i> L.	V	IV	III	II	III
<i>Trisetum flavescens</i> (L.) P. Beauv.	III		III	III	III
<i>Lotus corniculatus</i> L.	II	III	II	IV	
<i>Heracleum sphondylium</i> L. s. str.		II	I		I
<i>Leucanthemum vulgare</i> Lam. s. str.	III	II	III	II	
<i>Taraxacum officinale</i> F. H. Wigg.	III	II	II	I	III
<i>Trifolium dubium</i> Sibth.		II	I		
<i>Daucus carota</i> L.		I	I		
<i>Pimpinella major</i> (L.) Huds.		I			

cont. tab. 1

1	2	3	4	5	6
Ch. Calthion*et Filipendulion					
<i>Filipendula ulmaria</i> (L.) Maxim.				IV	
* <i>Cirsium rivulare</i> (Jacq.) All.				II	
* <i>Cirsium oleraceum</i> (L.) Scop.				V	II
* <i>Juncus conglomeratus</i> L. Emend. Leers.	I			IV	
* <i>Myosotis palustris</i> (L.) L. Emend. Rchb.				III	
* <i>Caltha palustris</i> L.				I	
* <i>Scirpus sylvaticus</i> L.				I	
Ch. Molinietalia					
<i>Deschampsia caespitosa</i> (L.) P. Beauv.	I		I	IV	V
<i>Lychnis flos-cuculi</i> L.	II		I	II	I
<i>Colchicum autumnale</i> L.				II	
<i>Trollius europaeus</i> L. s. str.				II	
<i>Angelica sylvestris</i> L.			I	I	
Ch. Molinio-Arrhenatheretea					
<i>Festuca rubra</i> L. s. str.		V	V	V	III
<i>Festuca pratensis</i> Huds.	II	II	I	IV	V
<i>Holcus lanatus</i> L.		II	I		
<i>Alopecurus pratensis</i> L.	I	II	I		
<i>Poa pratensis</i> L. s. str.		I	I		
<i>Vicia cracca</i> L.	IV	IV	III	IV	II
<i>Rhinanthus minor</i> L.	IV	III	I	III	
<i>Ranunculus acris</i> L. s. str.		IV	IV	V	III
<i>Lathyrus pratensis</i> L.	III	IV	III	V	IV
<i>Rumex acetosa</i> L.	V	IV	IV	II	V
<i>Plantago lanceolata</i> L.	V	IV	IV	III	III
<i>Centaurea jacea</i> L.		II	I	III	
<i>Trifolium pratense</i> L.	IV	IV	III	III	IV
<i>Avenula pubescens</i> (L.) Dumort		V	I		
<i>Phleum pratense</i> L.	II	II	II	III	V
<i>Leontodon hispidus</i> L.	I	II	I		
<i>Prunella vulgaris</i> L.	I		I		

liance, order and class were noted in the species composition. Most abundant and frequent were: *Galium mollugo* L. s. str., *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl, *Achillea millefolium* L. s. str., *Dactylis glomerata* L., *Rumex acetosa* L., *Plantago lanceolata* L., *Rhinanthus minor* L., *Trifolium pratense* L. and *Vicia cracca* L.

Arrhenatheretum elatioris was found in 5 sites of the Sowie Mts (Jugowice, Walim, Glinno), in 1 site of the Wałbrzyskie Mts (Lubiechów) and in 3 sites of the

Kamienne Mts (Sokołowsko). The association was distinguished based on the presence of characteristic species: *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl and *Geranium pratense* L. (Tab. 1). Besides, species characteristic for the alliance *Arrhenatherion*: *Campanula patula* L. s. str., *Galium mollugo* L. s. str., *Knautia arvensis* (L.) J. M. Coult, *Crepis biennis* L. and *Tragopogon pratensis* L. s. str. were also present. There were 9 species characteristic for the order *Arrhenatheretalia* e.g. *Achillea millefolium* L. s. str., *Dactylis glomerata* L., *Trisetum flavescens* (L.) P. Beauv. and *Lotus corniculatus* L. (Tab. 1).

The third phytosociological unit was the community with *Agrostis capillaris* distinguished upon the domination of this species. It was found in 5 sites of the Sowie Mts near Jugowice. In patches of this phytocoenosis the alliance *Arrhenatherion* was represented by e.g. *Arrhenatherum elatius* (L.) P. Beauv. ex J. Presl & C. Presl, *Campanula patula* L. s. str., *Galium mollugo* L. s. str. and *Knautia arvensis* (L.) J. M. Coult. The order *Arrhenatheretalia* was represented by: *Achillea millefolium* L. s. str., *Dactylis glomerata* L., *Trisetum flavescens* (L.) P. Beauv. and *Leucanthemum vulgare* Lam. s. str. Species characteristic for the class *Molinio-Arrhenatheretea* included e.g.: *Festuca rubra* L. s. str., *Plantago lanceolata* L., *Ranunculus acris* L. s. str., *Rumex acetosa* L., *Lathyrus pratensis* L., *Trifolium pratense* L. and *Vicia cracca* L.

The community with *Alopecurus pratensis* grew in most wet sites (3) of grasslands in the Wałbrzyskie Mts (Lubiechów), Sowie Mts (Glinno) and Kamienne Mts (Sokołowsko). Species characteristic for the alliance *Calthion* (*Cirsium rivulare* (Jacq.) All., *Juncus conglomeratus* L. emend. Leers, *Myosotis palustris* (L.) L. emend. Rchb., *Scirpus sylvaticus* L.) and for the order *Molinietales*: *Deschampsia caespitosa* (L.) P. Beauv., *Lychnis flos-cuculi* L. had a great share in the species composition. *Filipendula ulmaria* (L.) Maxim. of the alliance *Filipendulion* was also abundant. *Festuca pratensis* Huds., *Lathyrus pratensis* L. and *Phleum pratense* L., among others, represented meadow species.

Lolio-Cynosuretum (Tab. 1) was noted in 2 sites in the Kamienne Mts near Sokołowsko. It was distinguished based on the presence of the following characteristic species: *Cynosurus cristatus* L., *Trifolium repens* L., *Lolium perenne* L. and *Leontodon autumnalis* L. An important role in this association was played by species of the orders *Arrhenatheretalia*: *Dactylis glomerata* L., *Trisetum flavescens* (L.) P. Beauv., *Taraxacum officinale* F. H. Wigg., *Achillea millefolium* L. s. str. and *Molinietales*: *Deschampsia caespitosa* (L.) P. Beauv. and of the class *Molinio-Arrhenatheretea*: *Festuca pratensis* Huds., *Rumex acetosa* L., *Phleum pratense* L., *Lathyrus pratensis* L., *Trifolium pratense* L., *Festuca rubra* L. s. str., *Ranunculus acris* L. s. str., *Plantago lanceolata* L.

NATURAL VALUES OF MEADOW-PASTURE COMMUNITIES

Species richness and the index of floristic diversity

The greatest number of species was noted in communities with the domination of *Agrostis capillaris* – 103 species in *Arrhenatheretum elatioris* – 99 species. The least species were noted in the community with *Alopecurus pratensis* of the order *Molinietalia* – 57 species while in pastures the number of species was slightly higher (62) (Tab. 2).

Table 2. Species richness and floristic diversity of meadow-pasture communities

Phytosociological units	Number of relevés	Total number of species	Index of floristic diversity H' of the community
<i>Arrhenatheretum elatioris</i> community	105	99	3.1
<i>Poa pratensis-Festuca rubra</i> community	23	72	3.0
community with <i>Agrostis capillaris</i>	74	103	2.6
community with <i>Alopecurus pratensis</i>	20	57	3.0
<i>Lolio-Cynosuretum</i>	10	62	3.0

Species diversity index assumed mean values and was not much differentiated. Most diverse were meadows of *Arrhenatheretum elatioris* ($H' = 3.1$) and the least diverse – the community with *Agrostis capillaris* ($H' = 2.6$). Other phytosociological units had the H' value = 3.

Forms of nature protection

Studied grasslands hosted strictly or partly protected plant species. The presence of *Platanthera bifolia* (L.) Rich, *Dactylorhiza majalis* (Rchb.) P. F. Hunt & Summerh. and *Trollius europaeus* L. s. str. was noted in communities of *Arrhenatheretum elatioris*. *Dactylorhiza majalis* (Rchb.) P. F. Hunt & Summerh., *Iris sibirica* L., *Trollius europaeus* L. s. str. and *Colchicum autumnale* L. were present in the community with *Alopecurus pratensis*. The communities *Poa pratensis-Festuca rubra* and those with *Agrostis capillaris* were found to include *Gymnadenia conopsea* (L.) R. Br. subsp. *conopsea*, *Carlina acaulis* L., *Lilium martagon* L. and *Primula veris* L. The presence of protected species in grasslands increases their natural value.

Species from the list of endangered species of vascular flora in Lower Silesia (KACKI, 2003) of various risk categories (endangered and rare) were noted in grassland communities. From among vulnerable species, the presence of *Trollius europaeus* L. s. str. and *Iris sibirica* L. was noted in the community with *Alopecurus pratensis*; *Gymnadenia conopsea* (L.) R. Br. subsp. *conopsea* was found in the community with *Agrostis capillaris* and in the association *Arrhenatheretum elati-*

oris and *Dactylorhiza maculata* (L.) Soó – in the association *Arrhenatheretum elatioris*. Near threatened species included *Dactylorhiza majalis* (Rchb.) P. F. Hunt & Summerh. in communities with *Agrostis capillaris* and *Eriophorum vaginatum* L. in the community with *Alopecurus pratensis*. Species of least concern included: *Colchicum autumnalis* L. in *Arrhenatheretum elatioris* and *Platanthera bifolia* (L.) Rich. in the association *Arrhenatheretum elatioris* and in the community *Poa pratensis-Festuca rubra*.

Grassland communities were also analysed in view of valuable habitats within the scope of European interest. Among studied communities the identifiers of valuable habitats were the association *Arrhenatheretum elatioris* and the community *Poa pratensis-Festuca rubra* for lowland habitats and extensively used mountain meadows (habitat code 6510).

Location of the studied grassland communities within the borders of protected areas has an additional natural value. The association *Arrhenatheretum elatioris* and the community with *Alopecurus pratensis* were found in the Landscape Park of the Wałbrzyskie Sudetes south of Wałbrzych. *Arrhenatheretum elatioris* and *Lolio-Cynosuretum* were noted in the Natura 2000 area of the Kamienne Mountains (PLH020038). *Arrhenatheretum elatioris*, the community *Poa pratensis-Festuca rubra* and communities with *Agrostis capillaris* and with *Alopecurus pratensis* were localised in the Bat Reserve of the Sowie Mountains (PLH020071).

DISCUSSION

Obtained results showed that communities of the studied grasslands belonged to the orders *Arrhenatheretalia* and *Molinietalia* of the class *Molinio-Arrhenatheretea*. The communities were characterised by relatively high species richness and mean values of the floristic diversity index. The greatest species richness was found in the community with *Agrostis capillaris* (103 species) and in the association *Arrhenatheretum elatioris* (99 species). The highest species diversity index was recorded for *Arrhenatheretum elatioris* ($H' = 3.1$), slightly lower for pastures *Lolio-Cynosuretum* ($H' = 3.0$). Shannon-Wiener indices calculated for the two associations and for the community with *Agrostis capillaris* were slightly lower than those obtained by TRĄBA *et al.* (2006) in the San River valley. Communities in the studied grasslands showed, however, a greater number of species and a higher diversity index compared with the same communities studied by ŻYSZKOWSKA (2004) in the Bystrzyca Dusznicka River valley in the Middle Sudetes, by ŻYSZKOWSKA *et al.* (2009) and ŻYSZKOWSKA and PASZKIEWICZ-JASIŃSKA (2010) on Złotoryja Foothills. According to many authors (HARKOT *et al.*, 2006; WYŁUPEK, 2002; SABINIARZ and KOZŁOWSKI, 2009) diverse and rich in species meadows and pastures affect landscape variety and increase its attractiveness for tourists.

High natural value of grassland communities is also evidenced by the presence of protected, rare and endangered species (SZOSZKIEWICZ and SZOSZKIEWICZ, 1998). Many such species were found in the studied grasslands i.e. several species of orchids. The importance of these species for natural values was underlined by WOLAŃSKI and TRABA (2007), MEDWECKA-KORNAŚ (1986) and KAÇKI *et al.* (2006). In these authors' opinion, protected species may survive if the whole communities and habitats are protected in a system of protected areas Natura 2000, in landscape parks or in other higher forms of nature protection.

CONCLUSIONS

1. Phytosociological analysis revealed that the studied grasslands belonged to the class *Molinio-Arrhenatheretea*. The largest areas within this class were occupied by ryegrass meadows *Arrhenatheretum elatioris*.

2. Meadow-pasture communities in the studied area were characterised by relatively high species richness ranging from 57 species in the community of *Alopecurus pratensis* to 103 species in the community with *Agrostis capillaris* and by a mean diversity index H' between 2.6 and 3.1.

3. Great natural values were confirmed by the presence of 10 protected species 6 of which varying in the risk category are listed in the red book of vascular plants of Lower Silesia.

4. Due to a tendency of replacing productive role of grasslands by non-productive functions, it is important to estimate their natural values and to implement appropriate programmes specific for mountain areas to protect them.

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STRESZCZENIE

Ocena wartości przyrodniczej wybranych zbiorowisk łąkowo-pastwiskowych w regionie Sudetów Środkowych

Słowa kluczowe: *Sudety, zbiorowiska użytków zielonych, wartość przyrodnicza, gatunki rzadkie chronione i zagrożone*

W górskim regionie polskich Sudetów łąki i pastwiska pełnią ważną rolę w strukturze użytkowania ziemi, zajmując ponad 50% powierzchni użytków rolnych. Po okresie transformacji ustrojowej, na skutek spadku opłacalności produkcji zwierzęcej, doszło tam do niekorzystnych zmian w sposobie wykorzystywania przestrzeni rolniczej, m.in. odłogowania, zalesiania i zaorywania użytków zielonych. Zmiany te doprowadziły do przekształcenia zbiorowisk oraz zmniejszenia ich wartości przyrodniczej, a nawet do utraty wielu cennych gatunków i zbiorowisk. Wprowadzenie od 2004 r. wsparcia w ramach WPR spowodowało wznowienie użytkowania na wielu użytkach zielonych, co zapobiega niekorzystnym przekształceniom zbiorowisk łąkowo-pastwiskowych oraz prowadzi do poprawy struktury ich składu gatunkowego i różnorodności. Dlatego na terenach górskich, gdzie udział użytków zielonych w strukturze użytków rolnych jest znaczny, badania walorów przyrodniczych obszarów łąkowo-pastwiskowych jest bardzo istotne.

Celem pracy jest ocena wartości przyrodniczej wybranych zbiorowisk łąkowo-pastwiskowych w regionie Sudetów Środkowych, w mezoregionach: Gór Sowich, Gór Kamiennych i Gór Wałbrzyskich. W Górach Sowich badaniami objęto użytki zielone, położone w okolicy miejscowości Glinno, Jugowice i Walim, w Górach Kamiennych – w miejscowości Sokołowsko, a w Górach Wałbrzyskich – Lubiechów. Badania przeprowadzono w latach 2009–2010 na użytkowanych łąkach i pastwiskach. W tym okresie wykonano 232 zdjęcia fitosocjologiczne metodą Brauna-Blanqueta, które posłużyły do określenia przynależności fitosocjologicznej zbiorowisk użytków zielonych. Ponadto określono bogactwo gatunkowe na podstawie liczby gatunków ogółem w zbiorowisku oraz obliczono wskaźnik różnorodności florystycznej, odnotowano obecność gatunków chronionych oraz określono kategorie ich zagrożenia. Wskazano również zbiorowiska, będące identyfikatorami siedlisk podlegających ochronie w ramach sieci obszarów chronionych Natura 2000, oraz inne formy ochrony przyrody na badanym obszarze.

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