Poland belongs to the group of countries with a relatively large area of wetlands. They occupy about 4% of the country's territory and are concentrated mainly in its northern part. The Biebrza Marshes are among the largest and best known. The size of the mires in the Narew valley and the diversity and outstanding values of fens in the Rospuda river valley - impress. The countless lakes and peatlands of Kaszuby and Bory Tucholskie form part of an extraordinary landscape of poor forests. The beautiful, picturesque landscape of the glades in Gorce mountains is emphasized by the white fields of the cottongrass growing on the flush fens. Regardless of the region, all these swamps, mires and flush fens require protection! For centuries, they have been drained, exploited, turned into meadows and fields, and finally abandoned - they are overgrown with forest. They are dying! Together with them numerous, unique species of plants and animals. The disappearing swamps emit enormous amounts of carbon dioxide responsible for climate change, which is so much to blame for mankind. That's why we try to protect them. Especially one of them - alkaline fens. Unique in every way! Mowing and cutting trees, blocking drainage ditches, are activities that at first glance have little to do with nature conservation, and which we have been dealing with for the last 6 years. Just for the protection of alkaline fens. Where, how and how effective? We invite you to read our book!

ISBN: 978-83-63426-26-2

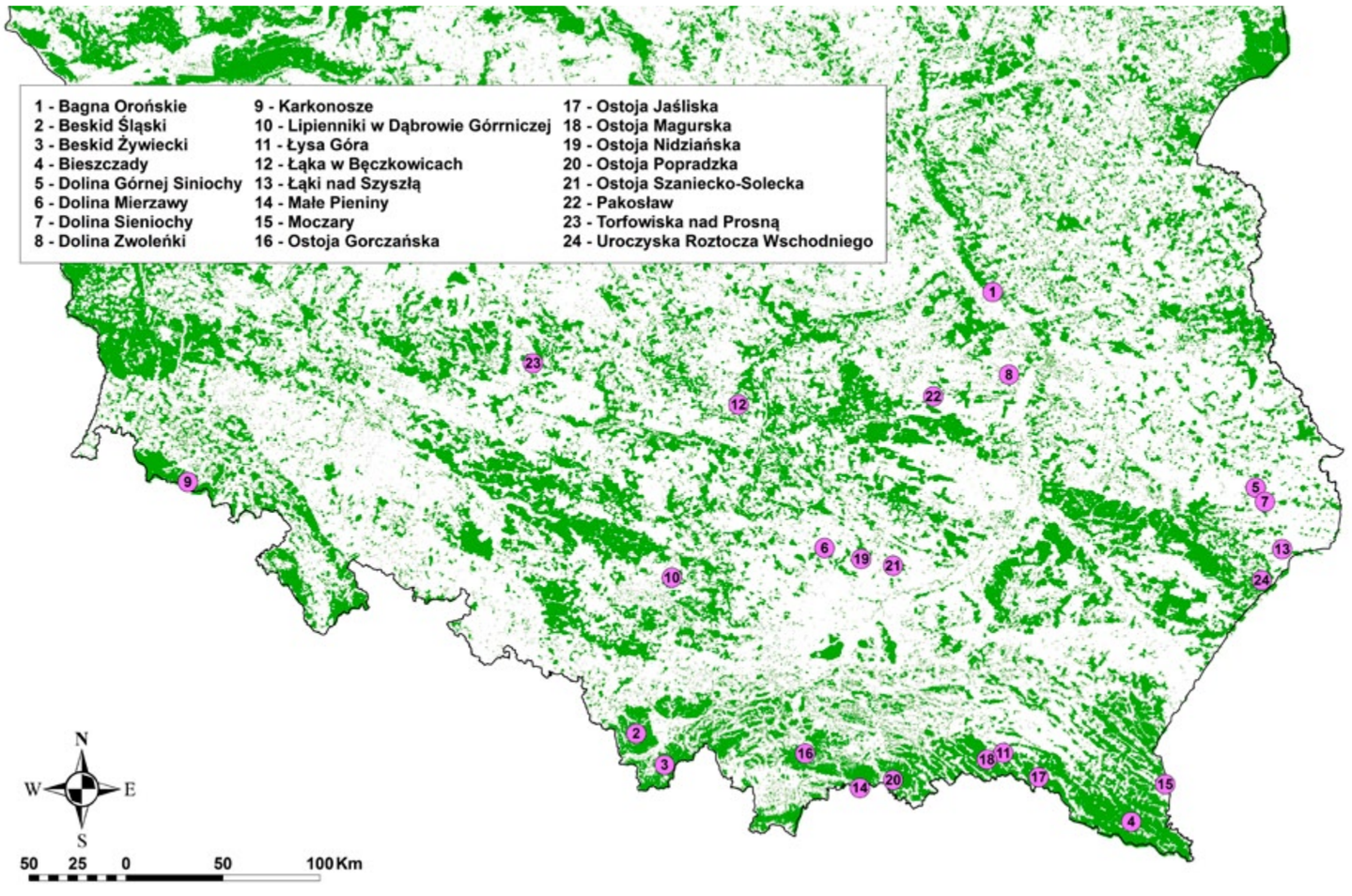
Conservation of alkaline fens (7230) in Poland

Scientific Report from realization of the projects
Conservation of alkaline fens (7230) in young-glacial landscape of northern Poland (LIFE11 NAT/PL/423)
Conservation of alkaline fens (7230) in southern Poland (LIFE13 NAT/PL/000024)

VOLUME II

Conservation of alkaline fens (7230) in Poland

Localisation of Natura 2000 sites, where project activities were implemented



Conservation of alkaline fens (7230) in Poland

Report from realization of the projects

Conservation of alkaline fens (7230) in young-glacial landscape of northern Poland (LIFE11 NAT/PL/423)

Conservation of alkaline fens (7230) in southern Poland (LIFE13 NAT/PL/000024)

Authors:
Lesław Wołejko, Robert Stańko, Filip Jarzombkowski, Magdalena Makowska, Dorota Horabik, Magdalena Bregin, Ewa Gutowska, Katarzyna Kotowska, Paweł Pawlaczyk

Klub Przyrodników
Świebodzin 2018

Conservation of alkaline fens (7230) in Poland

VOLUME II

Conservation of alkaline fens (7230) in southern Poland (LIFE13 NAT/PL/000024) and experiences of alkaline fens conservation in northern and southern Poland

Authors:
Lesław Wołejko, Robert Stańko, Filip Jarzombkowski, Magdalena Makowska,
Dorota Horabik, Magdalena Bregin, Ewa Gutowska, Katarzyna Kotowska, Paweł Pawlaczyk

Klub Przyrodników
Świebodzin 2018

ISBN: 978-83-63426-26-2

Authors (in alphabetical order):
Bregin M., Gutowska E., Horabik D., Jarzombkowski F., Kotowska K., Makowska M., Pawlaczyk P., Stańko R., Wołejko L.

Lesław Wołejko
Zakład Botaniki i Ochrony Przyrody
Zachodniopomorski Uniwersytet Technologiczny, Szczecin

Magdalena Bregin, Dorota Horabik, Magdalena Makowska, Paweł Pawlaczyk, Robert Stańko
Klub Przyrodników, Świebodzin

Filip Jarzombkowski, Ewa Gutowska, Katarzyna Kotowska
Instytut Technologiczno-Przyrodniczy
Zakład Ochrony Przyrody i Krajobrazu Wiejskiego, Falenty

Layout: Barbara Rynkiewicz

Correction: Magdalena Makowska, Lesław Wołejko

Translation: ATOMINIUM, Krakow

Print: Szmydt, Gostynin

Volume I i II was published in a frame of the projects: LIFE11 NAT/PL/423 and LIFE13 NAT/PL/000024 cofinanced by LIFE and National Fund for Environment Protection and Water Management.

Photo on front page: Spring-fed cupola fen in Śniatycze (photo R. Stańko).

VOLUME II

Complex of Szyszła valley peatlands (photo R. Stańko).

1. LIFE13 NAT/PL/000024 project „Protection of alkaline fens in southern Poland" – planned actions and achieved results

Dorota Horabik, Robert Stańko, Magdalena Makowska

The project „Protection of alkaline fens in southern Poland", similarly to the LIFE11 NAT/PL/432 Project „Protection of alkaline fens in the young glacial landscape of northern Poland" described in detail in the Volume I, was based on the results of the national inventory of habitat 7230 carried out within the framework of the completed project „Conservation programs for: alkaline fens (7230) and endangered species related to them – yellow marsh saxifrage, fen orchid, musk orchid, and fleshy starwort" (POIS.05.03.00-00-47/08). In principle, it was aimed at inhibiting the degradation process and improving or maintaining the proper condition of alkaline fens in 24 Natura 2000 areas in southern Poland, as a habitat for many rare, protected, and extremely endangered plant species including, in particular, species from Annex II of the Habitats Directive.

The project was implemented in the period 09/2014 – 12/2018[1] from the funds of LIFE+ financial instrument (50%), National Fund for Environmental Protection and Water Management (45%), its Beneficiaries - the Naturalists' Club (Beneficiary), Gorce National Park (Co-Beneficiary), and additional co-financing entity for the activities in the Podkarpackie Voivodeship – Regional Directorate for Environmental Protection in Rzeszów. The project covered 8 Voivodeships: Małopolskie, Śląskie, Podkarpackie, Lubelskie, Dolnośląskie, Łódzkie, Mazowieckie, and Świętokrzyskie. Among 97 selected "sites" (patches of habitats) constituting the most valuable and best preserved alkaline fens in the southern and central part of the country, there were both mountain flush mires in Beskid Żywiecki, Gorce, Pieniny, as well as alkaline fens located in the central part of Poland, i.e., Łąka w Bęczkowicach. The number of patches of habitats covered by the project during its implementation has changed; the activities cover new sites, most frequently inventoried during cataloguing and monitoring works within the project implementation.

The main task of the project was:

- inhibiting excessive outflow and raising the level of groundwater in the area of alkaline fens,
- inhibiting the process of mineralization and eutrophication of the surface layer of alkaline fens,
- inhibiting the process of decline in the biodiversity of alkaline fens caused by the expansion of species characteristic for habitats with lower moisture content, e.g., grasses, trees, and shrubs,
- popularizing methods for the protection of alkaline fens based on good management plans based on a sound scientific basis, with a particular focus on hydro-ecological aspects,
- promoting the protection of alkaline fens as sanctuaries for rare and endangered species, which are also regional and local natural attractions,
- gathering a group of people interested in the protection of alkaline fens, undertaking future maintenance activities for the results achieved within the framework of the project,
- encouraging as many individuals (farmers) as possible to use the sites for hay production extensively in the future.

The project created an opportunity to maintain or improve the condition of most of the alkaline fens of southern and central Poland, which constitute about 70% of the resources of this part of the country by surface area. The implementation of the project contributed to the preservation of the full geographical and regional diversity of the 7230 habitat, its unique nature – from particularly small fens and the flush mires in the Carpathians to the extremely alkaline fens of the Lublin region.

The implementation of the project contributed to the preservation of a few percent (on a national scale) of *Liparis loeselii* sites and other rare species strongly associated with alkaline fens, e.g., *Ligularia sibirica, Pinguicula vulgaris ssp. bicolor, Schoenus ferrugineus, Schoenus nigricans, Tofieldia calyculata, Swertia perennis ssp. perennis, Gymnadenia conopsea ssp. densiflora, Malaxis monophyllos, Carex dioica, Hamatocaulis vernicosus, Pseudocalliergon trifarium,* and *Tomentypnum nitens.*

1 Initially, the project was completed in June 2018. Due to the prolonged arrangements for the C1 measure, the European Commission agreed, at the request of the Naturalists' Club, to extend the project until the end of December 2018.

1.1. Activities

The following activities were carried out as part of the project:

A1. Preparation of design and technical documentation, agreement on the purchase of land, and obtaining necessary permits and administrative decisions permitting the construction of gates, throttling culverts, dams and other non-technical solutions to improve water conditions in the area of fens and flush mires. As part of the activity, arrangements were made for the purchase of land, and a database of owners was created in order to make appropriate arrangements for the implementation of protective measures on their land.

A2. Preparation of documentation and site management plans, including protection plans for Natura 2000 areas within the boundaries of the sites (where they have not been executed and are not planned to be executed during the project), including plans of protective tasks for Natura 2000 areas where habitat 7230 was the main subject of protection. In all the areas where the activities were carried out, studies were prepared to form a „compendium of knowledge" about individual patches of the habitat in the areas, as well as containing a comprehensive description of the protection of habitat 7230 within the Natura 2000 area. These documents were handed over to the land managers, owners and, above all, to nature conservation institutions and local authorities so that they could use their knowledge of the habitat in their daily work, for example when issuing administrative decisions and drawing up planning documents. The documentation has also been designed in such a way that it is easy to prepare an application for the inclusion of a particular patch of fen in the agri-environment-climate program on its basis.

B1. Purchase of land for nature conservation purposes. The aim of the buy-outs was to prevent the destruction of the most valuable patches of the habitat but, above all, to guarantee its long-term conservation. This activity was carried out by the Project Partner – Gorce National Park – purchasing land located on its territory from private owners. Further information on the experience with the implementation of this measure within the scope of the two projects in chapter 3.3 of the Report.

C1. Improvement of water conditions through construction of gates, dams and/or local elimination of „concentrated water flow areas" inhibiting erosion (especially within mountainous areas). In order to improve the disturbed water conditions, critical for the existence of fens, especially alkaline fens, a number of different technical solutions have been constructed, adapted to the needs of the individual sites. Further information on the experience with respect to this measure can be found in chapter 3.1 of the Report.

C2. Improvement of light and water conditions by removing trees and shrubs. The aim of this measure was to provide appropriate light conditions for the vegetation characteristic for habitat 7230 (open brown moss and low sedge communities), to stop adverse changes in water conditions caused by increased evapotranspiration of trees, as well as to stop the degradation of peat deposits and the surface layer of the fens due to penetration with tree and shrub roots. This treatment was also one of the elements of activities restoring extensive hay production for some fens. Further information regarding the experience with the implementation of this measure can be found in chapter 3.2. of the Report.

C3. Preparatory mowing. This measure constitutes the first step towards restoring extensive hay production on fens abandoned several years ago, and sometimes several decades ago. Due to the changes taking place, mowing again after a dozen or so years requires much more work and, consequently, financial resources (a greater amount of biomass, including plant litter for removal, presence of clumps, shrubs, tree wildings, etc.). On the one hand, this measure promotes species characteristic of moss fen plant communities and, on the other hand, it encourages the continuation of the use by managers and owners in the future. Further information on the results of the implemented measures is provided in the following chapter. More on the experience with the implementation of this activity can be found in chapter 3.2 of the Report.

C4. Changing the attitudes of the local community by organizing a series of workshops. This activity originally assumed a number of small meetings (about 40) organized in small towns in the immediate vicinity of the sites where protective activities are undertaken. However, experience from the first of the organized meetings showed that private owners prefer individual meetings, therefore this form of communication was selected. Further information regarding the meetings can be found in chapter 3.5.3 of the Report and in the publication "The Guidebook on Good Practices in alkaline fens conservation" (Stańko et al. ed. 2018).

D1. Phytosociological and hydrological monitoring in selected model sites. During the project, phytosociological and hydrological monitoring was carried out in order to monitor the effects of the ac-

tivities. The methodology and results are widely discussed in chapters 2 and 4 of the Report.

D2. Monitoring of socio-economic effects. As part of this measure, a short survey was conducted with private owners regarding their knowledge of habitat 7230, management practices within this valuable habitat, and the willingness to continue conservation activities on their land.

E1./E2. Information and publicity measures. They included, among others, development of the project website (www.alkfens.kp.org.pl), promotional materials, organization of a series of workshops/seminars and preparation of The Guidebook on Good Practices in alkaline fens conservation, or the Monograph of habitat 7230.

1.2.Results

The following table summarizes the results of the implementation of the main activities of the project in numerical form (Table 1). The table indicates the planned scope of implementation of the individual actions at the application stage („P"), which have been successfully implemented in the project („R"). The following list (in the case of mowing and felling) also includes measures carried out on individual patches of the habitat by the owners themselves or under other projects („other"), as well as those sites where - due to the lack of consent of the owner - it was not possible to carry out conservation measures („no consent").

As in the case of LIFE11 NAT/PL/423 project, described in Volume I of this Report, there are differences between the planned areas covered by individual measures and the actual scope of implementation. These are due to a variety of reasons which could not have been foreseen initially. In some cases, the area of the habitat covered by the measures has increased due to the progressive succession within the fens and the need for implementing measures in other areas as well. In some cases, private owners have joined the agri-environment-climate program, and the measures had already been carried out as part of their extensive hay production. Within other patches of the habitat it was not possible to carry out the measures due to the lack of consent of the owners; often there were cases where the owners had a negative attitude towards NGOs and the very idea of protecting the areas. In other cases implementation was not possible due to pending legal procedures resulting from the amendment of the Act on common land management, etc.

Also in the case of action C1, consisting in the improvement of water conditions, one can notice quite significant differences in what had been planned and what was implemented or is still being planned („R+"). As mentioned earlier, the completion date for the project was postponed by six months due to the prolonged arrangements with the State Treasury land managers. During the project 's implementation, legal changes took place in water management laws in Poland. The main changes concerned the competence of authorities issuing permits and decisions, as well as units managing land constituting drainage ditches. Therefore, this Report covers only those measures that were completed by the time of publication of the Report, while the column „R+" includes measures planned to be completed by the end of the project. We will make information about the success of these projects available on the project website (www.alkfens.kp.org.pl).

The table does not present other results of the project, which are difficult to present in a tabular form.

This mainly concerns the C4 measure, which consists in changing the attitudes of the local community. As mentioned above, individual meetings with the owners and managers of the area have been held. At the beginning of the project, several meetings were held mainly in the central part of Poland, in the Łódzkie Voivodeship, which attracted quite a lot of interest, but during the group meetings the owners were reluctant to sign agreements/statements of consent to implement the activities on their land. An attempt was also made to organize such meetings in the southern part of the country, but despite inviting several dozen people to the meeting, none of the owners actually came. The most successful were individual meetings with the owners, during which the owners were acquainted with the characteristics of the natural habitat 7230 and the necessity of its protection, asked for consent to carry out conservation activities under the project, as well as encouraged to continue them in the future. As a result, several hundred interviews with the owners were conducted, thanks to which it was possible to sign over 200 agreements, contracts, and statements, and several dozen oral consents were granted for the performance of activities on over 500 plots of land. Given the significant fragmentation of the cadastral parcels and the number of meetings, the educational dimension of the project is significant and we hope that it will result in the long-term conservation of the habitat in the future.

The following chapters discuss in detail the practical experiences with the protection of alkaline fens.

Table 1. List of the most important planned and implemented conservation measures during the project LIFE13 NAT/PL/000024

No.	Name of LIFE project site	Site name	Name and code of Natura 2000 site	Dams, gates and other facilities to improve hydrological conditions Action C1			Trees and shrubs removal [ha] Action C2				Preparatory mowing [ha] Action C3				Buyouts [ha] Action B1	
				P	R	R+	P	R	other	No consent	P	R	other	no consent	P	R
1	Karkonosze	Niedamirów	Karkonosze PLH020006				0,23	0,70			0,20	0,70				
2		Niedamirów 1					0,20		0,20		0,80		0,20			
3		Niedamirów 2									0,20		0,20			
4		Niedamirów 3									0,07		0,07			
5		Niedamirów 4									0,10		0,10			
6	Beskid Śląski	Polana Przysłop	Beskid Śląski PLH240005									0,06				
7		Twardorzeczka						0,04				0,04				
8		Hala Barania 1									0,05		0,05			
9		Hala Barania 2									0,15		0,15			
10		Hala Radziechowska 2					0,08		0,08		0,08		0,08			
11		Polana Cebula 1									0,19			0,19		
12		Hala Rysianka						0,55				0,55				
13		Pod Halą Rysianką						0,25				0,25				
14		Pod Rycerzową 1						0,71				0,71				
15		Pod Rycerzową 2						0,24				0,24				
16		Złatna Huta						0,50				0,50				
17		Dolina Ciapków					0,07	0,07			0,07	0,07				
18		Hala Bułkowa 1					0,08	0,08			0,08	0,08				

19		Hala Boracza		1							0,09		0,09			
20	Beskid	Hala Cebulowa	Beskid Żywiecki				0,10		0,10		0,10		0,10			
21	Żywiecki	Hala Cudzichowa 1	PLH240006				0,13		0,13		0,13		0,13			
22		Hala Górowa 1					0,08		0,08		0,08		0,08			
23		Hala Jodłowcowa 1					0,04		0,04		0,04		0,04			
24		Hala Krawcula					0,10		0,10		0,10		0,10			
25		Hala Miziowa					0,08		0,08		0,08		0,08			
26		Hala Bułkowa 2					0,10			0,10	0,10			0,10		
27		Hala Jodłowcowa 2					0,05			0,05	0,05			0,05		
28		Hala Jodłowcowa 3					0,07			0,07	0,07			0,07		
29		Mała Racza								0,10				0,10		
30		Pod Halą Miziową									0,07			0,07		
31	Lipienniki w Dąbrowie Górniczej	Torfowisko Antoniów i piaskownia Kuźnica Warżyńska	Lipienniki w Dąbrowie Górniczej PLH240037	9			3,75			3,75	6,00			6,00		
32		Borysówka						0,00			0,18	0,15			0,175	
33		Hala Długa/Wierchy Zarębskie		2	25		0,55	1,00			0,55	1,95	4,10		0,66	
34		Hala Nowa						0,64				0,50				0,7829
35	Ostoja	Jonkówki	Ostoja				1,10	0,35			1,10	1,00			1,353	1,3534
36	Gorczańska	Polana Bernadowa	Gorczańska					0,09			0,09	0,09				
37		Polana Rożnowa	PLH120018				0,07	0,07			0,07	0,07				
38		Średniak						0,21				0,21				
39		Polana Śmierdząca										0,48				
40		Ludwikowa										0,14				

41		Jasinkowa										0,42					
42	Ostoja	Gronie Chowańcowe	Ostoja									0,11					
43	Gorczańska	Gronie Drożdżowe	Gorczańska									0,04					
44		Przysłopy	PLH120018				0,60	0,77			0,60						0,4172
45		Stawieniec					1,33	0,00			1,10	1,00			0,723		
46		Skole Jędrasowe															0,3700
47		Gabrowska Mała					0,25			0,25	0,25			0,25	0,264		
48		Hala Filasowa		1			2,20			2,20	2,20			2,20			
49		Czerwona Skała						0,06				0,06					
50		Góra Homole						0,10				0,10					
51		Homole						0,01				0,01					
52		Homole 2						0,06				0,06					
53		Homole 2						0,03				0,03					
54		Huściawa 1						0,27			0,12	0,27					
55		Huściawa 2						0,00			0,07	0,05					
56		Huściawa 3						0,04			0,00	0,04					
57		Kociubylska Skała 2						0,03				0,03					
58		Kociubylska Skała						0,06				0,06					
59		Pod Durbaszką 5						0,01				0,01					
60		Pod Durbaszką 1					0,05	0,06			0,05	0,06					
61	Małe	Pod Durbaszką 2	Małe Pieniny				0,08	0,73			0,08	0,73					
62	Pieniny	Pod Durbaszką 3	PLH120025					0,03				0,03					
63		Pod Durbaszką 4a						0,04				0,04					
64		Pod Durbaszką 4b						0,02				0,02					
65		Pod Durbaszką 5						0,04				0,04					
66		Pod Dziurawą Skałą 2						0,02				0,02					

67		Pod Dziurawą Skałą 3						0,00				0,01				
68		Pod Dziurawą Skałą					0,06	0,03			0,06	0,03				
69		Pod Przełęczą Rozdziela 2						0,00			0,10	0,12				
70		Pod Przełęczą Rozdziela						0,15				0,15				
71		Pod Smrekową 1					0,12	0,03			0,12	0,03				
72		Pod Smrekową 2						0,00				0,02				
73		Pod Wierchliczką					0,07	0,07			0,07	0,07				
74		Pod Wysoką, źródła Kamionki						0,09			0,07	0,09				
75		Bukowina						0,13			0,08	0,13				
76		Długie Młaki 2					0,07	0,07			0,07	0,07				
77		Dolina Potaszni					0,11	0,11			0,11	0,11				
78		Dolina Sopotnickiego Potoku					0,16	0,69			0,16	0,69				
79		Dolina Sopotnickiego Potoku 2						0,12				0,12				
80		Jaworzynka 2									0,05		0,05			
81		Liskowa									0,07		0,07			
82	Ostoja	Łomniczanka	Ostoja					0,06			0,06	0,06				
83	Popradzka	Nad Wierchomlą 1	Popradzka								0,12		0,12			
84		Nad Wierchomlą 2	PLH120019				0,11		0,11		0,11		0,11			
85		Obidza						0,09			0,09	0,09				
86		Pokrywisko					0,07	0,07			0,07	0,07				
87		Polana Gwiaździsta									0,06		0,06			
88		Przełęcz Krzyżowa 1									0,16		0,16			
89		Przełęcz Krzyżowa 2									0,07		0,07			

90		Wyżnie Młaki										0,15		0,19			
91	Pastwa	Torfowisko Pastwa	Torfowisko nad Prosną PLH100037				0,90	1,50			11,30	4,80				
92		Torfowisko Pastwa 1						0,10				0,10				
93		Torfowisko Pastwa 2										1,30				
94		Torfowisko Pastwa 3						0,10				0,10				
95	Łąka w Bęczkowicach	Łąka w Bęczkowicach	Łąka w Bęczkowicach PLH100004				11,10	10,83			18,40	10,83				
96	Dolina Mierzawy	Sędowice	Dolina Mierzawy PLH260020				1,04	1,47			2,76	1,47				
97	Ostoja Nidziańska	Torfowisko Bełk	Ostoja Nidziańska PLH260003				2,10	1,81			5,00	1,81				
98	Ostoja Szaniecko - Solecka	Torfowisko Zwierzyniec	Ostoja Szaniecko - Solecka PLH260034	5			0,45	0,70			2,90	0,70				
99		Śladków Duzy					1,10		1,10		1,20		1,20			
100	Torfy Orońskie	Torfy Orońskie	Bagna Orońskie PLH140023				0,30	2,40			1,80	2,40				
101	Pakosław	Pakosław PLH140015	Pakosław PLH140015	3			6,63	3,16			6,63	3,16				
102	Dolina Zwoleńki	Dolina Zwoleńki koło wsi Stara Siekierka	Dolina Zwoleńki PLH1400006				0,70	0,64			0,70	0,64				
103		Dolina Zwoleńki koło wsi Mierziączka					1,13			0,40	1,23			0,20		
104	Dolina Górnej Siniochy	Miączyn	Dolina Górnej Siniochy PLH060086	2							0,24		0,24			
105		Kolonia Niewirków		8			3,00			2,70	0,88			2,70		

106	Dolina Sieniochy	Perespa	Dolina Sieniochy PLH060025	6	5	1	0,75	10,00			12,53	12,54	1,68			
107		Rudka		11		6		9,29			10,27	14,59	0,83			
108		Śniatycze-Swaryczów		10		4	7,58	5,89	6,98		43,02	10,92	31,62			
109		Kopuła Śniatycze		11		2		4,22			4,70	8,34				
110		Komarów		2							1,35		1,35			
111		Antoniówka		5		3				0,70	0,44			5,10		
112	Łąki nad Szyszłą	Jurów	Łąki nad Szyszłą PLH060042	1			0,00	1,29			0,25	1,29				
113		Plebanka		3	11		0,14	3,19			3,29	6,38	2,34			
114	Siedliska	Siedliska	Uroczyska Roztocza Wschodniego PLH060093	4	8		0,23	1,20			1,30	1,20				
115	Ostoja Magurska	Ciechan	Ostoja Magurska PLH180001				0,14	0,17			0,43	0,43				
116		Ciechan														
117		Grab					0,03	0,08			0,04	0,10				
118		Świerzowa Ruska					0,05	0,05			0,15	0,15				
119		Świerzowa Ruska														
120		Wilsznia		1			0,15	0,15			0,39	0,39				
121	Łysa Góra	Łysa Góra 1	Łysa Góra PLH180015				0,55	0,55			0,55	0,55				
122		Łysa Góra 3									0,02		0,02			
123		Łysa Góra 2									0,02		0,02			
124	Ostoja Jaśliska	Jasiel 2	Ostoja Jaśliska PLH180014				0,11	0,11			0,11	0,11				
125	Bieszczady	Młaki za cmentarzem w Wołosatym	Bieszczady PLC180001								1,50	1,50				
126		Ostry 3						0,13				0,13				
127		Ostry 2					0,11	0,11			0,11	0,11				

128		Bandrów I						0,93				0,93					
129		Bandrów II						0,06			0,15	0,42					
130		Bandrów III						0,04			0,00	0,09					
131		Bandrów 3				0,40		0,00		0,40		0,14					
132		Bandrów 7				0,07		0,03		0,07		0,06					
133		Bandrów 8				0,07		0,06		0,07		0,38					
134	Moczary	Bandrów x	Moczary				0,07		0,28		0,07		1,55				
135		Bandrów y	PLH180026				0,06		0,92		0,06		0,92				
136		Bandrów z							0,00				0,05				
137		Bandrów 10					0,10		0,18		0,10		0,62				
138		Bandrów i							0,03				0,25				
139		Bandrów ii							0,05				0,07				
140		Bandrów 9							0,01		0,11		0,04				
141		Moczary 1				0,30		0,32		0,30		0,32					
142		Moczary 2				0,10		0,13		0,10		0,13					
RAZEM				**85**	**49**	**16**	**51,62**	**69,76**	**11,01**	**10,32**	**152,14**	**100,36**	**50,23**	**17,03**	**3,17**	**2,92**	

Explanations:
P – planned scope
R – realized scope
R+ - planned realisation till the end of 2018
Other – actions undertaken by owners by themselves or within other projects.
No consent – lack of consent of private owner, lack of possibility to identify the owner etc.

2. Characteristics of alkaline fens protected by the project and the results of conservation measures and monitoring

Magdalena Bregin, Filip Jarzombkowski, Ewa Gutowska, Katarzyna Kotowska, Robert Stańko, Dorota Horabik

Natura 2000 site Karkonosze PLH020006

The Karkonosze are the central part of the Western Sudetes, stretching over 40 km, and the Natura 2000 area covers an area of 18204.09 ha. There are numerous, albeit small, fens which occupy 85 hectares and are concentrated mainly in the zone of the upper shelf.

The nature of the Karkonosze is protected within the transboundary Karkonosze National Park and in the Karkonosze-Jizera Mountains Protected Landscape Area. Since 1992, however, the Polish Karkonosze NP have, together with the Czech Krkonošský National Park, become a part of the border UNESCO Biosphere Reserve Krkonoše (MAB), with an area of over 60 thousand ha.

In the Karkonosze area, the activities covered two sites representing habitat 7230 - Niedamirów and Niedamirów 1. They are located in the eastern part of the Karkonosze, in the area of Lasocki Grzbiet, above the village of Niedamirów, in the valley of a small mountain stream that flows into Ostrężnik, which is the left tributary of the Bóbr River. Above the eastern part of the valley, where the sites are located, rises Góra Kalwaria (713 m above sea level). Geologically, the area lies within the eastern section of Karkonosze granite. The subsoil here is made up of metamorphic rocks, mainly conglomerate and shale (Kondracki 2011). The terrain is not very diversified; both sites lie on a slope and no geomorphological forms have been recorded in their area. Both fens are located on the same slope, with eastern exhibition and a gradient of about 10° – 30°. They are formed in strips along a stream that periodically floods the

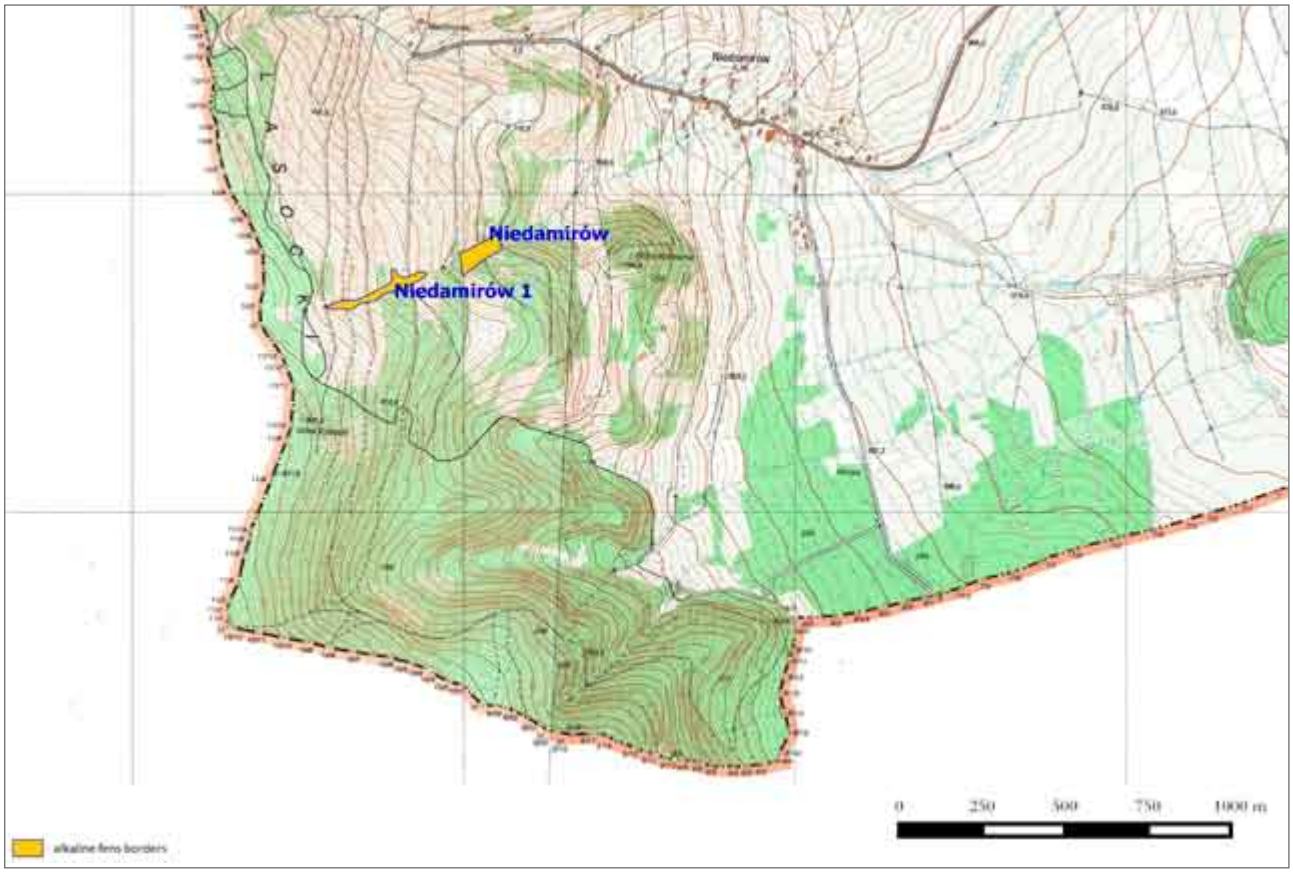


Fig. 1. Locations of the sites in the Karkonosze.

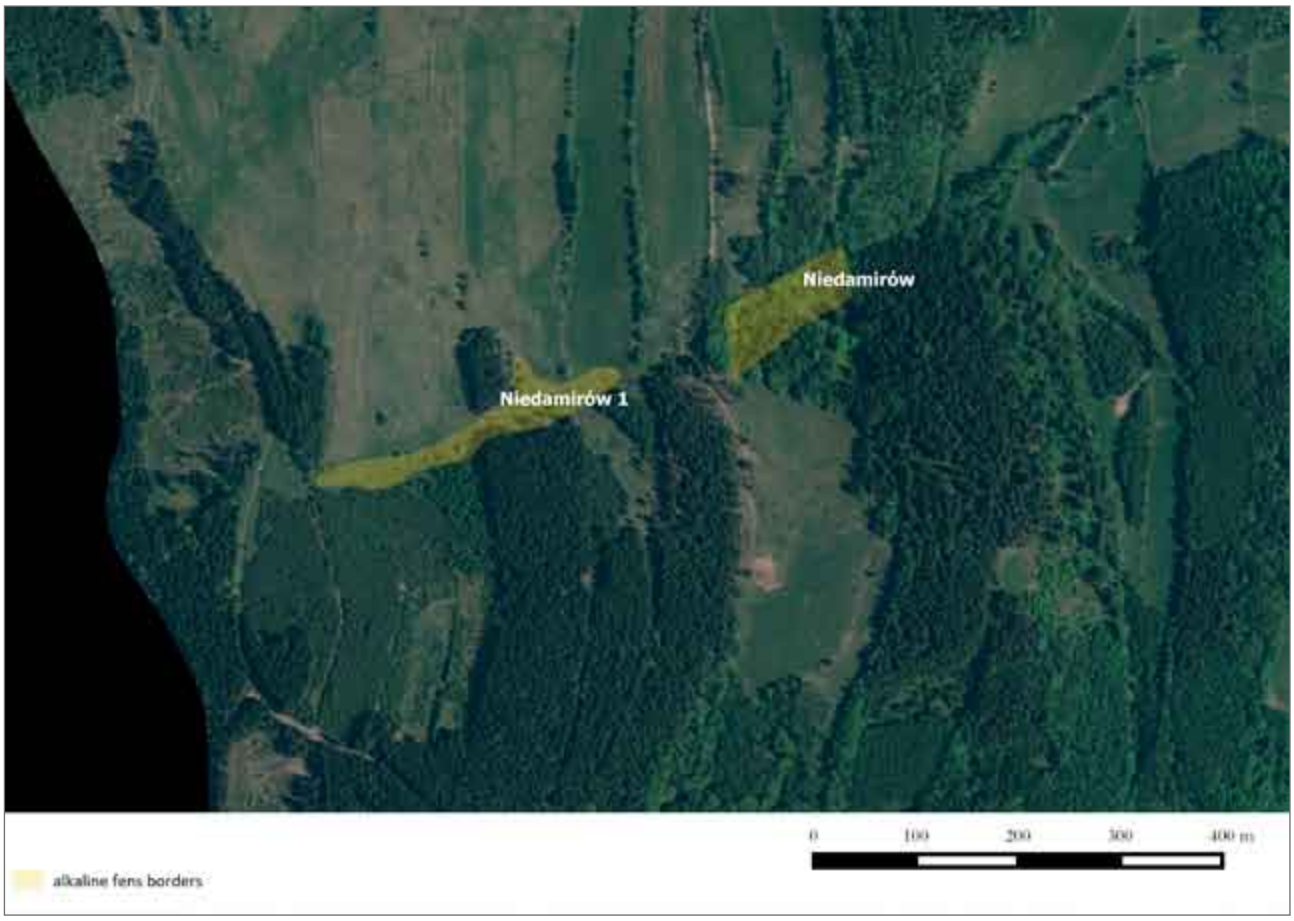


Fig. 2. Locations of the sites in the Karkonosze area.

Photo 1. A flush mire in the Karkonosze (photo D. Horabik).

area, creating local bogs. The first site, Niedamirów 1, is located in a spring area, where water seeps to the surface and collects a small watercourse down the slope. The stream dries out periodically.

Here, flush mire vegetation is built by the *Caricetum davallianae* sedge association in its typical form, with a large share of *C. davalliana*, creating characteristic tussocks. *Epipactis palustris, Eriophorum angustifolium*, and sedges *Carex nigra*, *C. panicea* and *C. echinata* are also numerous. The moss layer is formed, among others, by *Tomentypnum nitens*, *Aulacomnium palustre*, and *Calliergonella cuspidata.*

The sites in question have 47 vascular plant species, including 6 species of bryophytes, one of which is under strict protection – *Carex davalliana*. The plant cover contains a mosaic of spring, herbaceous, and moss fen communities. Two plant communities of the *Caricion davallianae* association were found within the sites, *Valeriano-Caricetum flavae*, *Caricetum davallianae*, as well as one of the *Magnocaricion* association – *Caricetum rostratae*. In addition, on the edges of the sites there are herbaceous communities with a large share of species such as *Filipendula ulmaria*, *Scirpus sylvaticus*, *Cirsium rivulare*, and *C. oleraceum*, as well as *Polygonum bistorta.* In some places there are also dense patches of the *Petasitetum albi* association. The valerian-sedge flush mire is characterized by a great abundance of species. In addition to the taxa typical of the habitat, there are also numerous wet meadow and herbaceous species. *Carex flava*, *C. echinata*, and *C. panicea*, as well as

Photo 2. Herbaceous vegetation patch at the edges of the site (photo M. Bregin).

Photo 3. Valerian-sedge flush mire *Valeriano-Caricetum flavae* (photo M. Bregin).

Photo 4. *Caricetum davallianae* sedge association (photo M. Bregin).

Eriophorum latifolium are found in the herbaceous layer, which contains a high proportion of sedges. In the lower layer, on the other hand, there is a very high proportion of butt leaves of *Valeriana dioica*. The moss layer is dominated by *Calliergonella cuspidata* and species of the genus *Plagiomnium*. At the top of the flush mire, in the spring area, a large number of species are found of the genus *Cratoneuron*. *Caricetum davallianae* sedge association occurs in a typical form, with a high proportion of *C. davalliana*, which forms characteristic clumps. There is a significant proportion of species common to the mountain flush mire habitat, such as *Epipactis palustris, Eriophorum angustifolium*, and sedges: *Carex nigra*, *C. panicea*, and *C. echinata*. Large numbers of *Tomentypnum nitens*, *Aulacomnium palustre*, and *Calliergonella cuspidata,* among others, have been found in the moss layer.

The peat deposits are very shallow, with a thickness of just a few centimeters. Peat soils and peat-gley soils are predominant. The area where the sites are located was used several years ago for hay production; now extensive grazing is carried out in the area and in its vicinity.

On both Niedamirów sites the mowing and removal of the undergrowth of trees and shrubs were carried out in order to improve light conditions and stop the succession of vegetation. The main threat to the habitat in this area are disturbances in the species composition of the community by species with a wide ecological amplitude. The above-mentioned implemented conservation measures contributed to the improvement of the condition by limiting the expansion of taxa unusual for the habitat. However, no significant improvement in parameters such as habitat structure or functions have been observed at present due to the short period of time that has elapsed since the measures were implemented. The results of the activities will be visible in the near future, provided that they are continued.

Natura 2000 site Beskid Śląski PLH240005 covers the range of Beskid Śląski built of Godula and Istebna sandstones, and in the southern part – Magura flysch. The natural values of the Beskid Śląski area are protected in the Silesian Beskids Landscape Park and in 9 nature reserves (Pępkowska-Król et al. 2013).

The fens of the Silesian Beskids are represented mainly by the *Valeriano-Caricetum flavae* mountain flush mire association, considered by some authors to be an endemic fen complex of the Carpathian range (Denisiuk & Korzeniak 1999, Hajek and Haberova 2001). They occur most frequently in concavities and edges of slopes and near springs. The distribution of this habitat is in the range of 540 – 1020 m above sea level, the subsoil on which they are recorded is difficult to permeate and the water shows horizontal movement (Wilczek 2006). Wilczek (2006) describes three variants in this area that are distinguished by the dominance of particular species. The first variant is characterized by a high proportion of *Luzula sylvatica* as well as of *Caltha laeta* and *Calamagrostis villosa*. It is located higher in the mountains (in the range of 980 – 1010 m above sea level), most often on shady spring areas, surrounded by *Abieti-Piceetum* plant communities. The second, more fertile and species-rich variant is found in the large, sunny mountain pastures where *Epipactis palustris* plays a significant role. The third variant, typical, is the most common and occurs on intermediate habitats between the two described above.

In the Beskid Śląski nature refuge, there are more than fifteen fens which are characterized by a limited surface area, rarely exceeding 0.5 ha. The project includes only two sites: Polana Przysłop and Twardorzeczka. The remaining flush mires in this area have been covered by protective measures carried out as part of another project, or are used for hay production by the owners or tenants of the alps.

Polana Przysłop – the site is located in the Przysłop glade, on a slope over the Czarna Wisełka stream. The flush mire formed in a hollow with groundwater seepage, rich in calcium compounds. There are no watercourses on the site. Sometimes the water stagnates above the ground surface. Additionally, the flush mire is supplied with rainwater which flows down the slope. As a result, during periods of heavy rainfall, especially in spring and early summer, water levels are high. The area is surrounded by herb

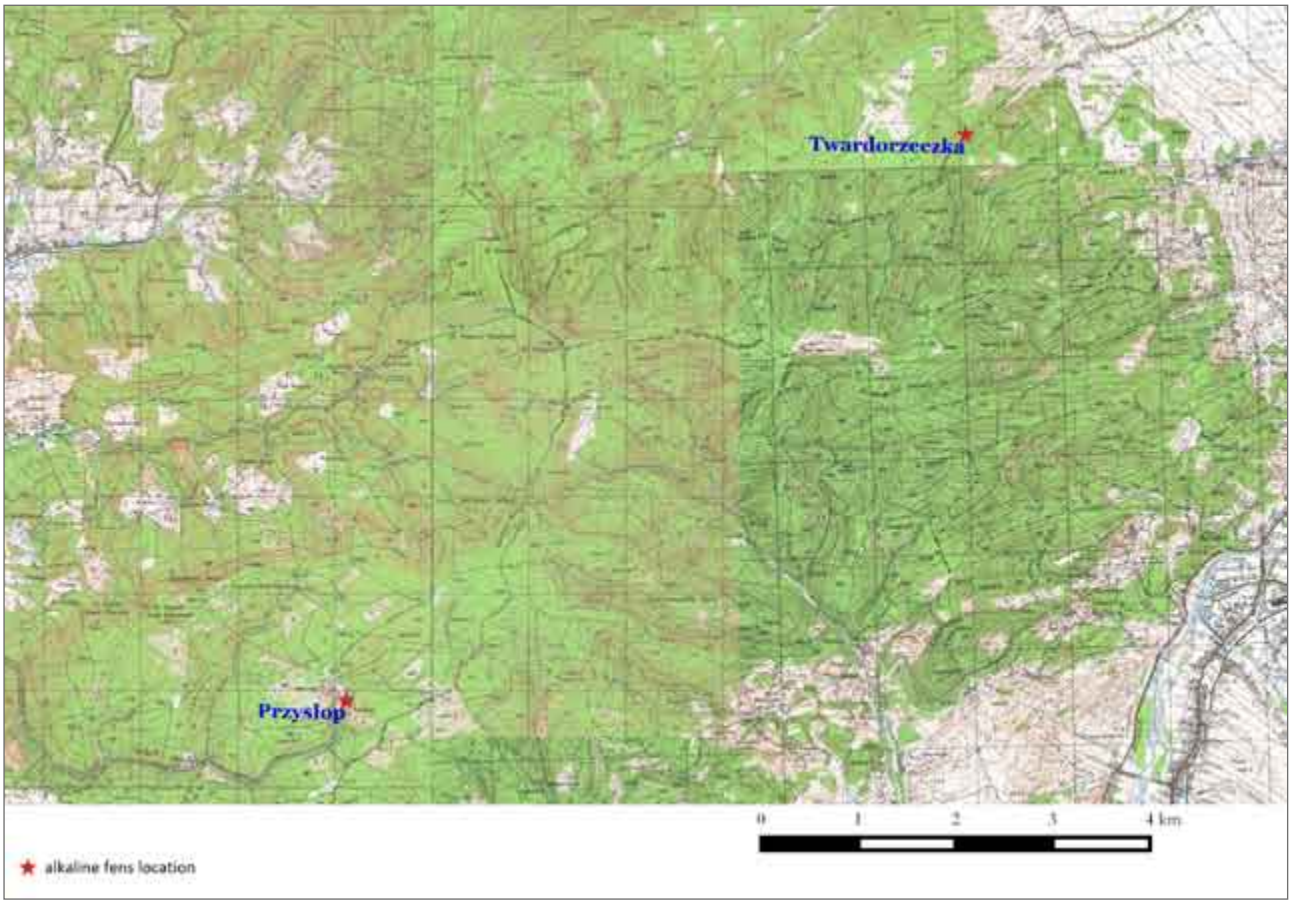


Fig. 3. Locations of two patches of the habitat included in the project in the Silesian Beskids.

Photo 5. Polana Przysłop (photo M. Bregin).

Fig. 4. Boundaries of the Przysłop site.

communities as well as wet and fresh meadow vegetation. Due to the high water content of the subsoil, the flush mire remains in good condition; however, the expansion of herbaceous species is observed.

The organic layer is only a few centimeters, but the phytocoenosis retains most of the structural and functional features typical of habitat 7230. The plant community growing in the area of the site is *Valeriano-Caricetum flavae*, representing a variant typical for the area of the Silesian Beskids with quite a large number of characteristic taxa. The herbaceous layer contains low sedges such as *Carex nigra*, *C. panicea* and *C. flava*. Of the protected species - *Epipactis palustris*. The moss layer is quite well formed, dominated by relatively common brown moss species such as *Calliergonella cuspidata* and *Climacium dendroides*. There is also a high proportion of species typical of meadows, such as *Agrostis capillaris* or *Festuca rubra*, as well as *Equisetum palustre*. The glade and the flush mire were mown and grazed several decades ago; however, this management is currently abandoned due to the inaccessibility of the land and low profitability. Lack of use has led to the slow overgrowth and expansion of common species that crowd out the taxa typical of mountain flush mire habitats. As part of the project, mowing operations were carried out which will prevent further succession and transformation of the plant community. However, it is essential that these activities be continued in the future.

Twardorzeczka – the site occupies a very small area of several ares and is located at the bottom of the valley of the Twardorzeczka River. It is separated from the river bed by an asphalt road. The flush mire formed at the foot of the slope in a small hollow of the terrain with groundwater seepage. Additional supply is provided by rainwater, which flows down the slope, stopping on the surface of the flush mire. The water content of the subsoil is quite good, although the water does not rise above the surface of the subsoil and its fluctuations are quite high. Only during periods of very heavy rainfall (usually in spring) does it sometimes stagnate on the surface of the ground. The subsoil is made of shale, which is difficult to permeate, and the peat layer is not present here, which is likely due to a very slow peat-forming process and unstable water conditions. The area is surrounded by clumps of blackberries, willow and growing trees, and on the eastern side – by wet meadows and herbaceous vegetation.

Photo 6. Flush mire – Przysłop after mowing (photo T. Bąkowski).

Photo 7. Twardorzeczka (photo M. Bregin).

Fig. 5. Boundaries of the Twardorzeczka site.

A plant community is formed here related to a valerian-sedge flush mire, but with an altered structure and not a high a proportion of species characteristic for the habitat 7230. The herbaceous layer consists mainly of sedges, including *Carex panicea, C. echinata*, and *Carex flava*. However, there is also a high percentage of meadow and herbaceous species. *Scirpus sylvaticus* is particularly abundant here. The moss layer is formed by common species, such as *Rhytidiadelphus squarrosus, Plagiomnium elatum*, and *Calliergonella cuspidata*.

Several decades ago, the area was used for herding, grazing sheep, cows, and horses. These activities have been abandoned, which results in overgrowing of the glade with the flush mire. The project involved mowing and removing bushes and trees. These measures improve the light conditions and prevent the expansion of species that are undesirable for the habitat. However, they need to be continued.

Photo 8. Flush fen Twardorzeczka after mowing and trees removal (photo T. Bąkowski).

Natura 2000 site Beskid Żywiecki PLH240006

The Żywiec Beskid range is part of the Western Beskids and is situated in the Outer Western Carpathians. The natural and landscape values of the region are protected in the special Natura 2000 area Beskid Żywiecki PLH240006, in the Żywiec Landscape Park, and in a network of ten nature reserves.

Hala Rysianka – a rather large fen located on the slope of the Rysianka alp, with eastern exposition. It

Photo 9. Hala Rysianka (photo M. Bregin).

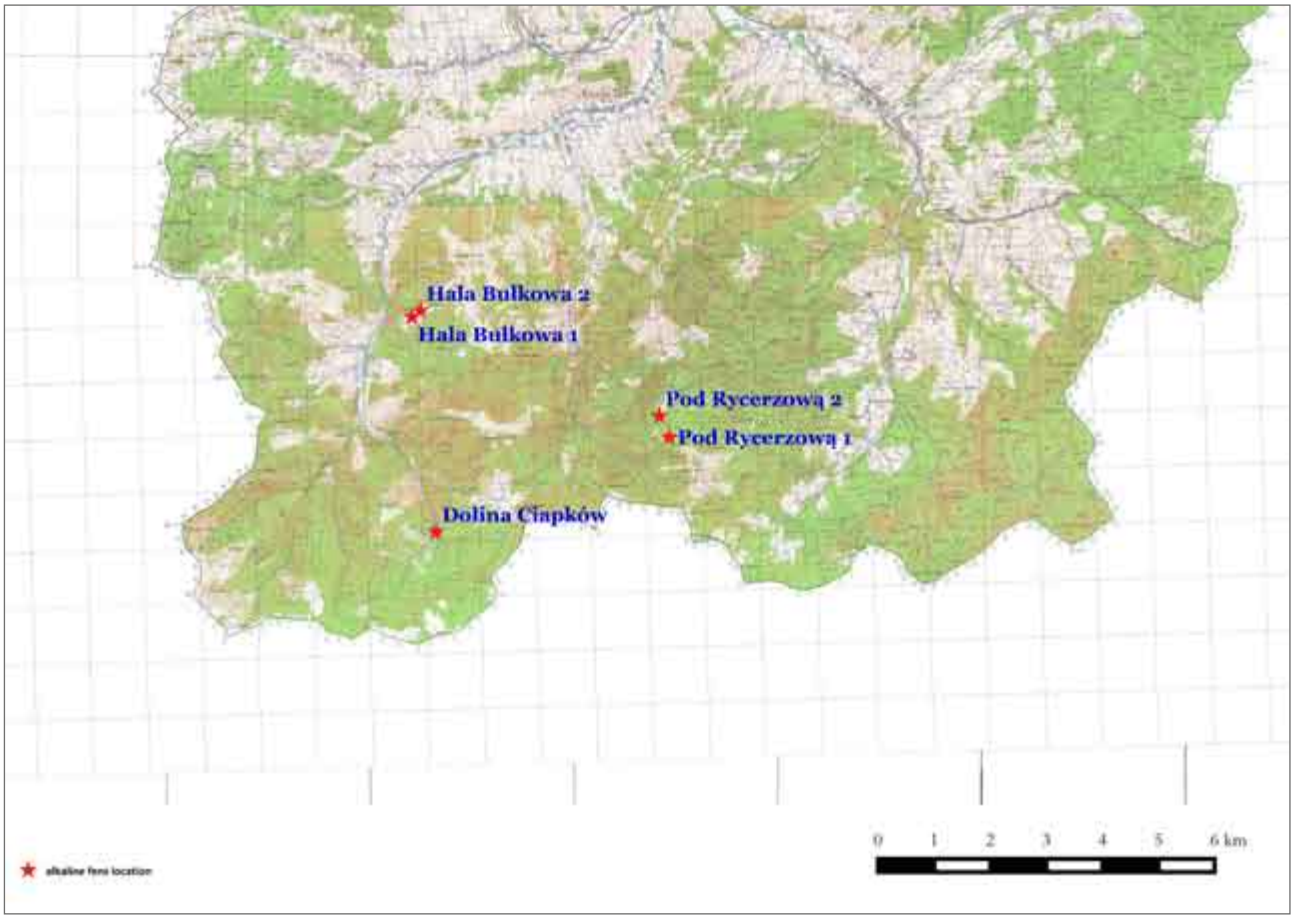


Fig. 6. Location of sites in the Żywiec Beskids (1/2).

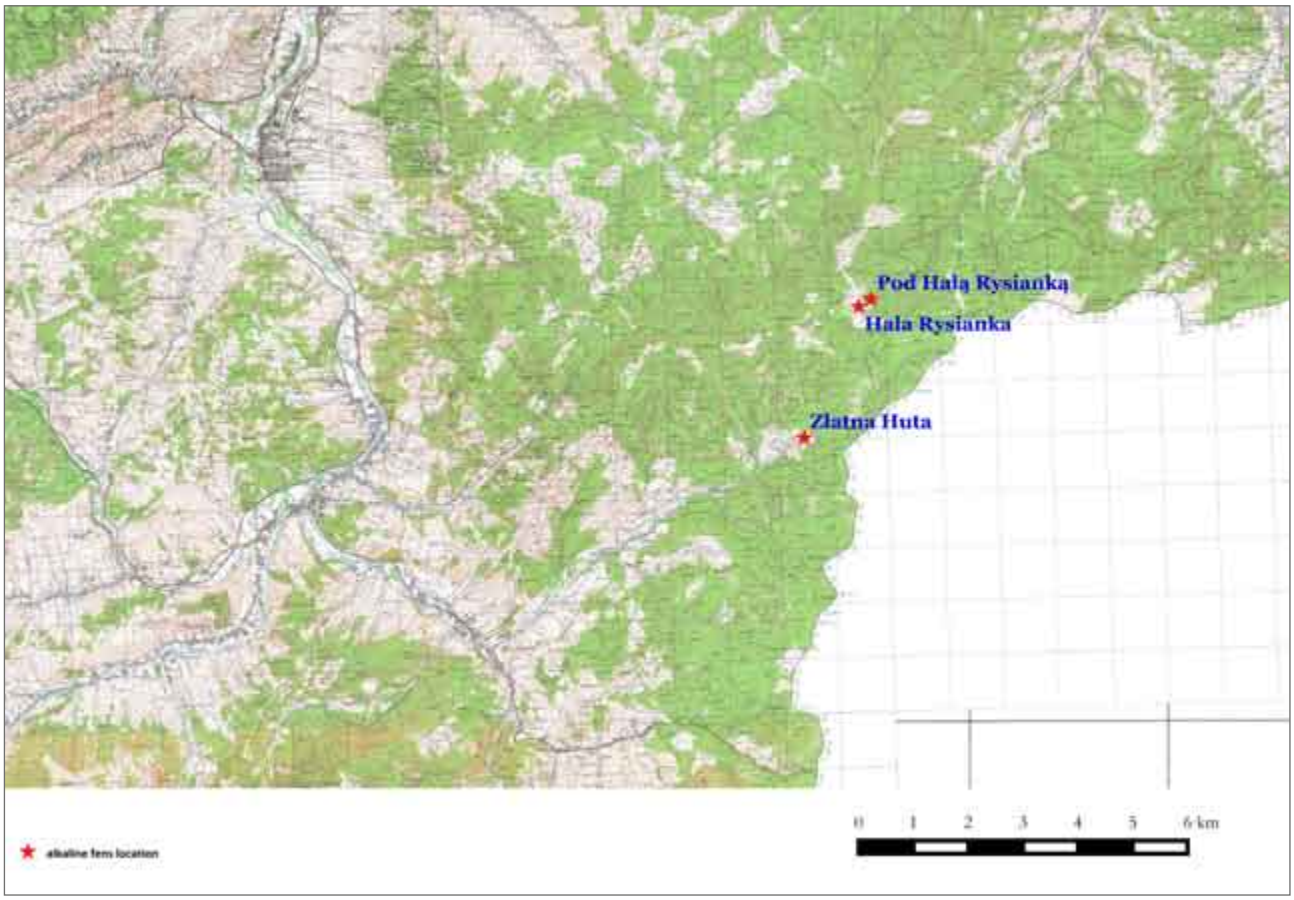


Fig. 7. Location of sites in the Żywiec Beskids (2/2).

is formed in the place of groundwater seepage which then flows down the slope. There are many species typical of the habitat, especially *Carex nigra*, *C. flava* sedges, and *Valeriana simplicifolia*, with some fresh meadow taxa.

Pod Halą Rysianką – a small site located on a steep slope with eastern exposure. The flush mire develops in a spring cone, where it reaches its greatest abundance of species. The farther along the slope, the less diverse the species composition is and the more blackberries and spruce undergrowth enter the area of the flush mire; the share of *Carex paniculata* sedge also becomes more pronounced. The moss layer is quite well formed with a high proportion of *Cratoneuron commutatum (= Palustriella commutata)*.

Photo 10. Pod Halą Rysianką (photo M. Bregin).

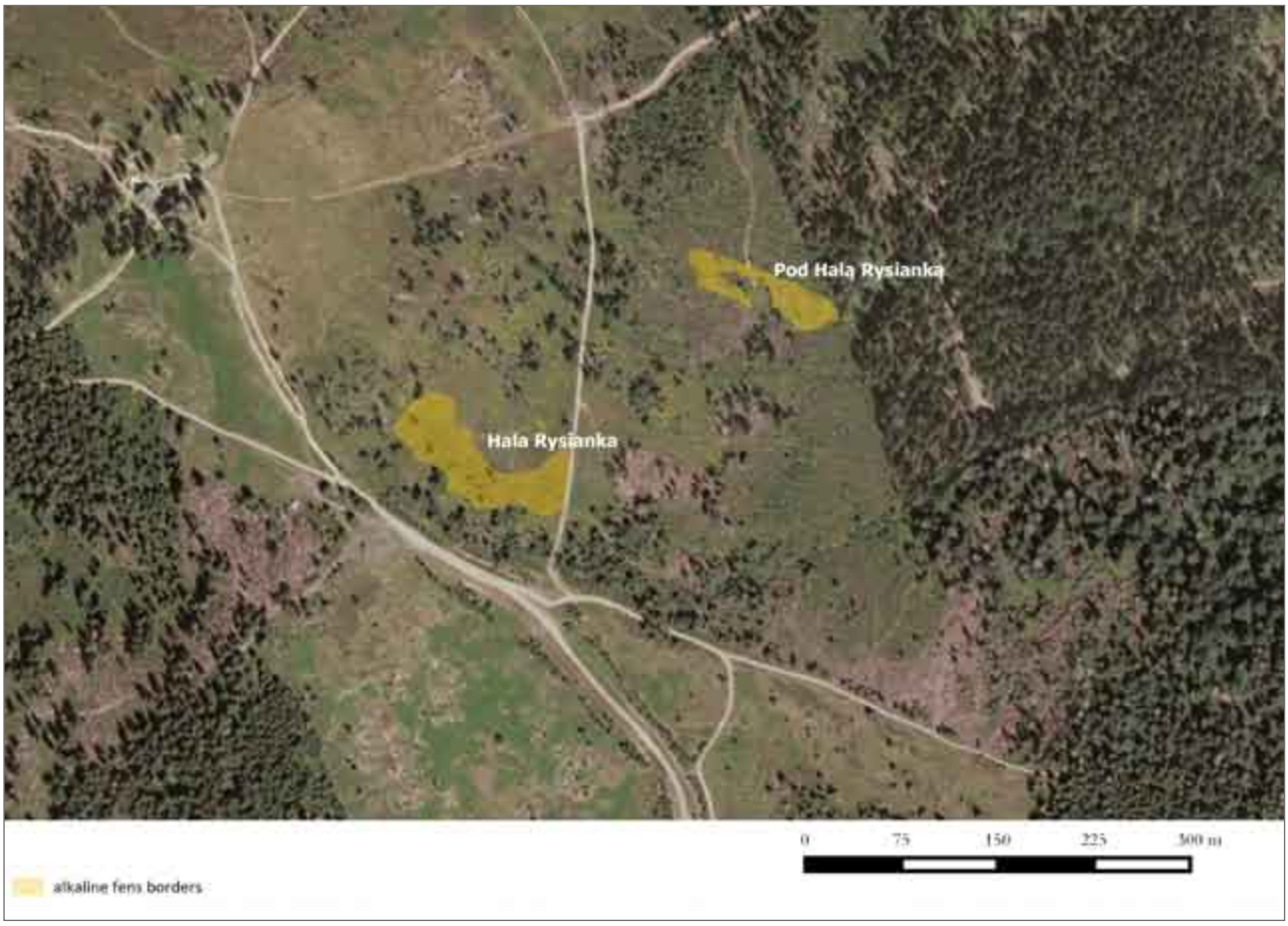


Fig. 8. Location of the Pod Halą Rysianką and Hala Rysianka sites in the Żywiec Beskids.

Pod Rycerzową 1, 2 – two sites located on the slopes of the Rycerzowa Mountain, formed in mid-forest glades, in places of high water content in the ground. Within the edge of the flush mire there are herbs and patches of humid meadows with a high proportion of *Scirpus sylvaticus*, which also penetrate the flush mire area to a small extent. The herbaceous layer is dominated by the sedges *Carex panicea*, *C. flava* and *C. nigra,* as well as the *Valeriana simplicifolia*, sometimes with quite a large number of *Epipactis palustris*.

Photo 11. Pod Rycerzową 1 (photo M. Bregin).

Photo 12. Pod Rycerzową 2 (photo M. Bregin).

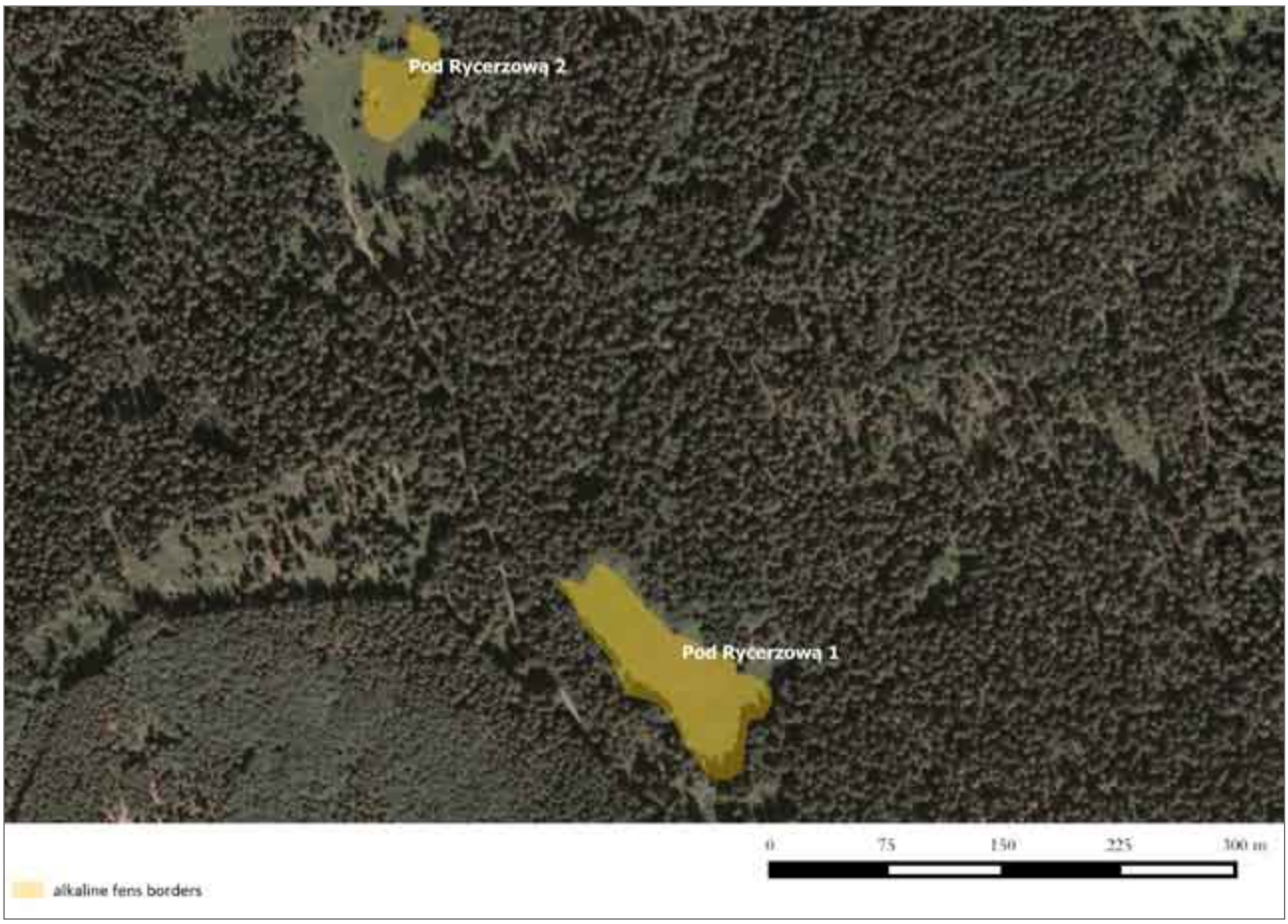


Fig. 9. Location of the Pod Rycerzową 1 and 2 sites in the Żywiec Beskids.

Złatna Huta – the fen is formed on a glade, on the slope of a valley descending into the Bystra stream. The phytocoenosis is quite heterogeneous with numerous instances of wet meadows and herbaceous species, as well as *Equisetum palustre*. At the same time, a large share of willow thicket and tree undergrowth was observed here before the protective measures (mowing and felling) were implemented. The species composition of the main part of the flush mire was represented by taxa typical for the habitat such as *Carex flava, C. panicea*, and *Valeriana simplicifolia.* The moss layer is fairly well formed with a high proportion of *Calliergonella cuspidata* and *Plagiomnium elatum.*

Photo 13. Złatna Huta (photo M. Bregin).

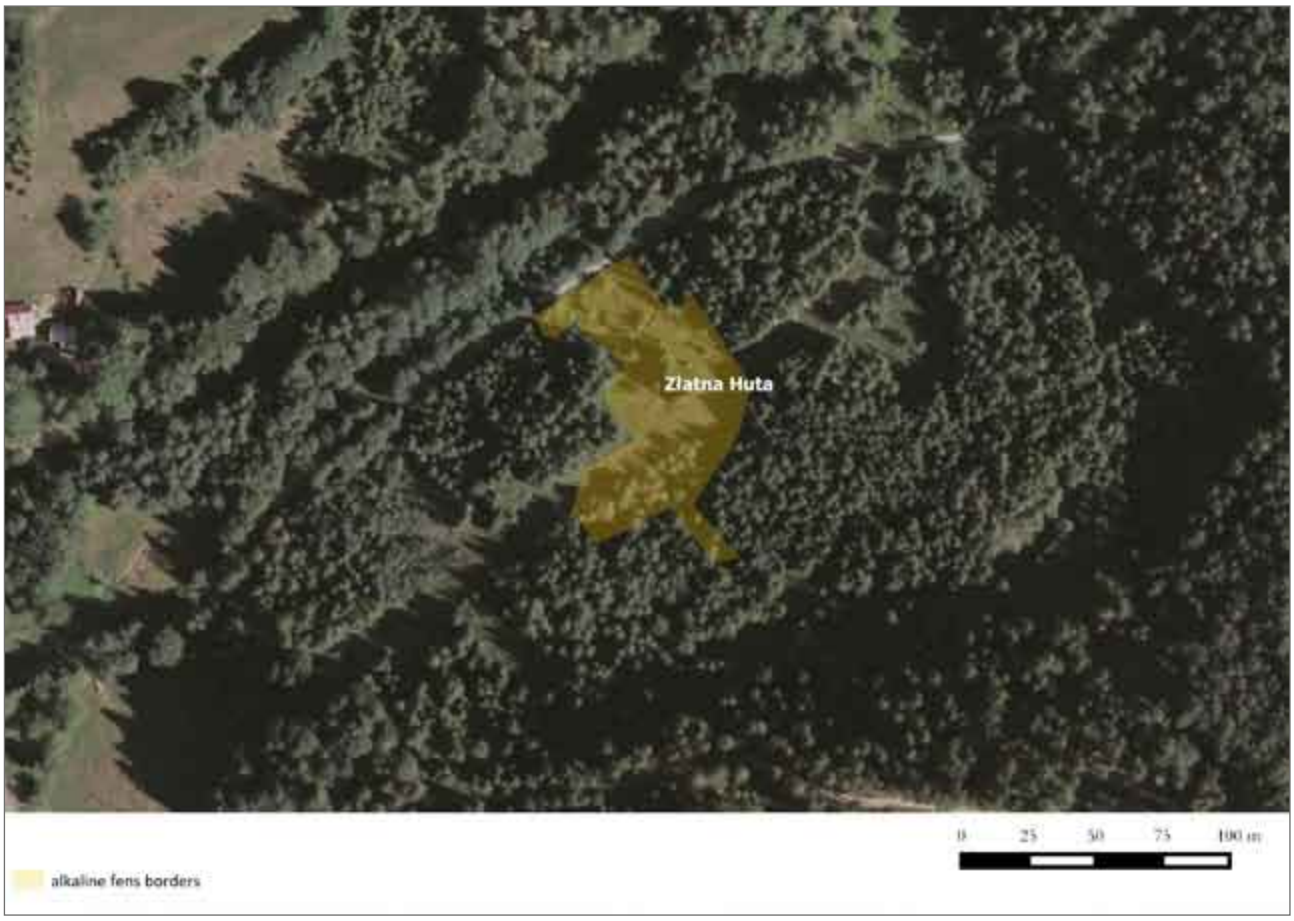


Fig. 10. Location of the Złatna Huta site in the Żywiec Beskids.

Dolina Ciapków – a small flush mire located on the flattening of the floodplain terrace in the valley of the Ciapków stream. The vegetation typical of the habitat is represented by the sedges *Carex flava, C. panicea*, and *Valeriana simplicifolia*. The moss layer does not reach a high level of coverage here and it is dominated by taxa such as *Cratoneuron commutatum* and *Plagiomnium sp.* The flush mire is under

Photo 14. Dolina Ciapków (photo M. Bregin).

Fig. 11. Location of the Dolina Ciapków site in the Żywiec Beskids.

strong pressure because the valley is home to intensive felling of trees – the felling area is located at the edge of the site.

Hala Bułkowa 1, 2 – two sites located in one complex in the Hala Bułkowa alp. The area was once used for herding and for grazing sheep, cows, and horses in the 1980s, as well as for mowing for fodder and litter. These activities have now been discontinued, resulting in the alp slowly overgrowing. Flush mires form in areas of groundwater surface seepage which then collects into a small watercourse below. They are characterized by a fairly well-developed moss layer and a lush herb layer. *Carex flava, Valeriana simplicifolia*, *Epipactis palustris*, and *Parnassia palustris* are numerous here.

Photo 15. Hala Bułkowa 1 (photo M. Bregin).

Mountain alkaline fens in the Żywiec Beskids do not occupy large areas and are dispersed. Most often they reach the size of a few to several dozen ares. They are formed at the foot of the slopes, descending into the valleys of mountain streams, in small, drainless bowls, in spring alcoves as well as on slopes with small inclination. The main factor determining the formation of mountain flush mires is proper hydration of the area. They are usually recorded at seepage and spring sites, at various altitudes and are not dependent on exposure. The intensity of the water supply and the stability of the groundwater table, as in the case of other areas, are the factors determining

Fig. 12. Location of Hala Bułkowa 1 and 2 in the Żywiec Beskids.

the internal diversity and abundance of flush mire plant communities. Peat deposits are very thin and often do not occur at all. This is due to the specific terrain conditions, the type of soil, and the climatic conditions in which they form.

The flush mires of the Żywiec Beskids are characterized by a great abundance of species, consisting of a set of basic taxa for the habitat, with an additional share of species permeating from fresh meadows and wet meadows that are the most common surroundings of flush mire patches. The area in question is dominated by the community of *Valeriano-Caricetum flavae* of the *Caricion davallianae*. association, typical for mountain flush mires. The herbaceous layer is well formed and dominated by low sedges which are characteristic of the habitat, including *Carex flava*, *C. panicea*, and *C. echinata*, as well as *Carex nigra; Eriophorum latifolium* and *Epipactis palustris* were also found in the area. *Valeriana simplicifolia*, a species typical of the mountain flush mire, is also abundant. The moss layer in most of the sites reaches quite a significant coverage. Species such as *Rhytidiadelphus squarrosus, Aulacomnium palustre, Calliergonella cuspidata*, and *Philonotis fontana* are found here. In the case of flush mires formed on spring areas, a large proportion of species of the genus *Cratoneuron* are found.

Most of the flush mires are not in regular use, despite the fact that several decades ago the glades and alps where they are found were extensively mown and used for grazing. This results in the succession and penetration of various species that are undesirable within the habitat. As a part of the project, mowing and shrub removal operations were carried out in places where the undergrowth of trees and shrubs limited the habitat area (for details see chapter 1.2). The effects of these actions in the form of changes in species composition or the share of particular species will appear gradually in the following vegetation seasons.

Photo 16 and Photo 17. Hala Rysianka, Pod Rycerzową 2 after protection measures (photo T. Bąkowski).

Photo 18 and Photo 19. Złatna Huta before and after protection measures (photo T. Bąkowski).

Natura 2000 site Lipienniki w Dąbrowie Górniczej PLH240037

The site is located in the eastern part of the city of Dąbrowa Górnicza, in the Dąbrowska Basin on the Śląsko-Krakowska Upland. It consists of two zones, the larger of them with an area of about 294 ha is located on the eastern edge of the inactive sand pit „Kuźnica Warężyńska". This part is characterized by a varied terrain - post-mining fields create considerable land elevations up to several meters, thanks to that, in the wet basins fed with local exudations, there were formed sedge-moss communities with numerous rare and protected vascular plants and mosses.

The second, south-eastern zone (Antoniów fen) is located in the valley of the Trzebyczka stream and covers only 2.42 ha. Also here, at the foot of the escarpment, alkaline percolating fens formed as a refuge for rare species of plants.

Lipienniki w Dąbrowie Górniczej site includes one of the largest populations of the *Liparis loeselii* in southern Poland. This species occurs both within the relic of the Antoniów fen in the valley of Trzebyczka, and on the initial patches of habitat 7230 in the nearby sand pit Kuźnica Warężyńska. It is accompanied by numerous rare and disappearing species of sedge-moss fens, such as: *Carex davalliana*, *Pinguicula vulgaris* ssp. *bicolor*, *Drosera anglica* and *D. intermedia* and orchids *Malaxis monophyllos*, *Dactylorhiza majalis*, *D. incarnata* and *Epipactis palustris*. There are also present *Parnassia palustris*, *Tofieldia calyculata*, *Eleocharis quinqueflora*, *Cladium mariscus*, *Equisetum variegatum*, *Eriophorum latifolium*, *Utricularia minor* and relatively rare in southern Poland *Menyanthes trifoliata*. Among mosses there are identified

Fig. 13. Natura 2000 site Lipienniki w Dąbrowie Górniczej.

Hamatocaulis vernicosus, *Pseudocalliergon trifarium*, *Limprichtia cossonii* and *L. revolvens* and sphagna – *Sphagnum warnstorfii* and *Sph. contortum*, but also numerous *Chara* sp. from family *Characeae*.

Habitat 7230 in the Antoniów fen remained preserved only in the eastern part of the area, although half a century ago it was described also in the western part, where now there are oligotrophilised and strongly acidic patches that do not have contact with alkaline groundwater. This fen is one of the last sedge – moss community relict in the Śląsko-Krakowska Upland, and due to its floristic composition it is also unique in the country.

In the Kuźnica Warężyńska sand pit, there are also very numerous populations of many species characteristic for habitat 7230, but they have the character of initial patches of fen growing mainly near the sandbank slopes and supplied with alkaline groundwater. In recent years, in the north-eastern part of the sand pit, drainage systems have been renovated and new ditches have been created, which significantly accelerated the overgrowing processes with cane and birch. Currently, in the entire site, succession towards forest communities is the main threat to the duration of habitat 7230 and associated species.

Unfortunately, the owners and managers of this site planned to transform it into recreational and residential areas, and the inclusion of the most valuable fragments in the Natura 2000 network did not meet with their favor. The conflict between investment plans and the needs of nature protection has been visible for years and is manifested, among others, in various administrative proceedings related to the destruction of the habitat (including on the implementation of a network of drainage ditches, backfilling, dislocating the habitat with heavy equipment or planting a knotweed *Reynoutria japonica*). Due to the not very favorable approach of owners and managers to all activities related to the protection of the habitat and species occurring here, and taking into account the accession of the Regional Directorate of Environmental Protection in Katowice to develop a Conservation Measures Plan for this site, it was decided not to conduct work under the project.

The refuge consists of a mountain group of Gorce, stretching over a length of about 40 km, with an area of 550 km^2 located in the central part of the Western Beskids. The highest peak is Turbacz (1310 m above sea level), where seven mountain ridges of different lengths descend in different directions. Gorce are built of flysch, which consists of periodically arranged layers of sandstone, shale, and conglomerate. The area of Gorce is characterized by a typical zonal system of vegetation; a very characteristic element of the landscape are numerous glades and alps which used to be intensively grazed. The nature of Gorce is diverse and valuable in the country, which is why the Gorce National Park was established here.

In the area of Gorce, fens belong to rare ecosystems, which is related to the conditions occurring here (mainly terrain), as well as to the effects of adverse human activities e.g., digging drainage ditches, afforestation of glades and lack of hay production. The rocky ground means that groundwater resources are not large, and thus the outflows of springs are not very intense and react to the intensity of rainfall. In winter, there are slight fluctuations in water levels due to the snow cover. In other periods of the year, however, the water level is variable, often increasing rapidly as a result of heavy rainfall (Stańko 2015a). Habitat 7230 in Ostoja Gorczańska takes the form of a flush mire. The fens are very rarely formed here, and the thickness of the organic layer usually does not exceed 50 cm. In the past, intensive grazing was carried out in the Gorce, preceded by felling of trees and mowing of herbs. As a result of this activity, many glades and alps were created here which are semi-natural systems, maintained to a large extent thanks to human activity (Kornaś 1967). As a result of the abandonment of use, some non-forest habitats are slowly disappearing. This problem also concerns habitat 7230.

In the area of Ostoja Gorczańska, the project covered 17 sites with a diversified surface area – from 0.07 to 1.98 ha. The flush mires are located on slopes with different inclinations and at their foot, most of-

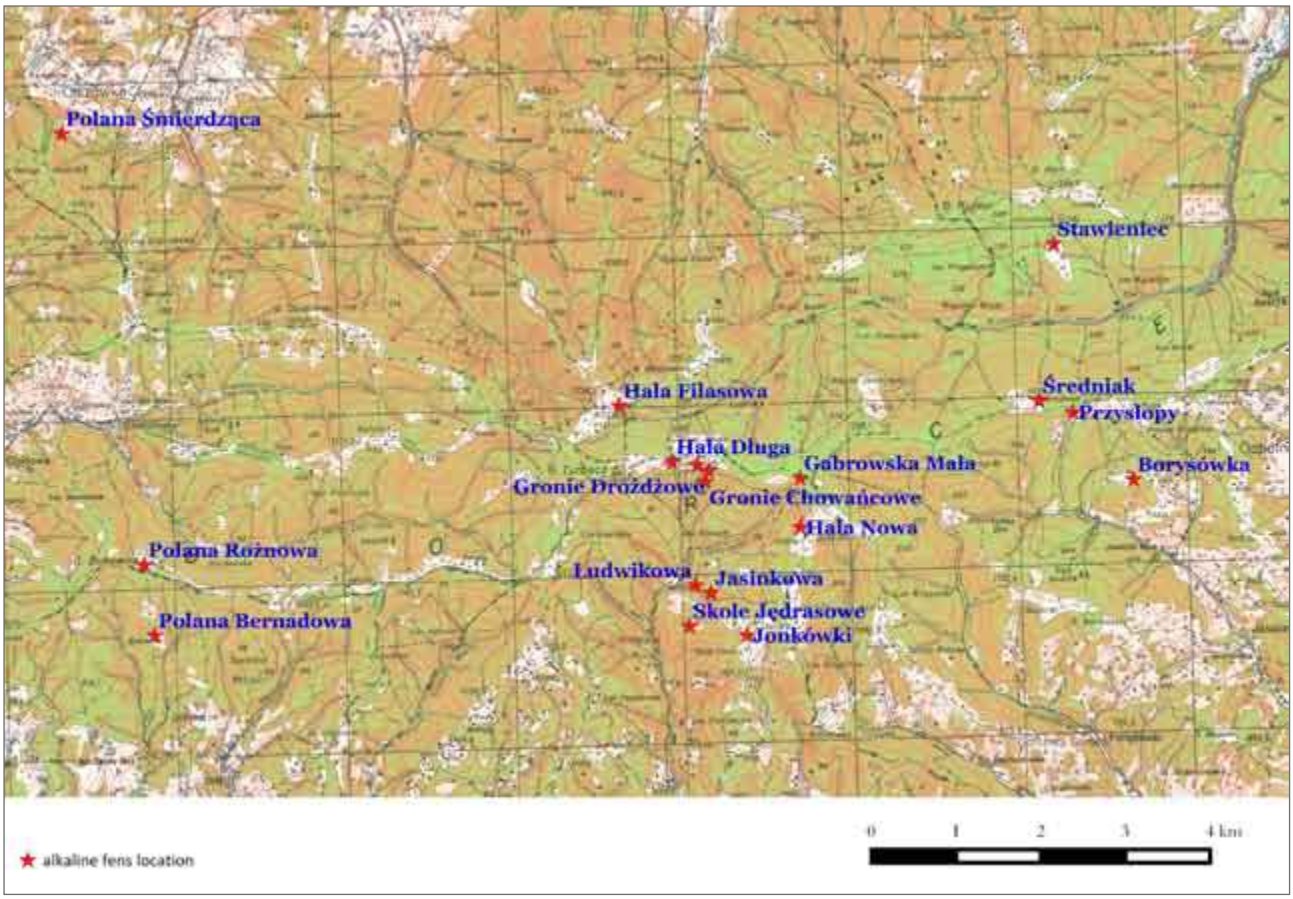


Fig. 14. General locations of the sites in Ostoja Gorczańska.

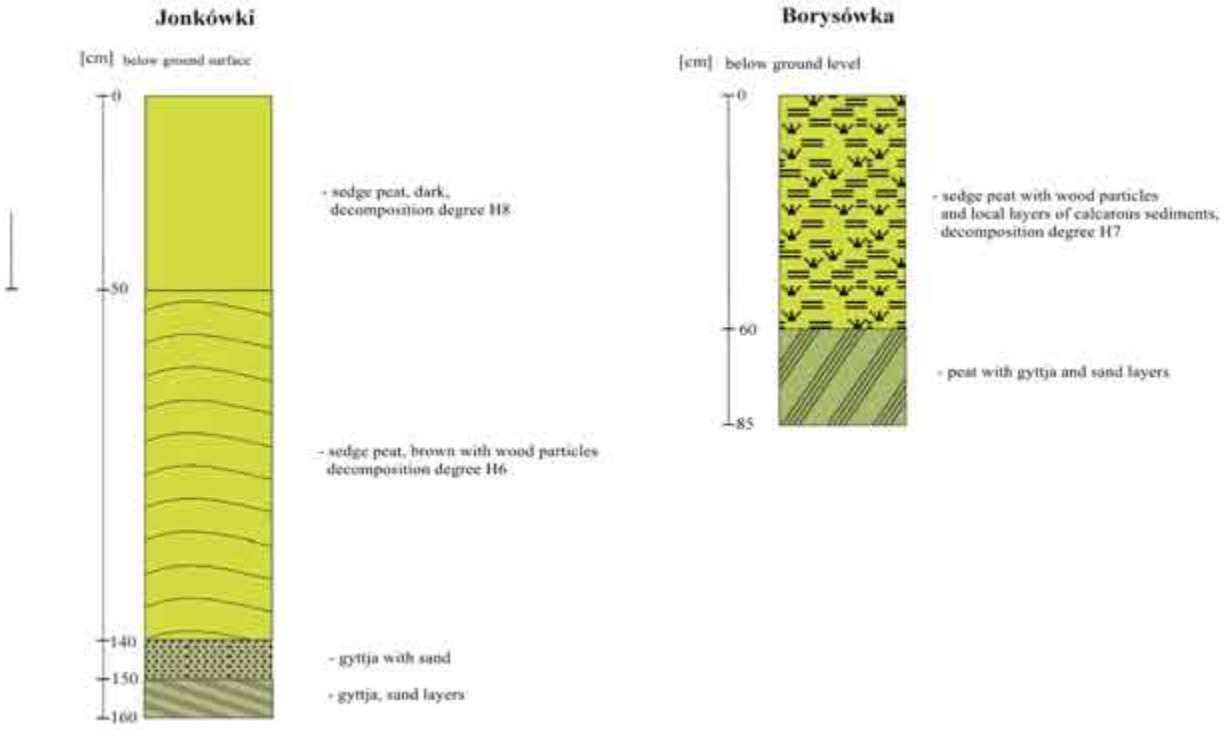


Fig. 15. Examples of the drilling results in the Jonkówka and Borysówka sites in the Gorce National Park.

ten in alps and glades which are currently extensively grazed. There are also some sites that occur in the forest glades, surrounded by forest from all sides. Flush mires located in the alps and large glades, in the vicinity of different types of meadows (mostly wet and fresh), are distinguished by a great abundance of flora; often on an area of several square meters almost 50 species of plants were recorded.

Photo 20. A valerian-sedge flush mire in the Hala Filasowa alp (photo M. Bregin).

Flora surveys conducted as part of the project confirmed the presence of 93 plant species, including 85 vascular plant species and 8 species of bryophytes. The communities forming the habitat were classified as a typical mountain flush mire community of the *Caricion davallianae* association – *Valeriano-Caricetum flavae* valerian-sedge flush mire. The most diverse and most valuable are the flush mires with unaltered water conditions, supplied with waters rich in calcium carbonate. In addition to the typical herbaceous plant species, there are also numerous relatively rare species of bryophytes, such as *Campylium stellatum*, *Limprichtia cossoni*, *Philonotis calcarea*, and *Cratoneuron filicinum*. The second type of flush mires found in this area is the mid-forest flush mire. They are distinguished by a slightly different floral composition and phytocenosis structure; they are often dominated by *Caltha laeta* and *Chaerophyllum hirsutum*.

In terms of hydrological conditions, the conservation status of the flush mires in Ostoja should be considered good. In the majority of flush mire areas, the thickness of the peat reaches on average about 30 cm; only in a few sites were deeper peat deposits recorded, among others, on the fen located in the Hala Długa alp.

Fig. 16. Locations of several sites on the background of Gorce glades.

Photo 21. Valerian-sedge flush mire with a high proportion of *Eriophorum* (photo M. Bregin).

Photo 22. Polana Bernadowa after the protective measures (photo T. Bakowski).

Photo 23. One of the flush mires purchased as part of the project (photo D. Horabik).

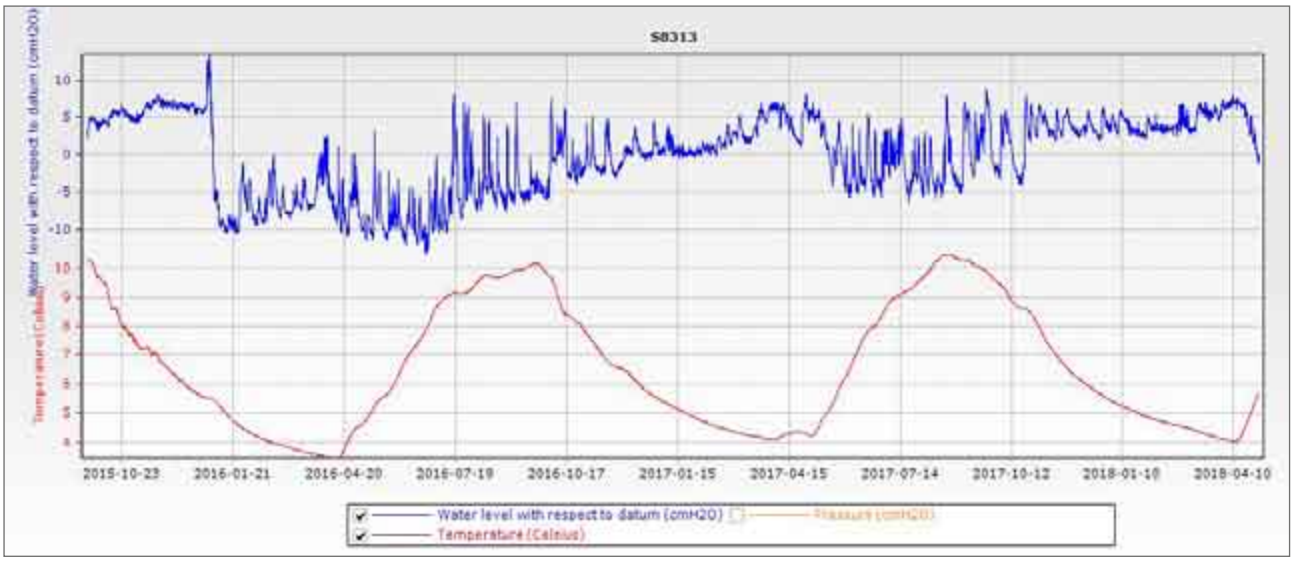


Fig. 17. Fluctuations in the level of the groundwater table in a fen with a meteorological station.

Photo 24. Cascading dams on one of the watercourses in the Gorce National Park (photo D. Horabik).

As part of the project, protective measures were taken – cutting down undergrowth of trees and shrubs and mowing (for details, see chapter 1.2). These treatments prevent the expansion of forest vegetation and thus the loss of habitat values, and such activities should be continued in the future.

The project's site – Ostoja Gorczańska – within the Gorce National Park was the only place where purchases of the most valuable flush mire, privately owned, were carried out. Under this measure, almost 3 ha of land was purchased within the national park. Buying out the land will enable maintaining the results of the activities performed, and to continue them in the following years as part of the protective activities carried out in the park.

As part of the project, a system of small gates was also built in Hala Długa, in the area of the Gronie Chowańcowe site, located on watercourses flowing through the flush mire complex. They prevent the flush mire from running out of water too quickly and from eroding. This measure allows for the improvement of water conditions and the preservation of the habitat in an appropriate condition. The effects of the 25 dams built in 2016 were visible already in the following year 2017, during subsequent field inspections – the groundwater level had increased. The improvement of water conditions is also evidenced by the research carried out on groundwater levels with the use of an automatic recorder - see Fig. 17.

The area of Małe Pieniny covers 1875.9 ha and belongs to the westernmost part of the Pieniny Klippen Belt stretching from the Pieniny Gorge to the Roz-dziela Pass (862 m above the sea level). The vegetation of the area has been quite significantly transformed by human activity – the area was used for hay production and grazing of animals.

There are 26 sites in the area, with surface area from 0.02 to 0.73 ha; they often occur in complexes, located in a single alp or glade. Small flush mires with vegetation typical for the habitat are the most common. Alkaline flush mires develop mainly in the ridge parts, in the groundwater seepage areas, as well as in areas of springs. They most often occur in hollows and drainless basins, where the subsoil is poorly permeable, which favors water stagnation.

Flush mires in the Lesser Pieniny are most often found in complexes with wet or fresh meadows. They are distinguished in the landscape by their characteristic, white-colored cottongrass. They form small patches, often spaced over short distances and separated by herbaceous or meadow vegetation.

Some of the sites can be found in mid-forest glades, surrounded by spruce forests. They are characterized by their small size, and on the border with the forest usually a transition zone exists formed by herbs mixed with species characteristic of a mountain flush mire - especially *Valeriana simplicifolia*. These sites are also much less frequently used, which is conducive to the succession and expansion of tree and shrub growth.

In the area of the flush mires in the Lesser Pieniny, 93 plant species were recorded, including 85 vascular plant species and 9 species of bryophytes. 4 of them are under species protection in Poland, including 2 under strict protection – *Epipactis palustris* and *Pinguicula vulgaris*, and 2 under partial protection – *Dactylorhiza majalis* and *Listera ovata*. Three species are included in the Red List of Plants and Fungi in Poland (Mirek et al. 2006) and are assigned the NT (near threatened) category. Mountain species are an important component of the fen flora as they distinguish it from lowland fens – examples include *Senecio subalpinus* and *Veratrum lobelianum*.

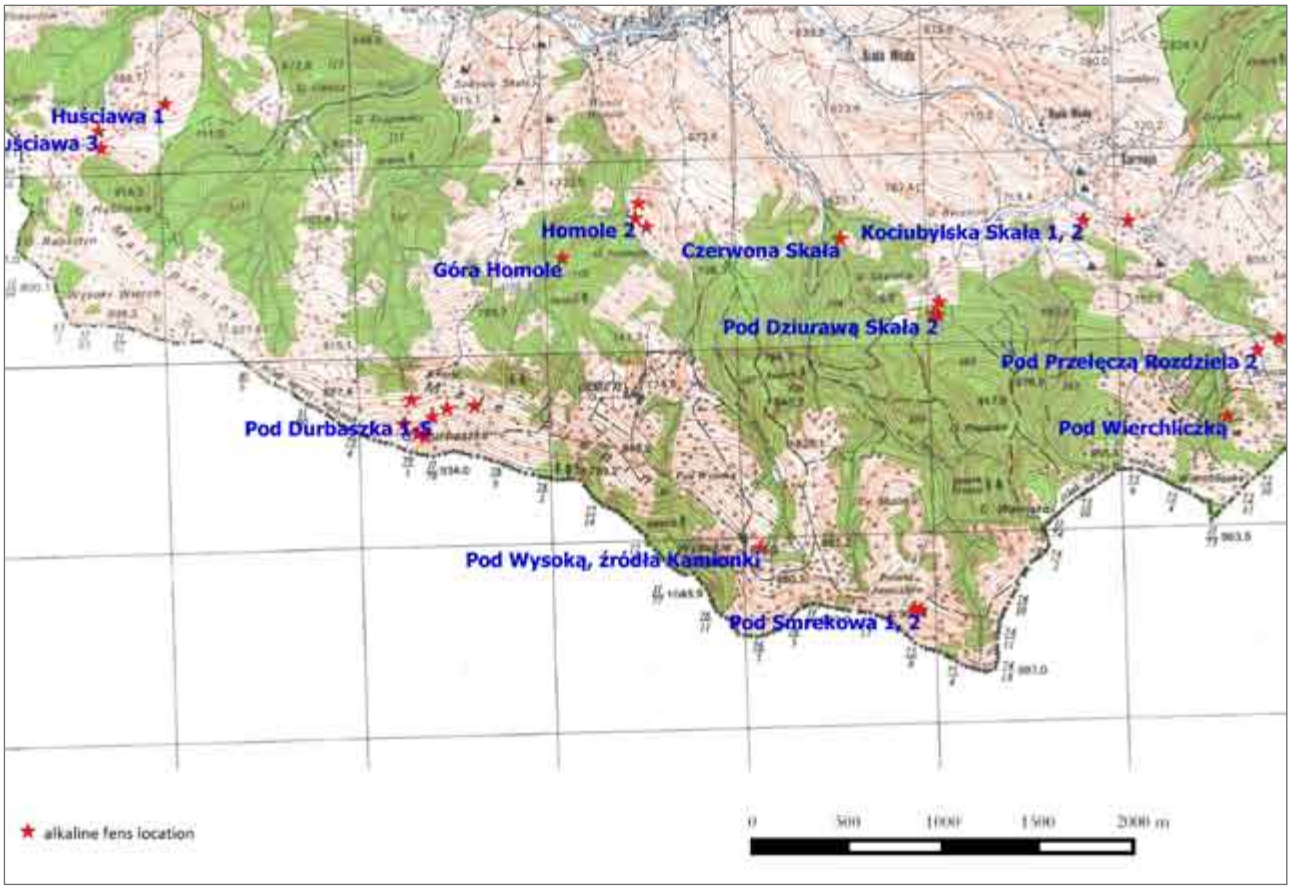


Fig. 18. Locations of the sites in the Male Pieniny area.

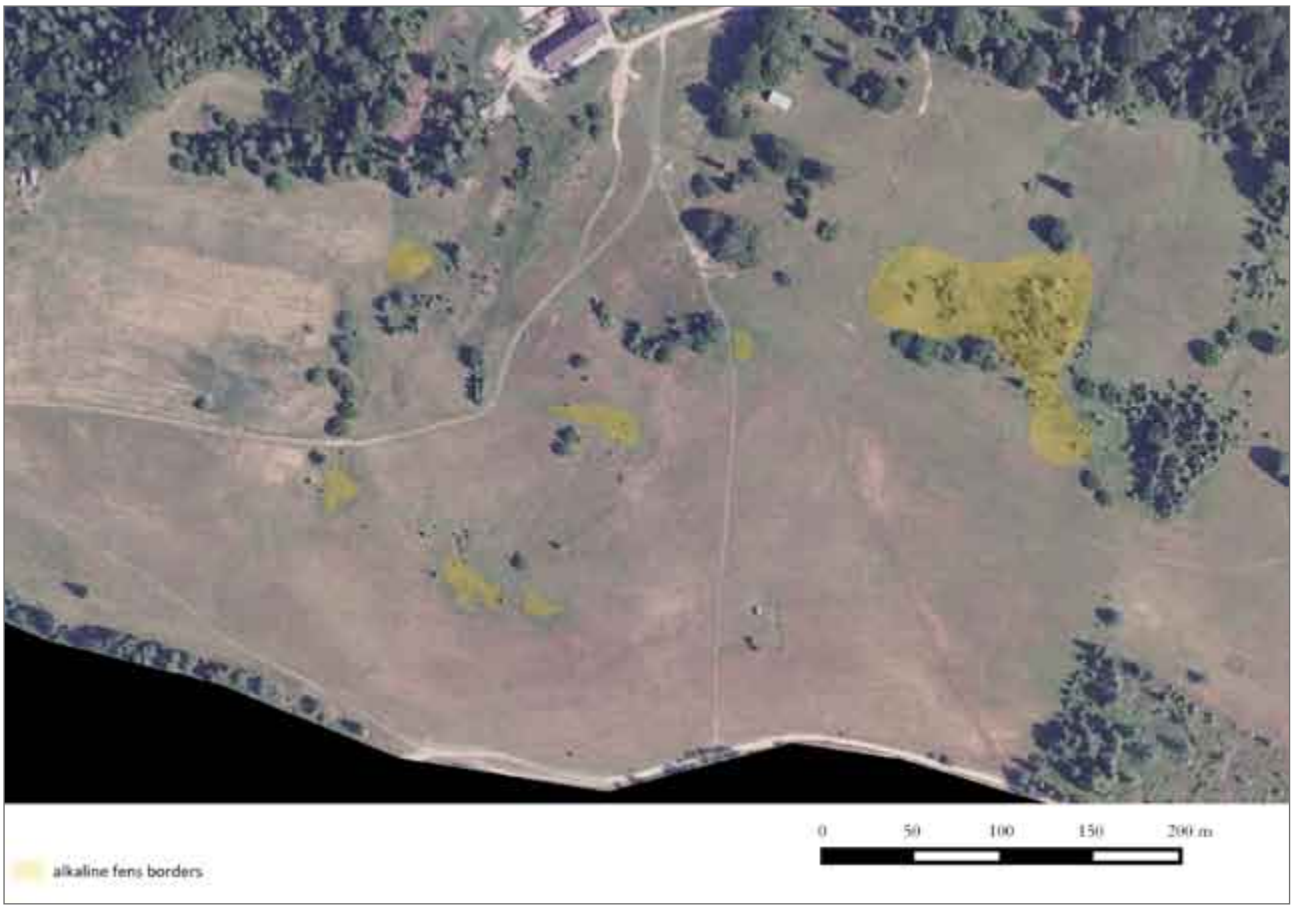


Fig. 19. A complex of alkaline flush mires near Durbaszka.

Fig. 20. A complex of alkaline flush mires within the Wąwóz Homole ravine.

Photo 25. Alkaline fen at in the alp near Durbaszka (photo M. Bregin).

Two plant associations have been distinguished here belonging to the *Caricion davallianae* alliance. Most of the sites are dominated by the *Valeriano-Caricetum flavae* group which is characterized by a typical two-layer structure. The upper layer is dominated by *Eriophorum latifolium*, sometimes with *Epipactis palustris*; the lower layer is dominated by sedges, mainly *Carex flava*, *C. panicea*, and *C. nigra*, as well as *Carex davalliana*. *Valeriana simplicifolia* is also numerous. On the best-preserved patches, *Campylium stellatum*, *Climacium dendroides, Aulacomnim palustre*, and species of the genus *Drepanocladus* were found, among other vegetation. In the patches formed in spring areas, species of the genus *Cratoneuron sp*. are abundant. In places of intensive grazing, or in the areas of the flush mire with animal drinking points – collecting water in troughs – the layer of mosses is poor and occupies small areas. It is connected with the trampling of turf by sheep, as well as with the disturbances of water conditions caused by it (trodden paths cause the formation of micro-pathways draining water away from the fen).

Photo 26. Mid-forest flush mire on the Góra Homole site (photo M. Bregin).

The second plant community to be found in the area is *Caricetum davallianae* Dutoit 1924 which develops in the best-preserved patches of the habitat, often in a complex with the *Valeriano-Caricetum flavae* valerian-sedge flush mire. This group develops as small, uneven patches in which *Carex davalliana* forms a fairly compact turf consisting of clumps. It is accompanied by other species characteristic of the *Caricion davallianae* association, in particular the sedges: *Carex flava, C. panicea*, and *C. nigra*, as well as abundant *Valeriana simplicifolia.* Part of this association is also occupied by the rare *Pinguicula vulgaris*, occurring individually only in a few patches. The moss layer is similar to that of a valerian-sedge flush mire, and its coverage is also dependent on water conditions and pressure from sheep.

As a result of many years of sheep grazing in the area, nitrophilic species such as *Potentilla anserina*, *P. reptans*, and *Rumex acetosa* are abundant in many areas of the habitat. Species from neighboring wet meadows, in particular *Cirsium rivulare* and *Scirpus sylvaticus*, have been observed to penetrate the area. *Equisetum palustre* is also characterized by a high share. On the other hand, on mid-forest flush mires which are not used for hay production or herding, expansion of the forest vegetation is observed, as well as high perennials from the surrounding herbaceous plants.

In most sites, water conditions are favorable – the level of groundwater table oscillates just by the ground surface. The thickness of the organic layer is small and usually does not reach more than a few centimeters. In many sites, there is no peat layer at all.

Photo 27. *Pinguicula vulgaris* (photo M. Bregin).

Photo 28. Valerian-sedge flush mire *Valeriano-Caricetum flavae* (photo M. Bregin).

Photo 29. The flush mire complex in Lesser Pieniny (photo D. Horabik).

Photo 30. *Caricetum davallianae* association (photo M. Bregin).

The entire area was used in herding for years, and the alps and glades where the flush mires are located were mown. This prevented the disappearance of the habitat and the overgrowth by trees and shrubs. At present, only some of the sites are still in extensive use.

Photo 31.The only way to the inaccessible forest flush mires, used in order to carry out protective activities (photo T. Bąkowski).

Photo 32. View of the flush mire complex near Durbaszka after carrying out protective measures (photo T. Bąkowski).

As part of the project, mowing and cutting the undergrowth of trees and shrubs was carried out. The treatment was very difficult due to the poor access to mid-forest flush mires. As a result, the habitat surface was exposed and light conditions improved, which significantly affects the structure and functions of the plant communities in a positive manner.

Natura 2000 site Ostoja Popradzka PLH120019

The area of the refuge includes the Beskid Sądecki (Western Carpathians province). Beskid Sądecki is built of flysch formations, which are formed by undulating, alternating layers of sandstone, conglomerates, and silt-clay shale. The natural values of the area are protected in the Poprad Landscape Park and in 13 nature reserves.

Within the framework of the project, 8 sites with an area ranging from 0.05 to 0.12 ha were selected. Most often, they were individual, small patches of habitats, located in complexes with different types of meadows. Flush mires in Ostoja Popradzka form within different vegetation belts and no correlation has been noted between their distribution and altitude. Their formation is exclusively related to appropriate hydrological conditions. Fens are formed at the foot of slopes that descend into the valleys of mountain streams, in small, drainless basins, on flat land, in concavities and edges of slopes with small inclinations, as well as in spring alcoves. They can often be found in mountain alps and they can also be found in dense forest complexes. Flush mires form on ground-glay soils in places of groundwater seepage. In sporadic cases, shallow peat layers have been observed within the flush mires. Most of the flush mires have been used for hay production and herding in the past. The extensive grazing on the mountain alps and meadows around the sites, which has now been restored, prevents the succession of forest vegetation.

One of the main threats to the habitat are poorly marked tree felling areas. The potential developing ski resorts could also be a threat.

Within the boundaries of the sites covered by the project and in their vicinity, no threats were observed. Local risks include mechanical damage to the turf caused by overgrazing and water abstraction for the animals. However, the main factor threatening the natural values of the habitat in the area is the lack of mowing, which in the long run may lead to the disappearance of the habitat. The changes observed are relatively slow and therefore the prospects for fen protection seem good.

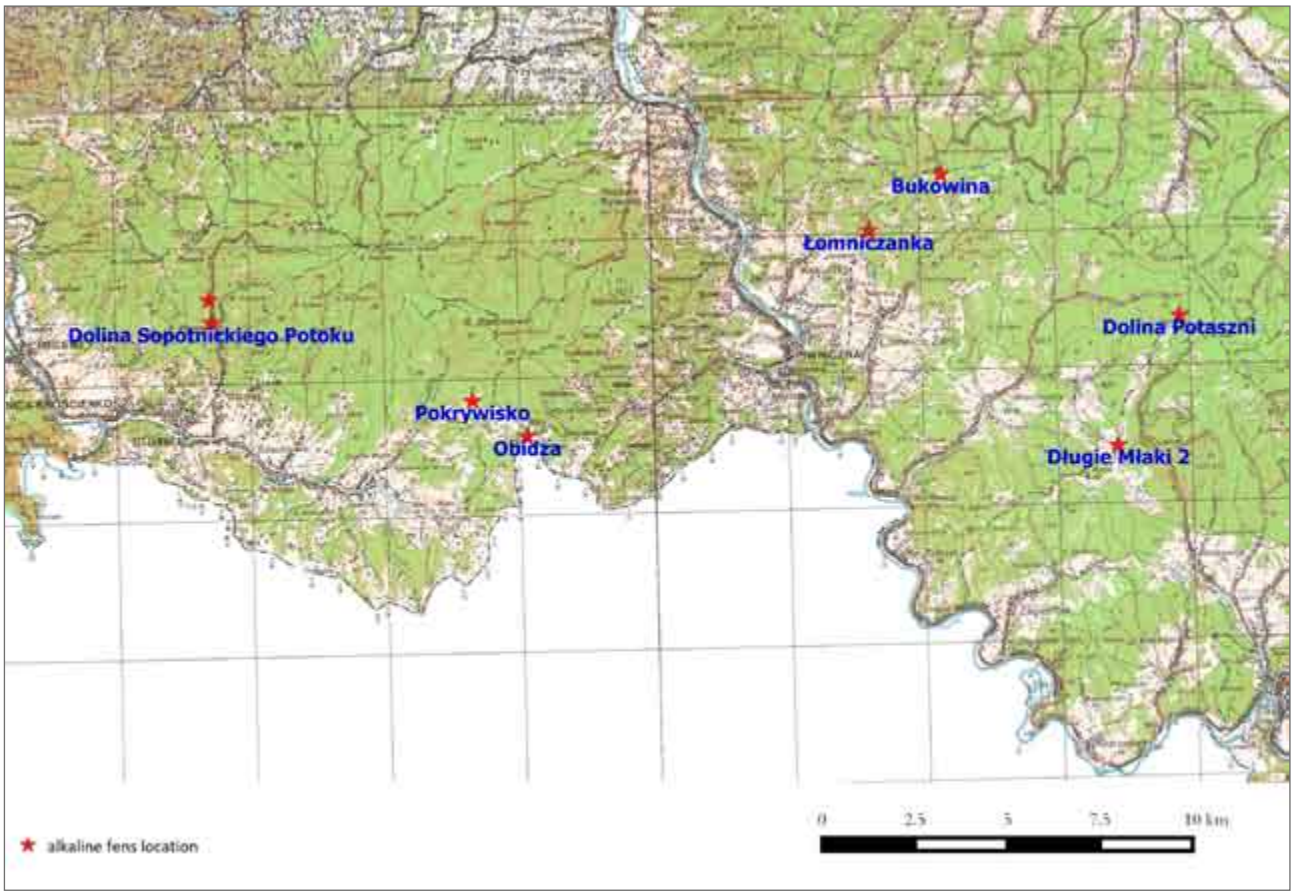


Fig. 21. General locations of sites in the Ostoja Popradzka refuge.

Photo 33. Liskowa site, located near a ski lift (photo M. Bregin).

Photo 34. Flush mire patch with a high proportion of *Eriophorum latifolium* at the Jaworzynka 2 site (photo M. Bregin).

Photo 35. *Colchicum autumnale* on Długie Młaki 2 (photo M. Bregin).

Photo 36. Flush mire formed on a mid-forest spring area at the Dolina Potaszni site (photo M. Bregin).

During the research carried out under the project, 98 vascular plant species were recorded in the area, including 88 plant species and 10 species of bryophytes; 4 of them are under species protection in Poland, including 2 under strict protection – *Epipactis palustris* and *Pinguicula vulgaris*, and 2 under partial protection – *Dactylorhiza majalis* and *Listera ovata*. Three species are included in the Red List of Plants and Fungi in Poland (Mirek et al. 2006) and are assigned the NT (near threatened) category. Mountain species are an important component of the fen flora, as they distinguish it from lowland fens – examples include *Senecio subalpinus*, *Veratrum lobelianum*, and *Caltha laeta.*

The fens of the Ostoja Popradzka area are dominated by communities of the *Caricion davallianae* alliance, mainly *Valeriano-Caricetum flavae*, valerian-sedge flush mire typical for mountain areas. In the best-preserved sites, this group develops in its typical form. The groundcover layer is dominated by low sedges that give the phytocoenosis its characteristic appearance. The predominant species are *Carex flava, C. panicea*, *C. nigra*, and the occasional *C. echinata*. There is also high quantity of cottongrass, *Eriophorum latifolium*. An important component of the vegetation is also *Valeriana simplicifolia* that sometimes reaches a large coverage. In several sites relatively rare species can be found, such as: *Colchicum autumnale* or *Parnassia palustris*. On a part of the fens, the fen vegetation forms a mosaic with vegetation of wet meadows and herbs – occurring on the edges. In such places the *Calthion* alliance species have a greater share in the flora: *Crepis paludosa*, *Cirsium rivulare*, and *Scirpus sylvaticus*. A high proportion of *Equisetum palustre* is also noted in some places. Depending on the water conditions within the flush mire, numerous species of moss can be found in favorable conditions. However, quite common vegetation – typical for flush mires and wet meadows – such as *Aulacomnium palustre*, *Calliergonella cuspidata*, *Climacium dendroides*, and *Philonotis fontana* are dominant. In the best hydration conditions, species of the genus *Cratoneuron* dominate.

The vegetation occurring in the area of sites in Beskid Sądecki endures successive pressure which is connected with the abandonment of use, leading to the overgrowth of the flush mires.

Habitat 7230 is represented by plant communities from the *Caricion davallianae* alliance, within which species characteristic of the habitat are found. It is characterized by a system of sedge-dominant mire, typical for this type of phytocoenosis, sometimes mixed with meadow and herbaceous taxa. In most sites, habitat 7230 is quite well developed. As part of the project, treatments were performed to inhibit the expansion of forest vegetation (bush and undergrowth cutting, as well as mowing). The aim of these activities is to stop the succession and deterioration of light conditions. The continuation of extensive hay production, in addition to inhibiting the succession of forest vegetation, should contribute to the improvement of the habitat status in terms of many other indicators.

One of the two areas in the Łódzkie Voivodeship included in the project which, in reference to the physico-geographical regionalization according to Kondracki (2002), is located in the Grabowska Valley mesoregion (macroregion: South Greater Poland Lowland). The area lies in the municipality of Galewice, Wieruszów district (poviat), on the south-western border of the Łódzkie Voivodeship. The western part of the area consists of flooding meadows, and the most valuable parts are located in the south-eastern and eastern parts, where habitat 7230 occurs – mountain and lowland alkaline fens of the character of flush mires, sedges, and moss fens. It is also a location of *Liparis loeselii*. The area occupied by the habitat and its perimeter zone are significantly influenced by groundwater flowing from the mineral plateau bordering the area from the east. The edge of the valley is formed by sloping terrain with a gradient of more than 45° and a height of 2 – 6 m (Pawlak & Wilżak 2012). Peat was extracted in the area in the past, as evidenced by the historical maps from 1936, where the extraction sites are marked. The map also shows numerous drainage ditches in the area. The area of the habitat, belonging to the Land Community of Osiek Village, was later used also for hay production, but in the last dozen or so years the use ceased. In the area, habitat 7230 occurs mainly in the form of two fen complexes; the largest complex of about 4.8 ha is located in the south-eastern part of the area (former oxbow lake). To the north of it, is the second complex of alkaline fens, consisting of 4 patches of the habitat. The largest patch has an area of about 1.3 ha, the remaining patches have an area of: 0.14 ha, 0.09 ha, and the smallest 0.07 ha. Overall, the water conditions within the habitat are good.

Active conservation activities focused mainly on mowing and shrub removal (see chapter 1.2). After the protective measures were carried out, the nature documentation was prepared, thanks to which the owners joined the agri-environment-climate programme and now receive compensation for extensive hay production in this area. An important advantage of the area is its close proximity to the town and a nearby school. Thanks to the involvement of the residents, information and education boards were erected under the project on the natural values of the area and habitat 7230.

Fig. 22. Localisation of the 7230 habitat in Natura 2000 site Torfowiska nad Prosną PLH100037.

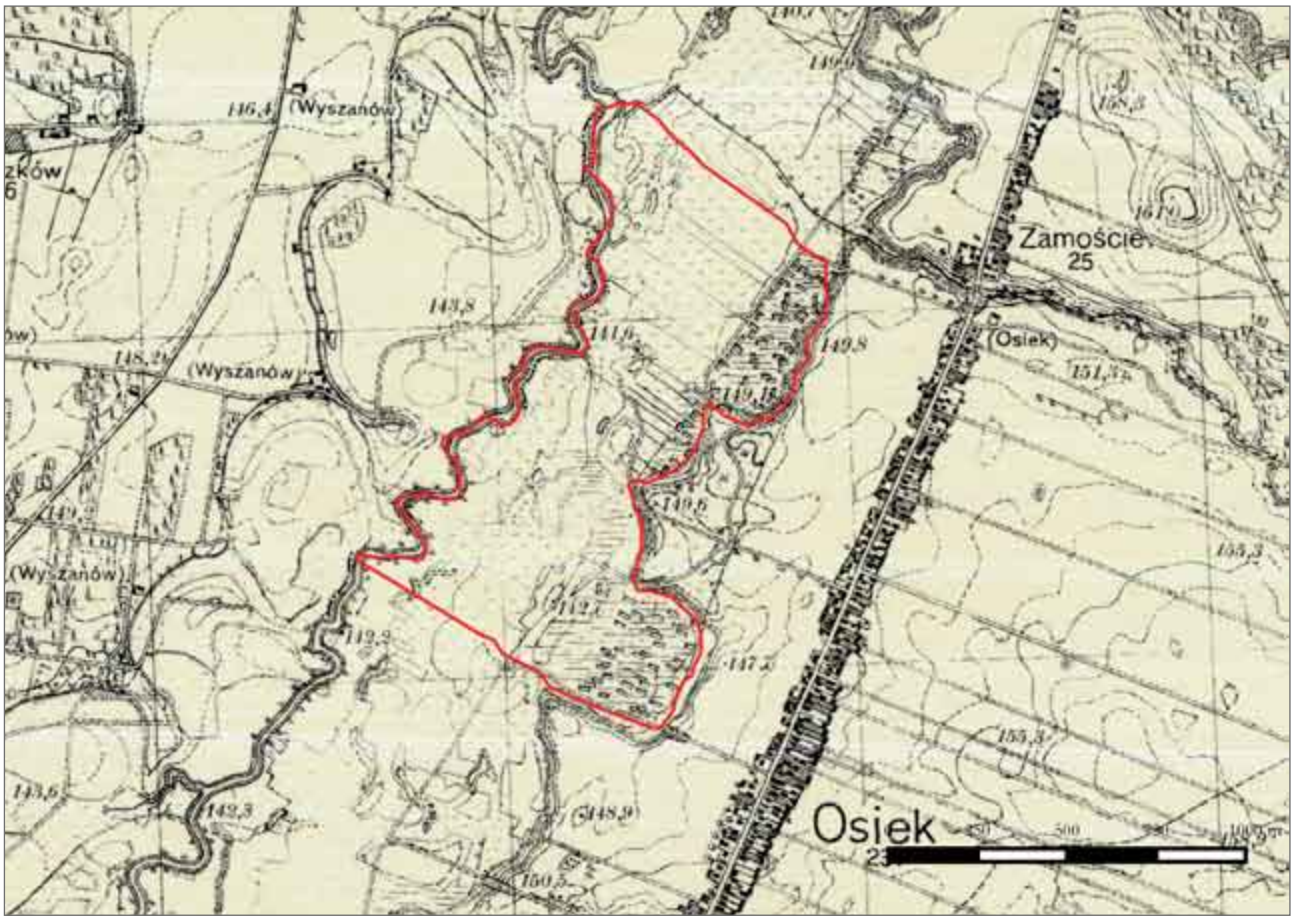


Fig. 23. Historical mpa showing Natura 2000 area Torfowiska nad Prosną PLH100037 in 1936.

Within the largest patch of the habitat, hydrological monitoring was carried out by means of automatic recorders; the entire area was covered by phytosociological surveys. The results of hydrological monitoring carried out over a period of 2 years (2015 – 2017) are presented in Fig. 24. The diagram shows significant fluctuations in the water level in the fen during the summer period, from June to mid-Sep-

Photo 37. Information board on the natural values of the Torfowiska nad Prosną site (photo D. Horabik).

Fig. 24. Changes in groundwater table in years 2015-2017.

tember, reaching about 40 cm, caused by droughts occurring during this period. Despite such significant fluctuations, the status of the habitat seems to remain satisfactory.

The first flora observations noted in this area were made in 2007 – 2011 (Pawlak & Wilżak 2012), which showed the occurrence of many valuable and rare vascular plants, including *Liparis loeselli* and *Carex pulicaris*. The results of these studies were confirmed by a detailed field inventory conducted in 2015 – 2016 within the framework of project works, among others, for the purpose of preparing a plan of protective tasks. It also confirmed the misidentification of habitats in the past. The 7140 habitat indicated in the SDF actually represents habitat 7230. Due to the large diversification of habitat 7230 depending on the regions of its occurrence, it is a common mistake, most often referring to transition patches or patches with an altered appearance. Relevées taken and, in particular, the type of groundwater supply identified (seepage of pressure waters with pH 6.6 – 7.2), clearly indicate habitat 7230. However, it should be pointed out that there are indeed many species within the small patches that are characteristic of transition fens, mainly those of the genus *Sphagnum*, and this was probably the main cause of the mistake. These patches are often of an intermediate nature between alkaline and transition fens, which is a natural consequence of the ongoing biocoenosis evolution. It is difficult to determine unequivocally to what extent this process is the result of natural fen growth and the occurring change in hydrological conditions (increase in rainwater impact and gradual disappearance of groundwater impact), and to what extent it is the result of artificially lowering the groundwater level and the dominant role of precipitation.

Photo 38 and Photo 39. One of the patches of habitat 7230 before and after the performance of protective measures under the project (photo T. Bąkowski).

Among the characteristic species found in the area in addition to the aforementioned fen orchid and flea sedge are: *Epipactis palustris*, *Eriophorum latifolium*, *Parnassia palustris, Carex panicea, Dactylorhiza incarnata, D. majalis, Fissidens adianthoides, Carex diandra, Menyanthes trifoliata*, and *Aulacomnium palustre*. The population of fen orchids in the Torfowiska nad Prosną area is currently probably the most numerous in central Poland.

Photo 40. Torfowiska nad Prosną site – one year after implementing conservation measures (photo D. Horabik).

Photo 41. Torfowiska nad Prosną site one year after protective measures were carried out (photo D. Horabik).

The Bęczkowice Fen is a soligenous low fen with moss-sedge and meadow vegetation related to a moss fen, developed in the edge, left-bank section of the Luciąża River Valley. It represents the habitat subtype 7230-2: alkaline fens of southern Poland (excluding mountains) and central Poland.

It stretches for about 1.8 km between the road connecting Bęczkowice with Grabowiec in the north-west and Grabowiec Kolonia in the south-east (see Figure below).

The Bęczkowice Fen is situated in the left-bank section of the Luciąża valley (regulated tributary of the Pilica, flowing into the Vistula River), which is not used and now overgrown with shrubs and trees. The valley was strongly transformed as a result of the former non-industrial peat extraction. In the southern part of the fen complex there is an artificial watercourse, which collects natural streams of water seeping from the mineral edge of the valley. These waters are discharged in a north-eastern direction to Luciąża. Between the patches of the habitat located in the north-western part of the complex and the patches of the south-eastern part, there is an area with numerous exploited peatland hollows, only partially overgrown, constituting small water reservoirs. North-east of the site there is a large complex of breeding ponds. The surroundings of the valley are dominated by agricultural land, and small forest complexes are located south-west of the site. The boundaries of the patches of the habitat are defined by fragments of open moss fens and communities with related vegetation, which stand out in the landscape due to their lower location than the adjacent meadow areas.

Peat deposits located in the Luciąża Valley were exploited in the past. This process continued until the early 1950s. In addition, until the mid-1980s, the area was used for agriculture as hay meadows and pastures. At the end of the twentieth century the use was abandoned completely.

The vegetation of the fen is varied and mostly related to the exploited peatlands. Part of the plant communities in the described fen complex are typical phytocenoses of the *Caricion davallianae* alliance, including *Caricetum paniceo-lepidocarpae* and *Caricetum davallianae*. The others are communities related to the above, most often with a species composition similar to rushes or wet and variable-hydration

Fig. 25. Location of the Bęczkowice Fen against the background of an orthophoto map.

meadows. The best-preserved patches are characterized by the predominance of *Carex rostrata*, a significant proportion of protected species (including *Orchidaceae*) and a well-developed bryophytic layer.

In the past, the fen was used as extensive meadows and pastures, and with the cessation of this use, the expansion of trees and shrubs intensified. Currently, most of the moss fen patches within the complex are subject to unfavorable succession changes. The share of willow thickets (built mainly by *Salix cinerea*) is increasing, and the growth of *Alnus glutinosa* and birches (mainly the *Betula pendula*) occurs. In addition, some of the patches are evolving towards rushes or meadow communities.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2.)

The Bęczkowice fen during the observation period was characterized by relatively constant humidity (see Fig. 27). In the 2017 growing season, it was relatively well hydrated - the water level ranged from approx. - 13 cm to approx. - 8 cm below the surface. Thanks to the capillary infiltration and the constantly high-level of groundwater table, the upper layers of fen were well hydrated even in the middle of summer. Since August, a slight increase in water level has been observed, which was associated with intense rainfall, which, however, did not cause flooding at the observation site.

The stability of hydrological conditions on this relatively strongly hydrologically changed area is probably related to the activity of beavers, which on the sewered section of Luciąża built dams that slowed the outflow of water. It should be remembered that 2017 was a relatively humid year and therefore, to ensure favorable conditions for the existence of habitat 7230, it seems important to maintain these dams, even when the Luciąża river basin is flooded in some periods.

Stratigraphic studies have confirmed the presence of a peat deposit built by moss-sedge peat with varying degrees of decomposition. The drilling surveys covered the entire peat bed. The fen has been developing for many centuries and since the beginning of its existence it has been home to moss-sedge vegetation. A relatively high degree of peat decomposition, noticeable at different stages of fen development, indicates periodic disturbances of the fen ecosystem and drying out of the top layers of the fen.

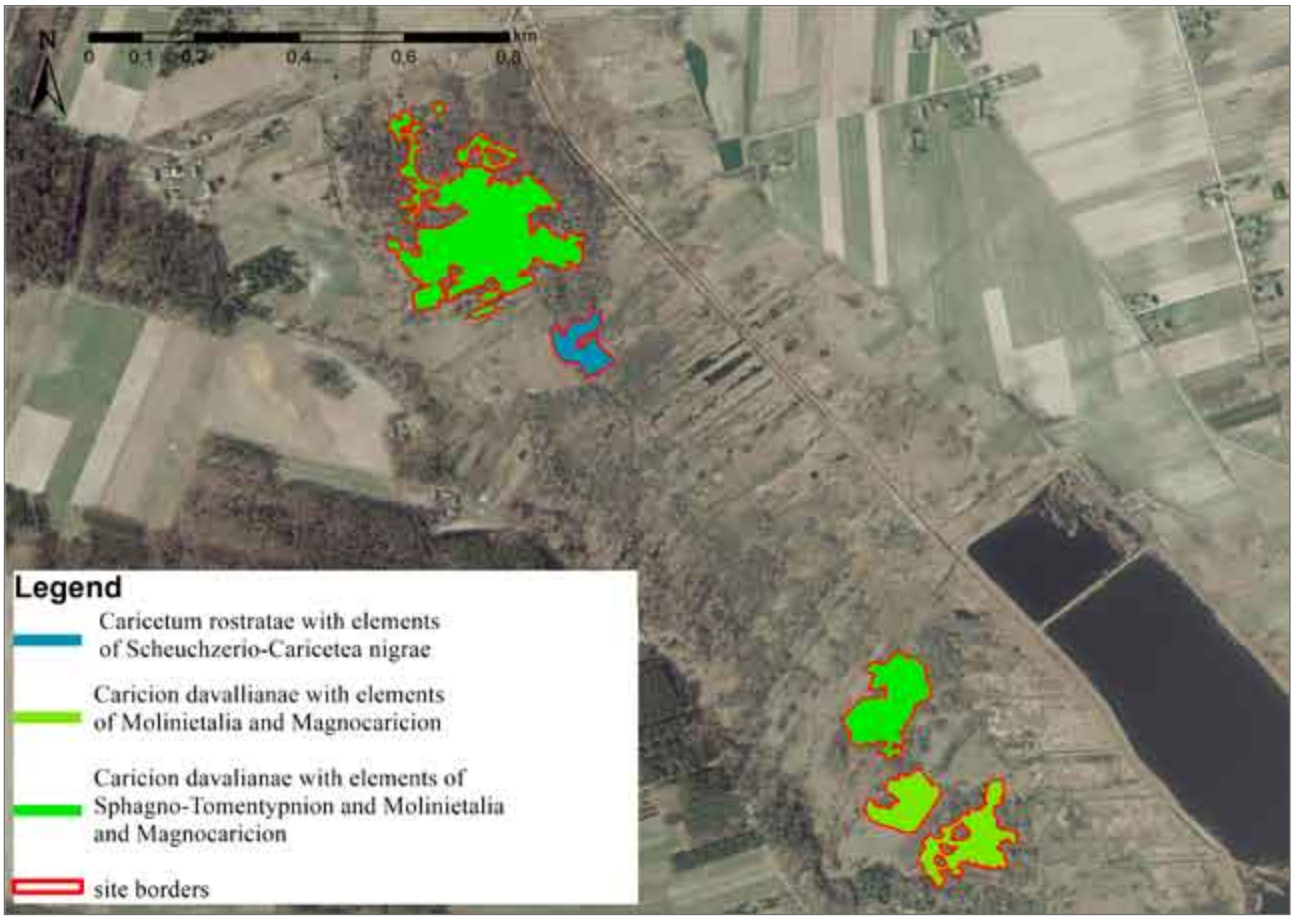


Fig. 26. Actual vegetation of the Łąka w Bęczkowicach Fen.

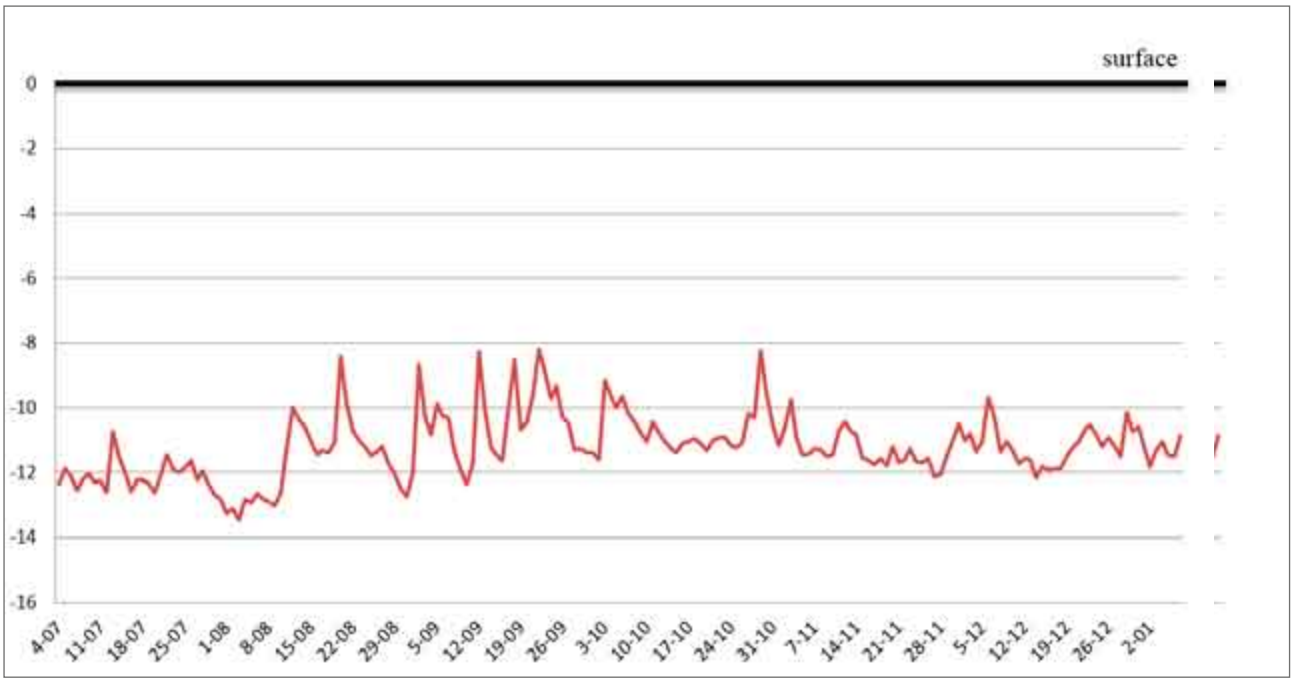


Fig. 27. Groundwater table fluctuation on Bęczkowice fen.

The natural values of the area were discussed, among others, in the studies by Andrzejewski et al. (2002), Chmielecki et al. (2009), Halladin-Dąbrowska et al. (2009), Kil (2010), Kucharski (1989), Kucharski (1996), Kucharski and Pisarek (2001), Zając and Kucharski (2011), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012), as well as in an expert report commissioned by the Regional Directorate for Environmental Protection in Łódź (Jarzombkowski et al. 2017).

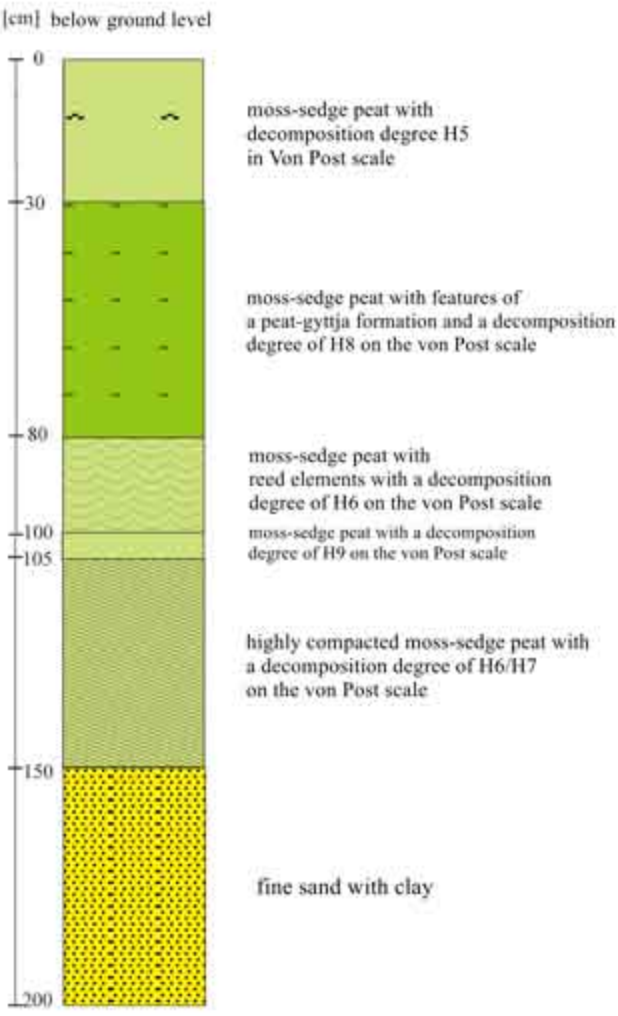


Fig. 28. Peat profile of the Bęczkowice Fen.

Photo 42. Łąka w Bęczkowicach (photo D. Horabik).

Photo 43. Łąka w Bęczkowicach after conducting conservation measures (photo T. Bąkowski).

Photo 44. Łąka w Bęczkowicach (photo K. Kotowska).

Torfowisko Sędowice is a soligenous low fen with moss-sedge and rushes vegetation, developed in a valley of a medium-sized river. It represents the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The site is located in the Nida Basin, in the Mierzawa Valley, in its lower section, south from the village of Sędowice (see Figure below).

The fen is located in the Mierzawa Valley (the right-bank tributary of the Nida River, which then flows into the Vistula River) in a complex excluded from grassland management and remains under a strong influence of groundwater. In its immediate vicinity there are fragments of fens overgrown with trees and shrubs and a dyke leading towards the river (once connecting two villages – Helenówka and Sędowice). A small river flows through the northwestern part of the site, leading the water towards the Mierzawa. Around the fen complex, there are mainly grasslands and forests.

In the past, the fen area in the Mierzawa Valley was used as extensive hay meadow and pasture; mostly cows were grazed here as well as geese. It was also a place of peat extraction for fuel. The average excavation depth was 3 – 3.5 m. In recent years, however, most of the grassland in the area has been abandoned and is now subject to reed expansion and succession processes towards thicket and forest communities. Extensive farming continues to take place around the complex.

Due to a significant transformation of the fen complex, which includes the Torfowisko Sędowice Fen and unfavorable changes in local water conditions, the moss vegetation is disappearing and the peat-forming process takes place only on a limited area.

Despite the strong expansion of the reed, advanced secondary succession, and a decline in the surface area, the fen is still a place where valuable and rare species, both vascular plants and bryophytes, can be found. These include: *Liparis loeselii*, *Epipactis palustris*, *Dactylorhiza incarnata*, *D. majalis*, *Carex davlliana*, *C. dioica* and mosses – *Limprichtia cossoni*, *Hamatocaulis vernicosus*, *Campylium stellatum,* including *Campylium stellatum var. protensum, Tomentypnum nitens*, *Helodium blandowii*, and *Sphagnum teres.*

Fig. 29. Location of the Torfowisko Sędowice Fen against the background of an orthophoto map.

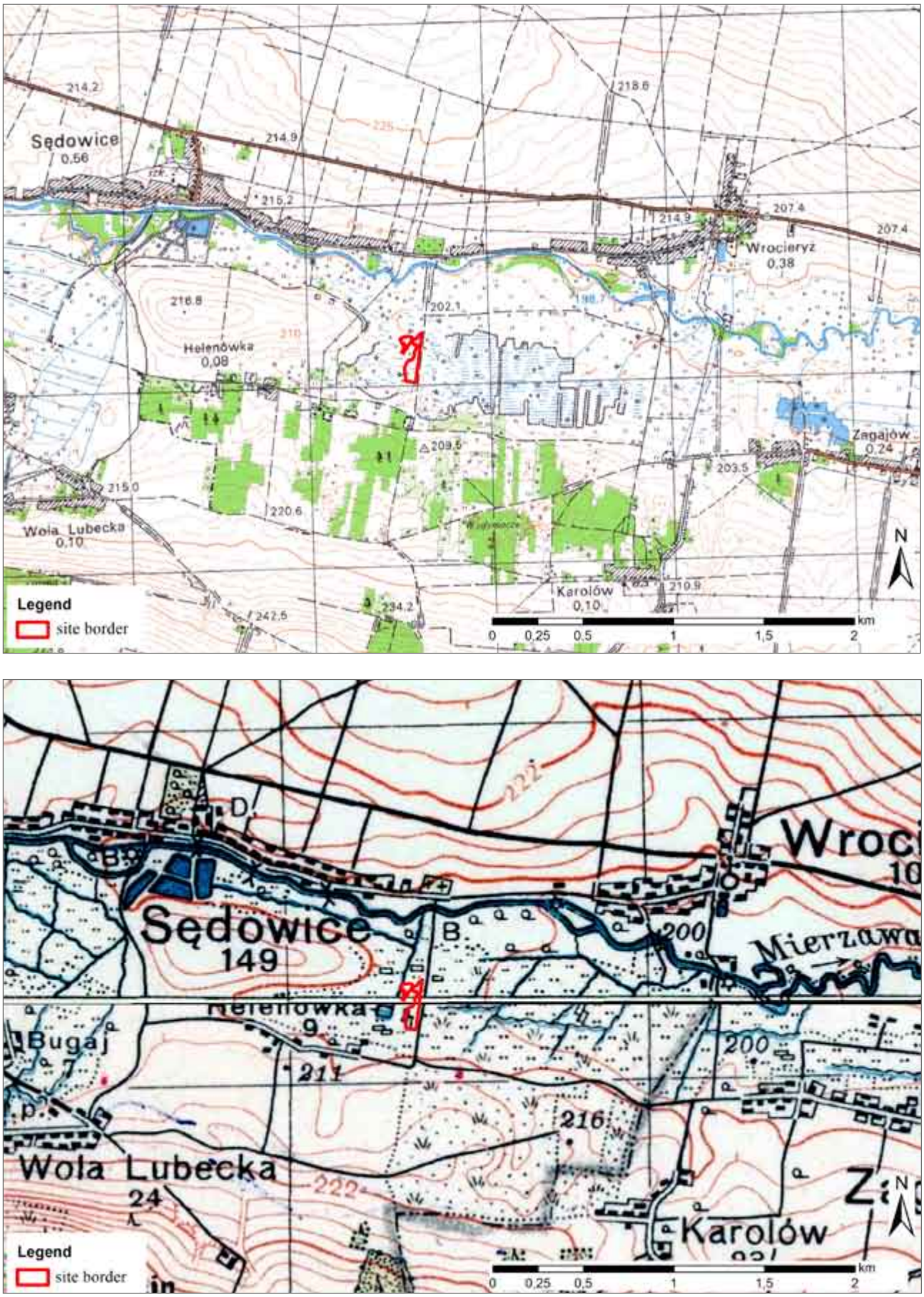


Fig. 30. Fragments of topographic maps – historical from 1938 (left) and actual (right) where peat extraction places are visible.

The vegetation of the Sędowice Fen is quite homogeneous and consists of phytocoenoses from the *Caricion davallianae* alliance that have developed in the area of former exploited peatland hollows. It is represented by the *Caricetum paniceo–lepidocarpae* association and related forms, developed in the surroundings of rush communities. The central part of the fen is open, dominated by low sedge communities with *Carex panicea*, *C. flava*, *C. rostrata*, *C. dioica*, *C. davalliana*, *Festuca rubra*, *Potentilla erecta*, *Menyanthes trifoliata*, *Valeriana dioica*, *Eleocharis palustris, Eriophorum latifolium*, and *Pedicularis palustris*. The moss layer is well-developed with diverse species, mostly built by brown mosses – apart from the ones already mentioned, there are also *Calliergonella cuspidata*, *Calliergon giganteum*, *Climacium dendroides*, *Plagiomnium elatum*, *P. ellipticum*, *P. undulatum*, *Bryum pseudotriquetrum*, *Aulacomnium palustre*, and *Marchantia polymorpha*. In the edge parts of the fen, the vegetation is higher and meadow species such as *Cirsium palustre*, *Lychnis flos–cuculi*, *Lysimachia vulgaris*, and *Eupatorium cannabinum* predominate. In addition to the penetrating trees and shrubs (mainly *Salix cinerea*, *Frangula alnus* and *Alnus glutinosa*), the habitat is significantly overgrown with *Phragmites australis*.

The current area of habitat 7230 is only a small part of the fen vegetation preserved from a formerly vast moss fen. The abandonment of use after peat extraction resulted in the gradual overgrowth and secondary bogging of the area, which was further intensified by the activity of beavers. Only one patch of the fen has survived in a non-forest form, although its surface is also decreasing due to the strong expansion of reeds and the progressing succession.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2). In addition, hydrological monitoring was carried out here by means of an automatic recorder.

The area of the fen in the places where the patches of moss vegetation have been preserved in the period of several years of observation remained relatively well hydrated for most of the year, with the highest decreases during the growing season when the level of groundwater dropped to the surface of the ground. The constant flooding of the surface is connected with the development of the patch in the former exploited peatland hollow, i.e., in a place slightly lower than the surrounding area, and with the activity of beavers in this area, as their dam was close to the measurement point. Such a high level of

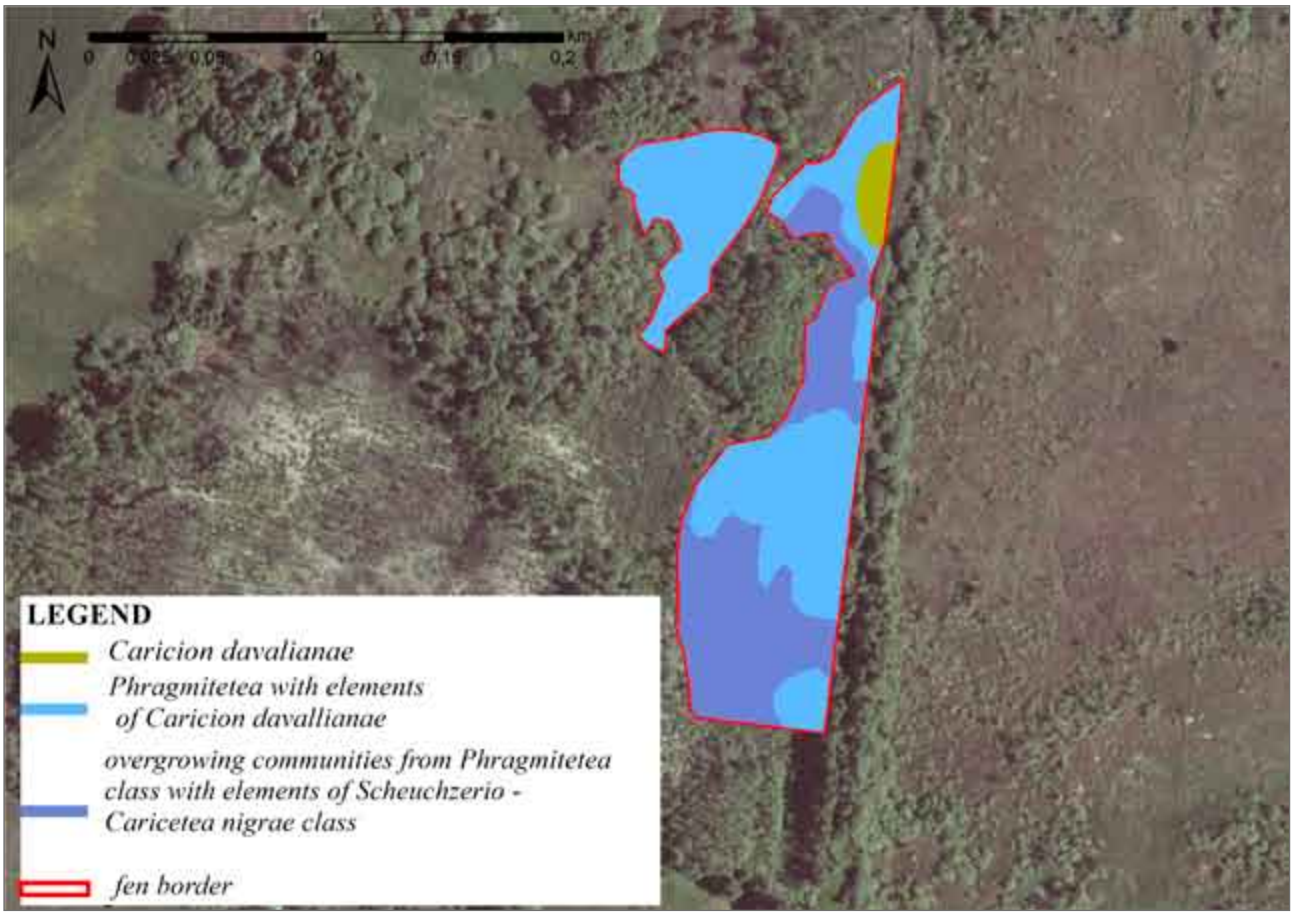


Fig. 31.Actual vegetation of the Torfowisko Sędowice Fen.

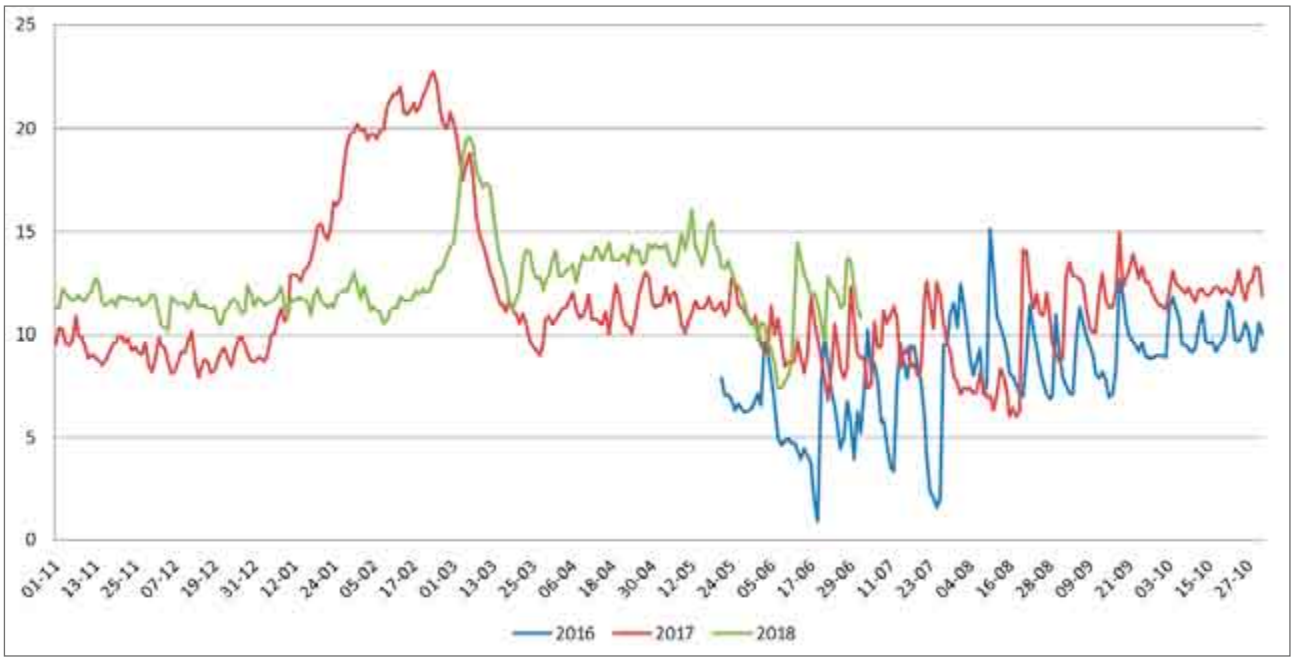


Fig. 32. Changes of the groundwater table on the Sędowice Fen in the hydrological years 2016 – 2018.

groundwater with simultaneous extensive use is not optimal for meadow vegetation, but rather favors the development of rushes. Significant fluctuations of the water table can be explained by climatic changes and altered hydrological cycle – in recent years there was no regular rainfall, and periods of drought were followed by torrential rains. Within a relatively short period of time, the water level dropped quickly, only to increase significantly after the downpours. In addition, as winter frost is lacking and there is no snow retention, winter increases in groundwater levels were observed and were quickly discharged into the river due to dry and warm springs. The groundwater table in the Sędowice Fen currently depends to a large extent on the weather conditions, and these conditions are very similar to those in the nearby Bełk Fen (see Fig. 31.).

As a result of hydrological disturbances on the fen – trees and shrubs have expanded, and primarily rushes – the fen vegetation remained only in the exploited peatland hollows. The remaining area is dominated by reed rushes and local dried, unused meadows on muck. After the removal of trees and shrubs, an improvement of light conditions was observed, but the return of vegetation typical for moss fens requires regular mowing while maintaining a high level of groundwater over the coming years.

Stratigraphic studies confirmed the presence of a peat deposit with a thickness of 1 – 1.5 m (depending on the drilling location) built by various types of sedge peat, sometimes with layers of reed.

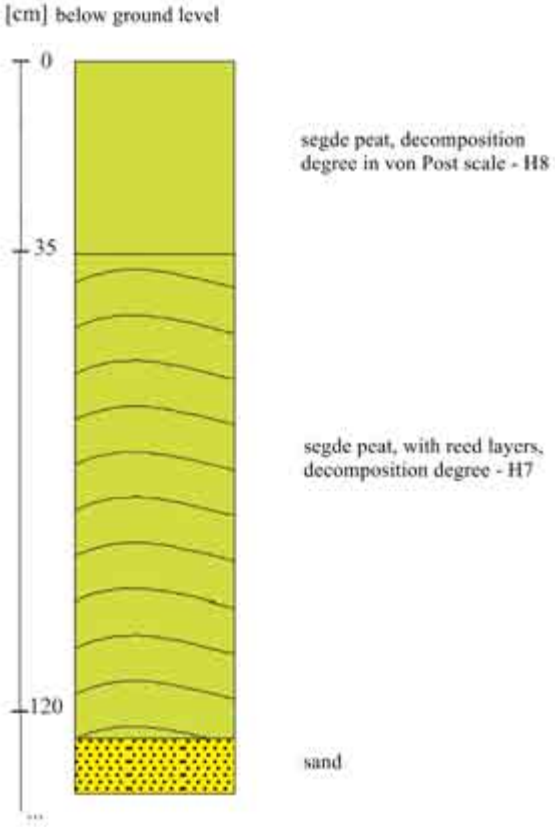


Fig. 33. Peat profile of the Sędowice Fen.

The natural values of the area were discussed only in the studies by Jarzombkowski and Pawlikowski (2012) and Wołejko et al. (2012).

Photo 45. Sędowice fen (photo K. Kotowska).

Photo 46. Sędowice fen after conducting conservation measures (photo T. Bąkowski).

The Bełk Fen is a soligenous low fen with moss-sedge and meadow vegetation related to moss fens, developed in a valley of a medium size river. It represents the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The site is located in the Nida Basin, in the Kruczka Valley, in its lower section, south from the village of Mierzwin (see Fig. 34).

The Bełk Fen is located in the Vistula River basin, in the valley of the Kruczki River, which is a small, right-bank tributary of the Nida, then flowing into the Vistula. The area is not drained and the site is located in an unused, heavily overgrown part of the valley. From the west it is adjacent to extensively used meadows. A road runs along the northern edge of the valley, along which several farms are located. The higher-lying areas to the north and south of the fen complex are covered by forest. The area is characterized by low intensity of agricultural management.

The fen area in the Kruczki Valley was used in the past as extensive hay meadows and pastures. In recent years, the wet part of the valley with a patch of preserved moss fens was excluded from agricultural management and is currently undergoing the process of reed expansion and succession towards thicket and forest communities.

The fen is of a soligenous origin. It is supplied by groundwater rich in calcium, flowing out of the slopes of the valley. It has developed where the flat bottom of the valley expands and where the northern edge of the valley clearly rises above the lower surface. The habitat is well hydrated and the peat-forming processes are active. The higher edges of the complex show dominant mucking processes.

The Bełk Fen is an extremely valuable habitat for many rare and protected species associated with fens and meadow communities. Its mosaic character creates favorable conditions for the occurrence of specific plant species, rare both in Poland and in Europe. These include: *Liparis loeselii*, *Dactylorhiza incarnata, Epipactis palustris*, *Carex davalliana*, *C. dioica, Eleocharis quinqueflora*, *Parnassia palustris*, and *Pedicularis palustris*. In the hollows filled with

Fig. 34. Location of the Bełk Fen against the background of an orthophoto map.

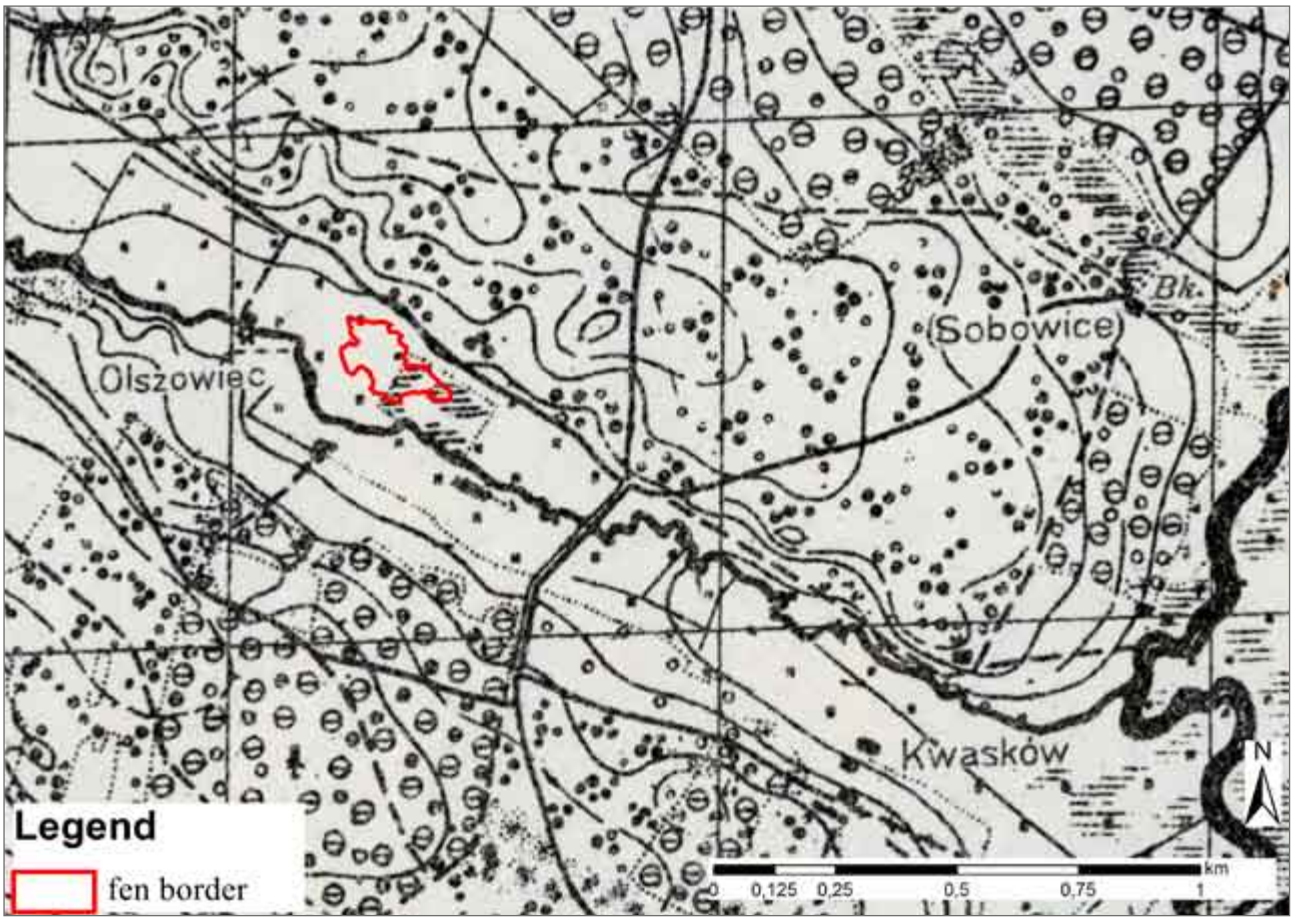


Fig. 35. Fragment of a historical topographic map from 1927.

water there are *Utricularia intermedia* and *U. minor*, as well as *Chara spp.* Particularly noteworthy is the species-rich moss layer, which includes species such as *Limprichtia cossonii, Limprichtia revolvens*, *Campylium stellatum, Fissidens adianthoides, Tomentypnum nitens, Scorpidium scorpioides* – rare in the region – and *Bryum pseudotriquetrum*. Among the species characteristic for fens, in small patches with meadow and grass vegetation there is *Sesleria uliginosa,* a species found only in the Nida Basin.

The flora of the Bełk Fen is mostly composed of the *Caricetum paniceo-lepidocarpae* and *Caricetum davallianae* plant communities of the *Caricion davallianae* association, which form a mosaic of patches with meadow communities of the order *Molinietalia,* partially overgrowing with *Alnus glutinosa,* thickets of *Salix spp.* and *Frangula alnus.* The best preserved patches of fen vegetation are located in the former shallow exploited peatland hollows and are formed by low sedges, mainly *Carex panicea* and *C. flava* with *Potentilla erecta, C. lepidocarpa*, and *C. diandra*. In addition, the species characteristic of fens include *Carex davalliana* and *Valeriana simplicifolia.* In the outer layers of the fen and in areas with a clear succession, the vegetation takes on the character of wet meadows of the *Calthion palustris* association with *Carex nigra*, *Cirsium rivulare*, *C. canum, C. palustre*, *Scirpus sylvaticus*, *Caltha palustris*, and *Mentha aquatica*, locally with signs of secondary bogging with the occurrence of tall sedges – *Crex acutiformis*, *Carex paniculata*, and *Equisetum palustre*. The share of variable-hydration and sward meadows increases in the higher-lying patches. A part of the area shows the penetration by *Phragmites australis* and *Alnus glutinosa*.

Within the boundaries of the site, the presence of *Vertigo geyeri* and *Vertigo angustior* was found.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2). Furthermore, hydrological monitoring was carried out here by means of an automatic recorder, together with phytosociological monitoring.

The surface of the fen remained relatively well-hydrated for most of the year during the several years of observation, with the largest decreases during the growing season when groundwater levels fell to the surface of the ground. The constant flooding of the surface is connected with the development of the patch in the former exploited peatland hollow, i.e., in a place slightly lower than the surrounding area. Such a high level of groundwater with simultane-

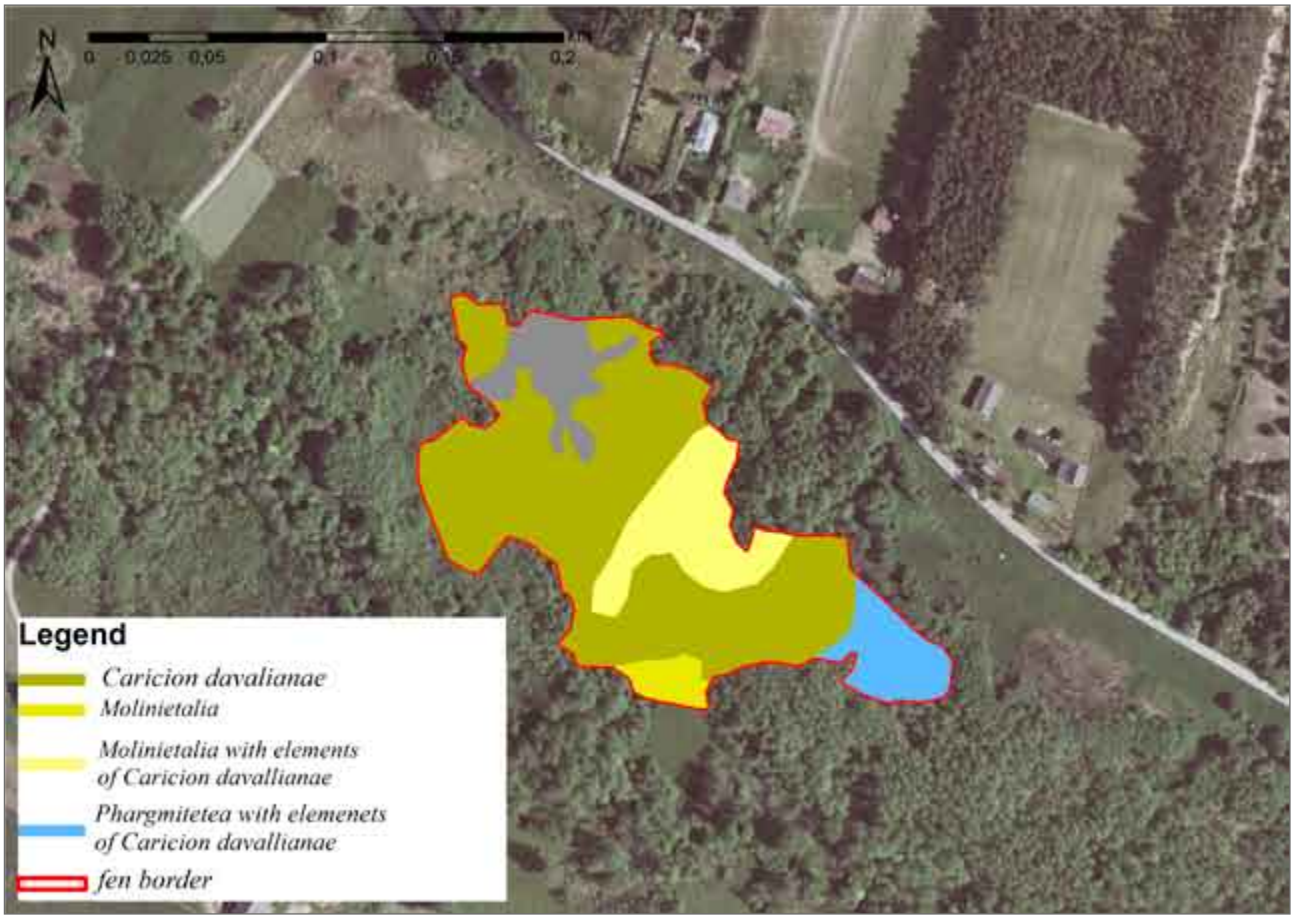


Fig. 36. Actual vegetation of the Bełk Fen.

ous extensive use is not optimal for moss fen vegetation, favoring the development of rushes. Significant fluctuations of the water table can be explained by climatic changes and altered hydrological cycle – in recent years there was no regular rainfall, and periods of drought were followed by torrential rains. Within a relatively short period of time the water level dropped quickly, only to increase significantly after the downpours. In addition, since winter frost is lacking and there is no snow retention, winter increases in groundwater levels were observed and were quickly discharged into the river due to dry and warm springs. The groundwater table in the Bełk Fen currently depends to a large extent on the weather conditions, and these conditions are very similar to those in the nearby Sędowice Fen (cf. Fig. 37).

As a result of hydrological disturbances, the rushes vegetation expanded to a part of the fen where hydrological observations are carried out, but this applies only to a part of the fen. The degree of hydration of the other patches, which are located slightly higher, is lower, favoring the maintenance of moss fen species.

Photo 47. Montage of piezometer on Bełk fen (photo E. Gutowska).

Fig. 37. Changes of the groundwater table for the Bełk Fen in the hydrological years 2016 – 2018.

Stratigraphic studies have confirmed the existence of a well-preserved peat deposit composed of various types of moss and sedge-reed peats. The peat profile is presented below, and it confirms the long-term development of the fen. The drilling surveys covered the entire peat profile. Over the years, the fen has developed in the form of reed-sedge rushes, with frequent changes in the river bed or significant flooding covering the top layer of the fen. Periodically, the fen was much better hydrated and even flooded, as evidenced by the remains of mollusc shells in the peat.

The natural values of the area were mentioned only in the studies by Jarzombkowski and Pawlikowski (2012) and Wołejko et al. (2012).

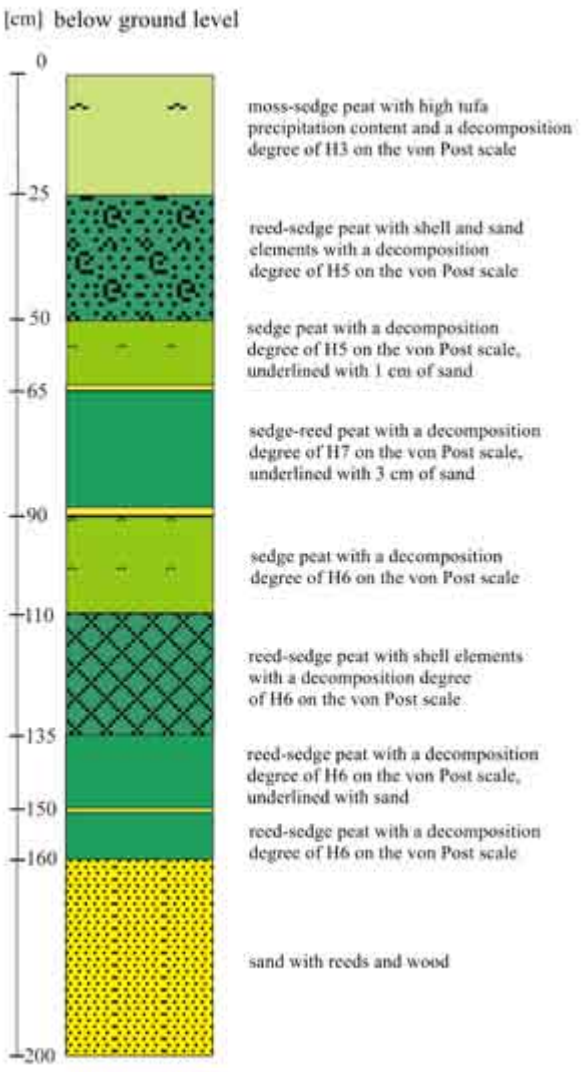


Fig. 38. Peat profile of the Bełk Fen.

Photo 48. Bełk fen (photo E. Gutowska).

Photo 49. Bełk fen (photo K. Kotowska).

Torfowisko Zwierzyniec is a soligenous low fen with moss-sedge and rushes vegetation, developed in a spring area. It represents the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The site is located in the Nida Basin, in the spring area, at the mineral edge of the depression between Szaniec and Mikułowice (see Figure below).

The Zwierzyniec Fen has developed in a spring area at the foot of a steeply sloping slope, and its surface is also sloping. Small watercourses begin to run here, discharging water to the neighboring drained grassland complexes and further to the Sanica and the Vistula River. In the past the fen itself was extensively used for hay production and grazing which is why it is cut through by several overgrown drainage ditches. Over the last quarter of a century, however, most of the grassland in the area has been abandoned and is now subject to reed expansion and succession processes towards thicket and forest communities. Apart from grasslands, the area surrounding the fen is also home to unused agricultural land and a forest complex extending north-east of it.

At present, the area is dominated by relatively poor and distorted moss fen formations, largely referring to the vegetation of alkaline fens, where the peat-forming process takes place only to a small extent. The majority of communities in this area are reeds or meadows with a small share of species typical for moss fens. The habitat is highly dry and is overgrown with reeds throughout its entire area. Despite its poor condition, Torfowisko Zwierzyniec is one of the floristically richest moss fen patches in the Świętokrzyskie Voivodeship, with vegetation typical for fens of upland Poland. Rare and endangered plant species are found here, such as *Liparis loeselii* (recently unconfirmed), *Dactylorhiza incarnata*, *Gymnadenia conopsea, Epipactis palustris, Schoenus ferrugineus, Carex davalliana, C. hostiana*, *Sesleria uliginosa, Tofieldia calyculata* (recently unconfirmed), and *Pinguicula vulgaris* (recently unconfirmed). In the moss layer there are rare mosses associated with alkaline fens – *Limprichtia cossonii* and *L. revolvens*. Among the species occupying the hydrated hollows, *Utricularia minor* and *Chara* sp. were found.

Fig. 39. Location of the Zwierzyniec Fen against the background of an orthophoto map.

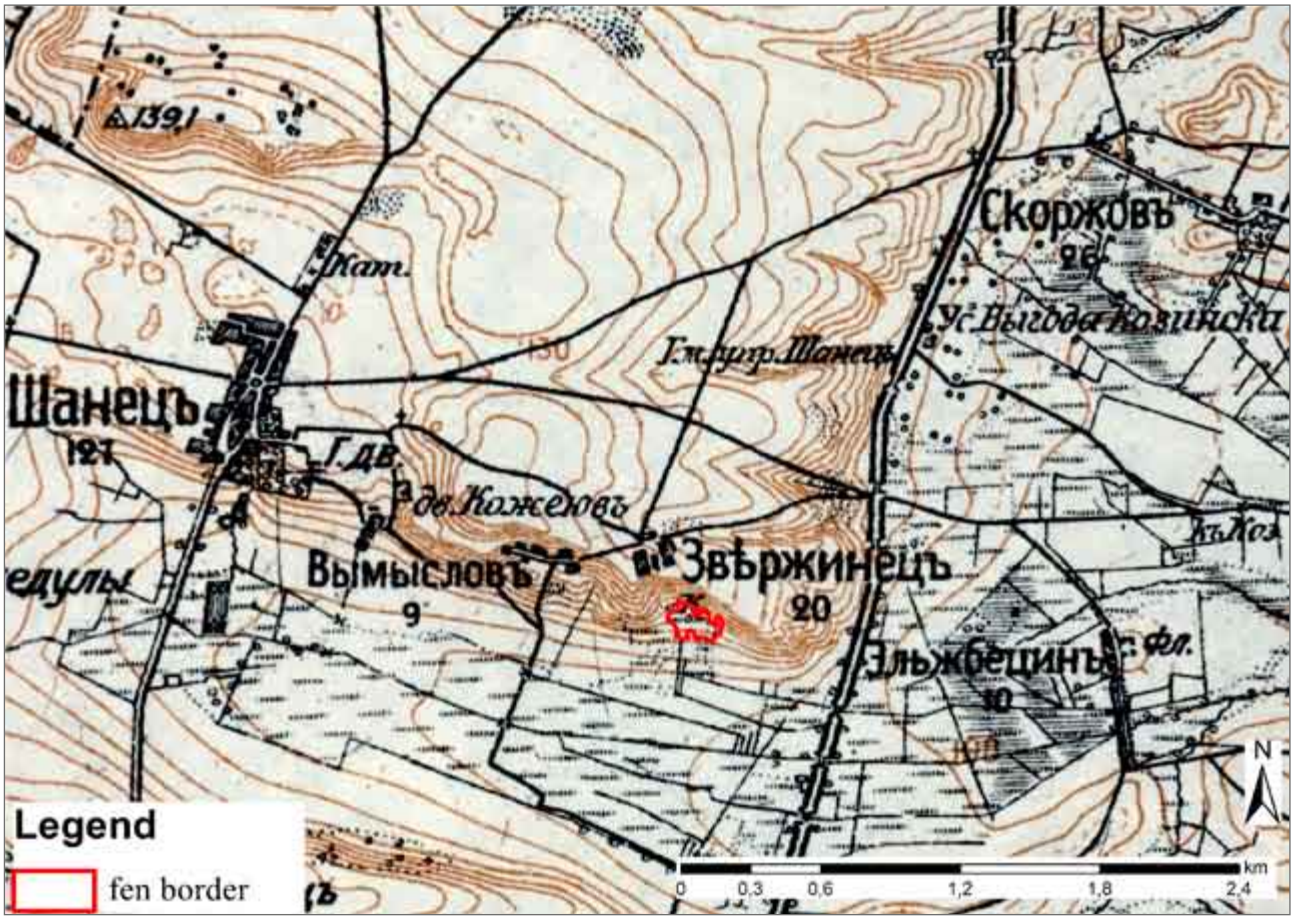


Fig. 40. Fragment of a historical topographic map from 1914 – even 100 years ago the area of the mire together with surrounding meadows was drained.

The vegetation of the Torfowisko Zwierzyniec Fen is quite uniform, represented by the phytocoenoses of the *Caricion davallianae* association and related, in the herbaceous layer with the dominance of *Phragmites australis* and with the participation of *Schoenus ferrugineus* and sedges – *Carex davalliana*, *C. panicea*, *C. lepidocarpa*, *C. flacca* and *C. acutiformis*, as well as *Valeriana simplicifolia*, *Eriophorum latifolium*, *Epipactis palustris*, and meadow species. In dried locations, the vegetation transits into meadow communities of the order *Molinietalia* and the association *Molinion caeruleae* with the dominance of *Molinia caerulea* with sedges, *Succisa pratensis*, *Sanguisorba officinalis*, *Galium boreale*, and *Potentilla erecta*, and locally – *Sesleria uliginosa*. In addition, there are species indicating the eutrophication of the habitat, such as *Eupatorium cannabinum*, and *Cirsium* spp. The moss layer is underdeveloped and limited to more hydrated areas, and its species composition is indicative of once good habitat conditions. It consists of brown mosses such as *Limprichtia cossonia*, *L. revolvens*, *Campylium stellatum*, *Fissidens adianthoides, Calliergonella cuspidata*, and *Plagiomnium elatum*. In addition to the expansion of *Phragmites australis* in the fen, the process of secondary succession is also noticeable. Willow thickets (*Salix cinerea*, *Salix pentandra*), wildings of *Alnus glutinosa* and *Frangula alnus*, as well as offshoots of *Rubus idaeus* can be locally observed.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2).

The natural values of the area were discussed only in the studies by Jarzombkowski and Pawlikowski (2012) and Wołejko et al. (2012).

The surface of the fen in the period of several years of observation remained dry for most of the year, especially during the growing season. The groundwater level dropped below 50 cm, which significantly limited the water access for plants. As a result of hydrological disturbances on the fen, reed growth took place, shading the bottom of the fen and storing large amounts of dead biomass. The limited use due to the lack of consent of a significant part of the owners perpetuated the negative changes on the fen. As a result, typical alkaline fen species have been observed to withdraw.

Stratigraphic studies confirmed the existence of a peat deposit composed of various types of sedge-moss and sedge fen peats. The surface of the peat layer decomposes and disappears but the deeper layers are still well preserved.

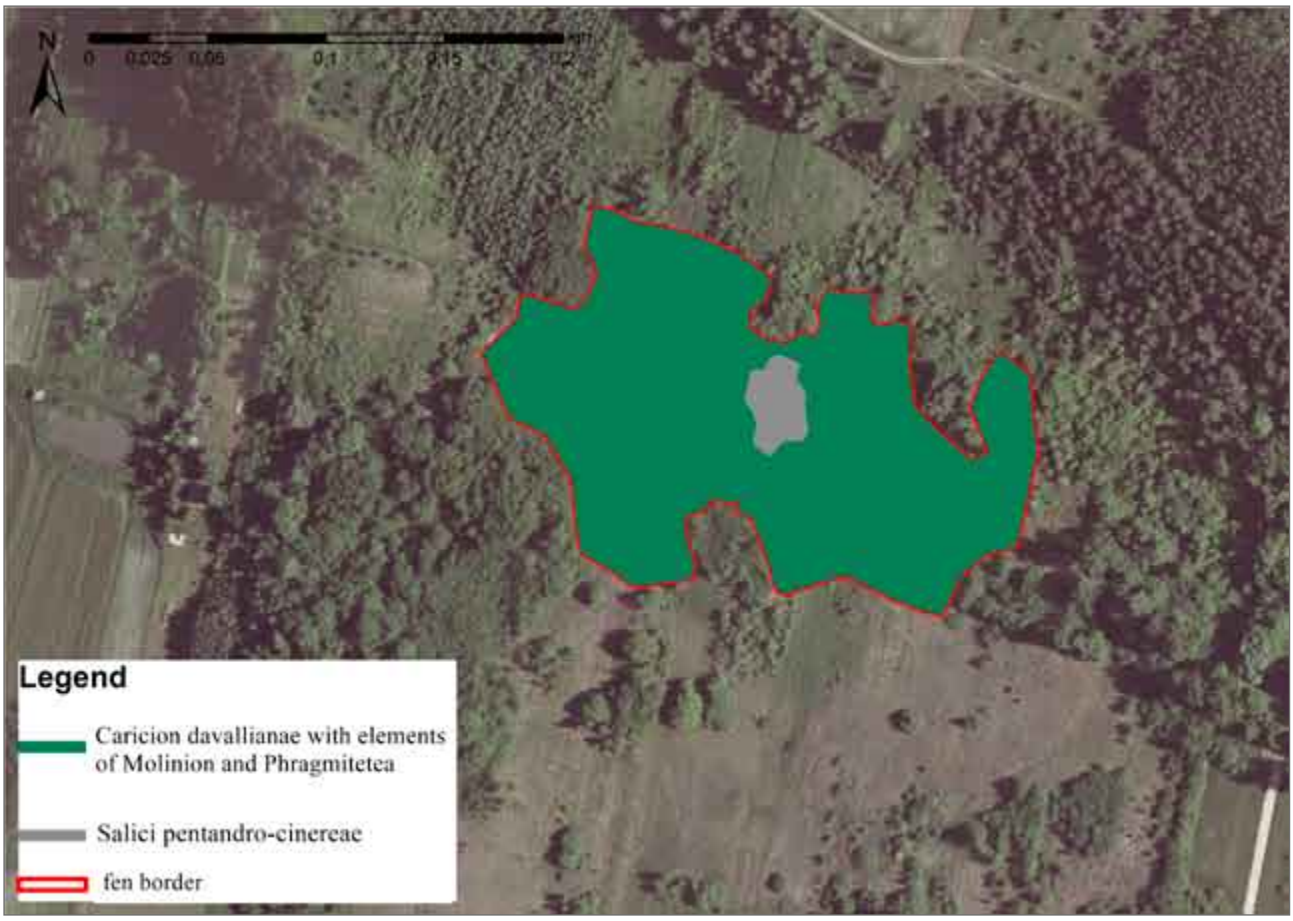


Fig. 41. Actual vegetation of Torfowisko Zwierzyniec Fen.

Photo 50. Zwierzyniec fen (photo K. Kotowska).

Photo 51. Zwierzyniec fen (after conducting conservation measures) (photo T. Bąkowski).

Photo 52. Zwierzyniec fen (view on the valley) (photo K. Kotowska).

Torfy Orońskie is a flow-through alkaline fen with moss fen vegetation. It is a mosaic of plant communities of moss fens, moss rushes and wet variable-hydration moor-grass meadows. The fen represents habitat 7230 Mountain and lowland alkaline fens of the character of flush mires, sedge fens and moss fens, subtype 7230-2.

The fen is located at the foot of the slope of the floodplain terrace in the Vistula Valley near the villages of Podzamcze and Oronne (see Figure below).

The fen is located in a small forest complex, surrounded mainly by cultivated fields and drained meadows. The habitat was formed in the vicinity of a wet forest of a group of alders and now consists of three patches with a different degree of conservation. The fen is of a flow-through type – it is supplied by seepage waters which flow out at the foot of the slope and filter through peats, and are then intercepted by ditches and canals directing them southwest through the tributary from the Dopływ z Lasu Ciosny and Okrzejka to the Vistula River.

The 7230 habitat probably developed in the place of a former water reservoir, whose traces can now only be seen in the calcareous gyttja sediments underlining the peat. In the past, the entire area was used for hay production and some for grazing, but since the mid-1980s, the use of this area has been completely abandoned, leading to the growth of forests surrounding the fen nowadays. The areas which were excluded from use a few decades ago are now occupied by alders, and the patches of the moss fen have been preserved only where the habitat was mown in the 1980s and where there was no one-way water drainage.

The fen is under reserve protection as a nature reserve – Torfy Orońskie. It was established in 1987 and covers an area of 12.61 ha. Apart from the moss fen, it also includes bog forests.

Torfy Orońskie is an extremely valuable habitat for many rare and protected species associated with fens and constitute the best preserved meadow vegetation patch typical for the 7230 habitat in the Mazovian Voivodeship. Fens have a diverse structure and species composition. The physiognomy is most affected by the species characteristic of the *Scheuchzerio-Caricetea nigrae* class (such as *Eriophorum angustifolium*, *Menyanthes trifoliata*, *Viola palustris*, *Juncus articulatus*, and *Triglochin palustris*)

Fig. 42. Location of Torfy Orońskie against the background of an orthophoto map.

as well as *Caricion davallianae* alliance (such as *Epipactis palustris*, *Dactylorhiza incarnata*, including the sub–species: *D. incarnata* ssp. *ochroleuca*, *Eriophorum latifolium*, *Eleocharis quinqueflora*, *Parnassia palustris, Valeriana simplicifolia*, and *Campylium stellatum*). Some of the patches are distinguished by a significant share of meadow species (e.g., *Molinia caerulea*, *Lysimachia vulgaris*, *Cirsium palustre*), as well as *Carex panicea* and, in some patches, *Phragmites australis*, *Eupatorium cannabinum*, and *Galium palustre*. *Utricularia minor* and *U. vulgaris* as well as *Chara vulgaris* are found in the land depressions. Rare species of brown moss are present in the moss layer (such as *Limprichtia cossonii* and *L. revolvens*, *Tomentypnum nitens*) as well as peat mosses – *Sphagnum warnstorfii*, *Sph. fuscum*, and *Sph. teres*. Locally, especially on the hills around wood rootstock, there are species of the *Oxycocco-Sphagnetea* class, including *Drosera rotundifolia*, *Ledum palustre*, and *Vaccinium uliginosum*. Moreover, Torfy Orońskie is a location of a significant population (up to about 100 individuals) of *Liparis loeselii* and protected and endangered species of snails, including *Vertigo geyeri* (the only known site in the Mazovian Voivodeship), *V. angustior*, and *V. moulinsiana*.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2). In addition, hydrological monitoring was carried out here by means of an automatic recorder.

During the period of several years of observations, Torfy Orońskie remained stably hydrated (see Figure below), and only during the summer was a decrease in groundwater levels observed. The water level was near the ground surface, in summer fluctuating even up to 60 cm below the ground surface. Lack of flooding and constant dampness for most of the year is conducive to the persistence of moss vegetation, but the declines during the growing season limit the availability of water to typical fen species, enabling the development of trees whose roots reach much deeper compared to herbaceous plants. It was only in 2014, when rainfall was abundant, that the water table remained close to the ground. Due to such disturbances, it seems particularly important to continue the removal of trees and shrubs and extensive mowing, which has so far been carried out by the Naturalists' Club and the Snopowiązałka Foundation. Significant fluctuations of the water table on the fen can be explained by climatic changes and altered hydrological cycle – in recent years the rainfall was not regular and periods of drought were followed by torrential rains. Within a relatively short period of time the water level dropped quickly,

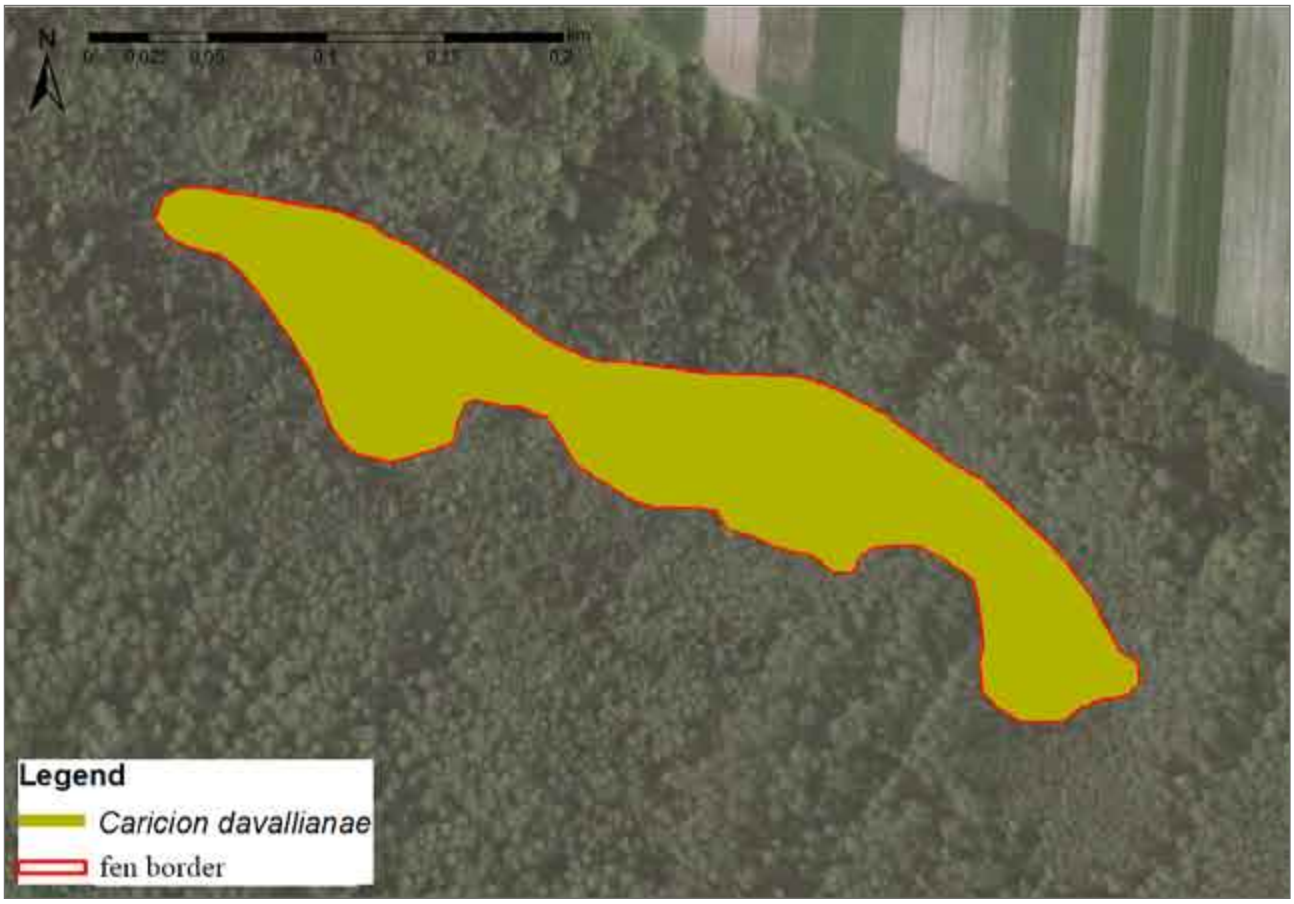


Fig. 43. Actual vegetation of the Torfy Orońskie Fen.

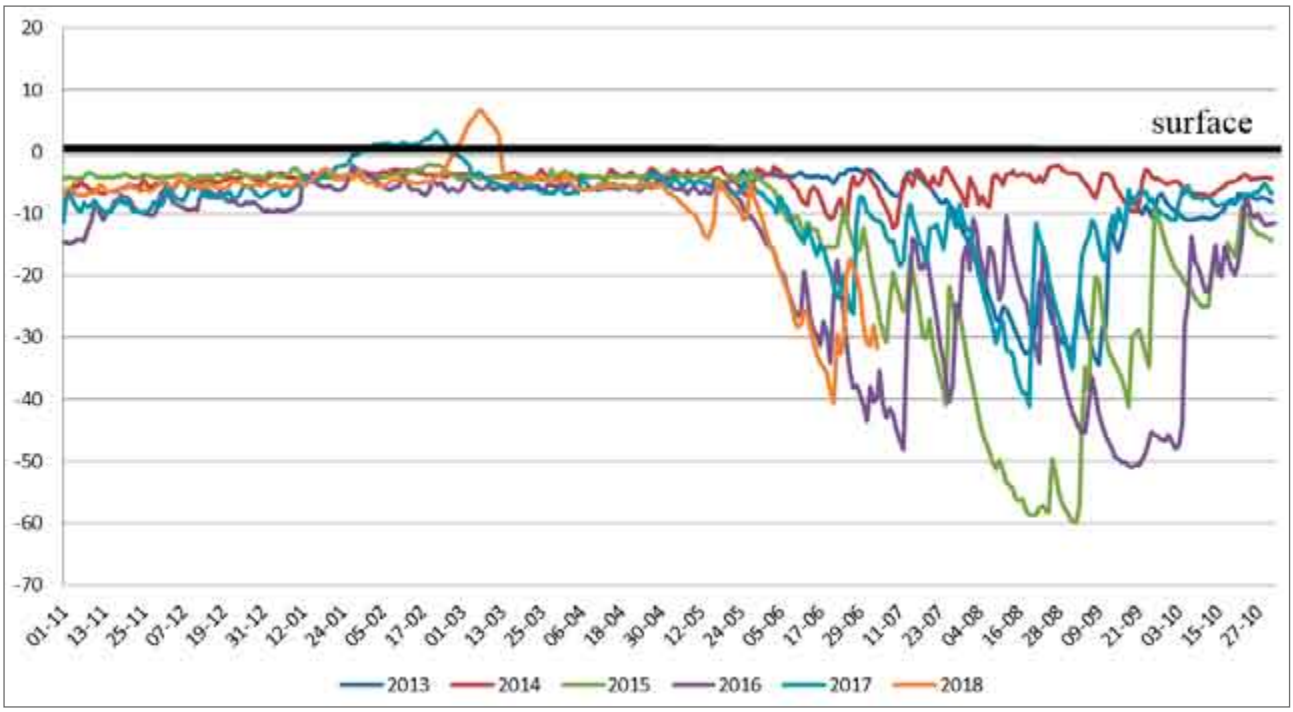


Fig. 44. Water table fluctuations on Torfy Orońskie.

only to increase significantly after the downpours.

The stratigraphic studies confirmed the existence of a well-preserved peat deposit built by various types of sedge-moss and sedge peats underlined with calcareous gyttja.

The natural values of the area were discussed, among others, in the studies by Ćwikliński and Głowacki (1984), Falkowski et al. (2005), Falkowski et al. (2009), Grzyb (1990, 1993), Jarzombkowski and Kozub (2011), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012).

Photo 53. Torfy Orońskie (photo T. Bąkowski).

Photo 54. Conservation measures on Torfy Orońskie (photo T. Bąkowski).

Natura 2000 site Pakosław PLH140015

The Pakosław Fen is a soligenous low fen with moss-sedge, meadow and rush vegetation related to a moss fen, developed in a spring area. It represents the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The site is located in a basin extending northwest of Pakosław, approximately 1 km from the village (see Figure below).

The Pakosław Fen is located in a largely unused, heavily overgrown fen complex, whose natural water conditions have been significantly altered due to an extensive network of drainage ditches. It is located in the Vistula River basin, in the vicinity of a small river – the Modrzejowianka, a left tributary of the Iłżanka (which is a left-bank tributary of the Vistula). Around the better hydrated fragments of the fen, herbaceous and meadow communities developed on muck, still used on a part of the surface.

In the past, the fens were used as meadows and pastures, and in the 20th century most of the area was used for peat extraction for heating purposes by local farms. As a result of drainage and peat exploitation, the vegetation typical of fens is currently found in only a few exploitation hollows, and the surrounding area shows clear mucking processes.

The Pakosław Fen is an extremely valuable habitat for many rare and protected species associated with fens. It is one of the few in the country and the only position of the *Ligularia sibirica* in the Mazovian Voivodeship. In addition, there is *Liparis loeselii*, *Dactylorhiza incarnata* and *D. majalis*, *Epipactis palustris*, and *Dianthus superbus* in meadow communities. It is also worth noting that there is a varied moss layer with rare species of brown moss, such as *Hamatocaulis vernicosus*, *Limprichtia cossoni*, *Helodium blandowii*, and *Tomentypnum nitens*.

The vegetation of the fen was significantly transformed in the 20th century as a result of hydrological changes caused by intensive drainage of the area. Currently, the vegetation of the Bagno Pakoslaw site is heterogeneous and constitutes a mosaic of communities of *Scheuchzerio-Caricetea nigrae* class, wet

Fig. 45. Location of the Pakoslaw Fen against the background of an orthophoto map.

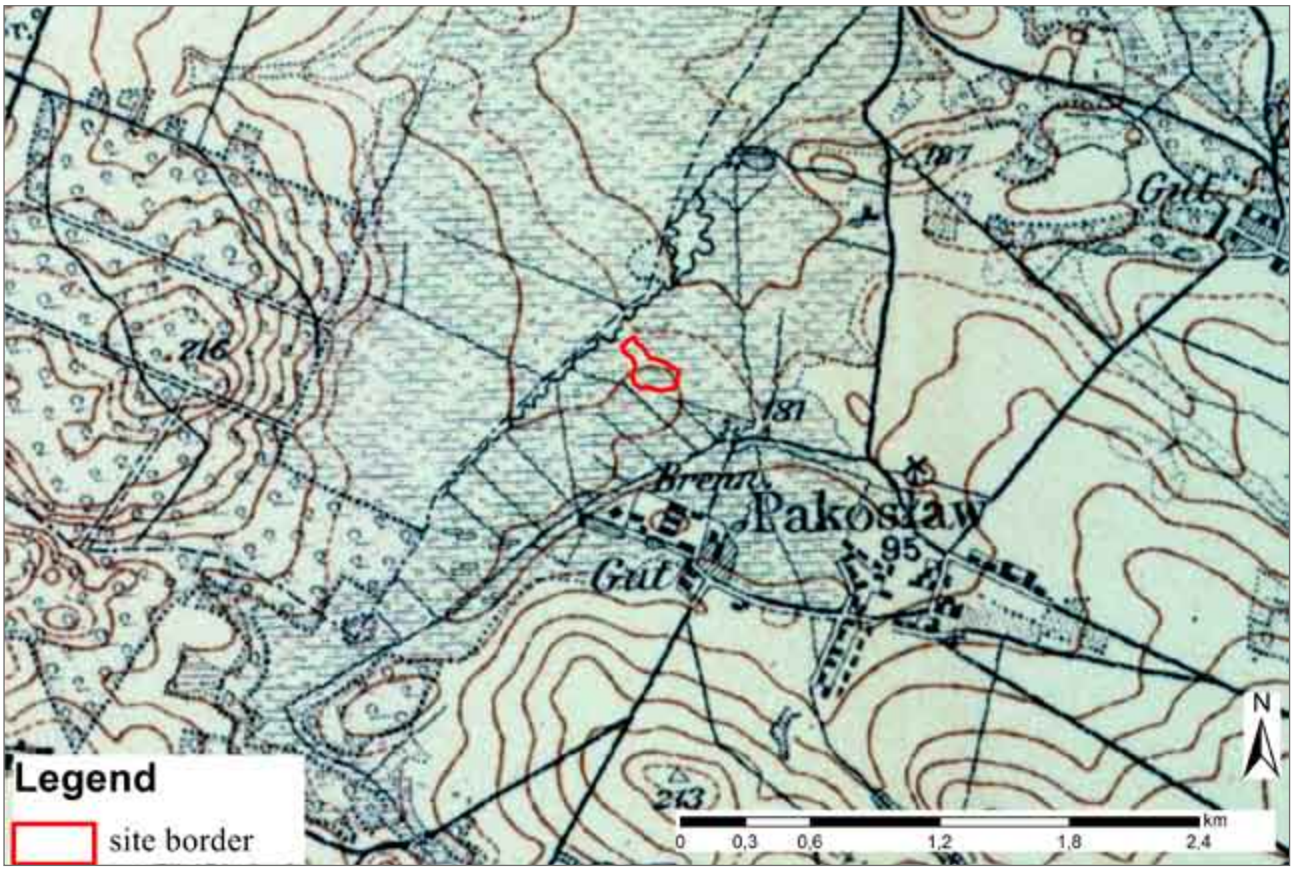


Fig. 46. Fragment of topographic map from 1915.

meadows, and herbs *(Molinietalia)* in various stages of succession. The fen vegetation is dominated by communities with *Carex rostrata*, *Menyanthes trifoliata*, and *Comarum palustre*, as well as *Carex diandra*, and *Thelypteris palustris*. At the water seeps, clumps of *Carex paniculata* dominate. The moss layer is diverse, with many species, formed by brown mosses, mainly *Aulacomnium palustre*, *Calliergonella cuspidata*, *Plagiomnium elatum*, *Bryum pseudotriquetrum*, *Marchantia polymorpha*, and *Tomentypnum nitens* – locally dominant. Among the vegetation of the order *Molinietalia*, the most numerous are the patches of wet meadows with the predominance of *Cirsium rivulare, Ranunculus repens*, *Lychnis flos-cuculi*, *Caltha palustris*, and grasses, turning into herbaceous communities with the dominance of the *Eupatorium canabinum* and *Mentha sp*. On the entire surface area of the habitat, advanced succession of trees and shrubs is observed, mainly *Salix cinerea*, to a lesser extent *S. pentandra*, *Betula pubescens*, and *B. pendula*, as well as *Viburnum opulus*.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2).

The surface of the fen in the period of several years of observation remained dry for most of the year, especially during the growing season. Groundwater level dropped below 50 cm already in late spring, significantly limiting the access of plants to water. As a result of hydrological disturbances on the fen, trees and shrubs expanded and the fen vegetation remained only in the exploited peatland hollows. The activity of beavers in recent years has caused local flooding and increased water content in former peat excavations, which has to a small extent, although positively, affected the state of hydration of the habitat. As a result, reed vegetation developed in the lower part of the area, while alkaline fen species persisted, and the hills are dominated by the vegetation of dry, unused meadows on muck.

Stratigraphic studies confirmed the existence of a thick peat deposit composed of various types of sedge-moss and sedge fen peats. Residues of reed, trees, and shrubs can be seen in some places. The surface of the peat layer decomposes and disappears due to dryness, but the deeper layers (from approx. 1 m depth) are still well preserved.

The natural values of the area were discussed in the studies by Gramsz (1984), Olaczek and Kurzac (1997, 1998), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012).

Fig. 47. Actual vegetation of the Pakosław Fen.

Photo 55. Pakosław fen (photo E. Gutowska).

Photo 56. Pakosław fen after trees and shrubs removal (photo T. Bąkowski).

Photo 57. Waters feeding Pakosław fen are rich in iron (Fe) compounds (photo E. Gutowska).

Natura 2000 site Dolina Zwoleńki PLH140006

The fens in the Zwoleńka Valley are low fens with moss-sedge vegetation, consisting of two patches of habitats of different origins. The Mierziączka Fen is a soligenous fen (with the characteristics of a flow-through fen) and forms within the valley, based on groundwater flowing from underneath its slopes, while the Stara Siekierka site is a topogenic fen, developing as a result of overgrowing of the water reservoir created after peat exploitation. Both sites represent the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The moss fens are located in the middle of the Zwoleńka Valley; they are approx. 5.5 km away from each other, between Kolonia Barycz and Stara Siekierka. Mierziączka is located in the left-bank part of the valley, while Stara Siekierka is located in the right-bank part of the valley (see Fig 48).

The described sites are located in the Vistula River basin, in the Zwoleńka Valley, left tributary of the Vistula, surrounded by forest complexes. In the higher areas, in the vicinity of forests stretching along the open part of the valley, agricultural land dominates. In the immediate vicinity of Stara Siekierka, there is also a complex of former peat excavations filled with water that is drained by a small watercourse to the southeast, to Zwoleńka. A drainage ditch runs north of the Mierziączka site, which takes off the water in a southeastern direction.

The fens in the Zwoleńka Valley were once used as meadows and pastures, but this use ended decades ago. Within the boundaries of Stara Siekierka, non-industrial peat extraction was also carried out; the extracted peat was used as fuel in households. Peat extraction took place over large areas throughout the valley, as evidenced by the numerous exploited peatlands occurring along almost the entire length of the valley.

Fig. 48. Locations of the fens in the Zwoleńka Valley against the background of an orthophoto map.

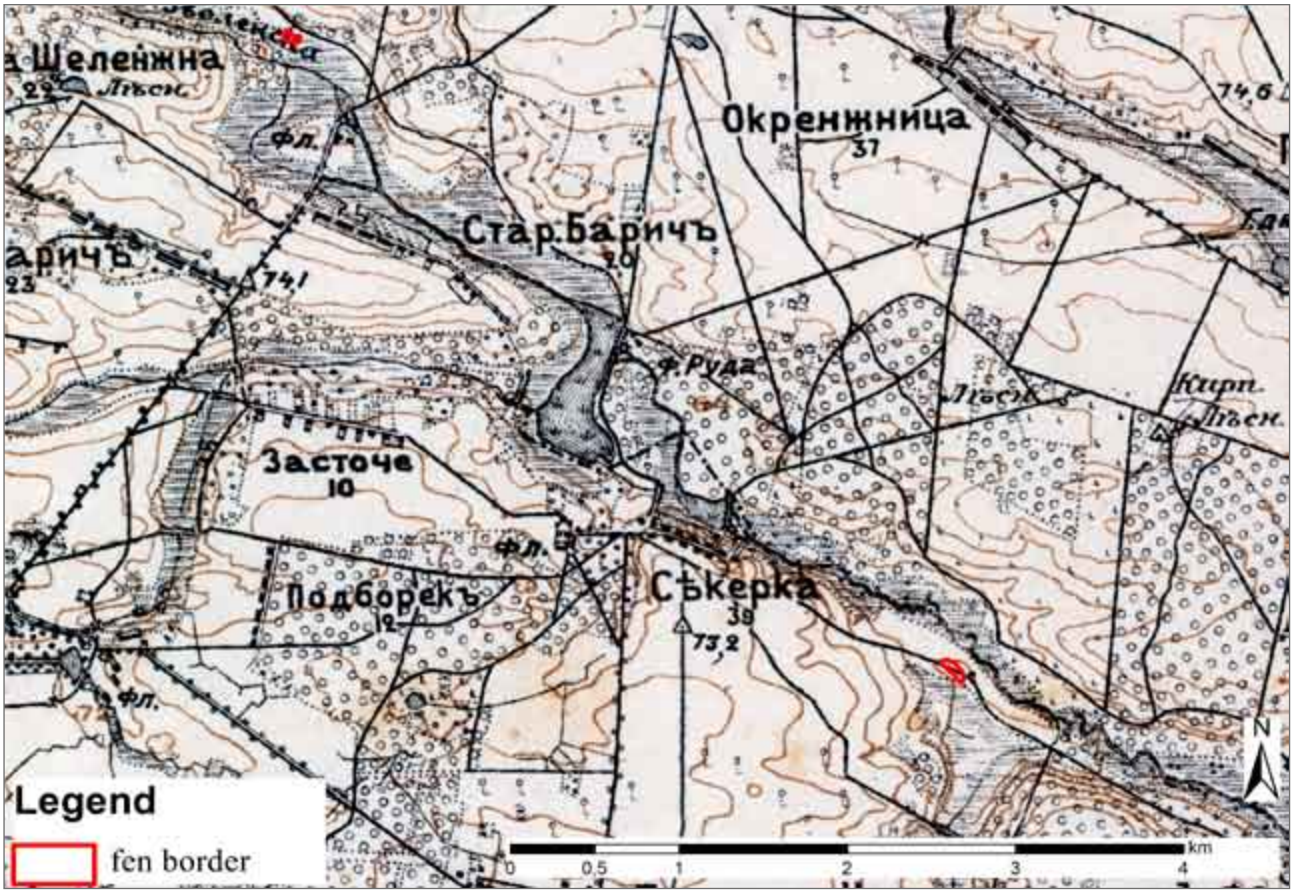


Fig. 49. Fragment of a historical topographic map from 1915.

The existing moss fen patches in the Zwoleńka Valley are a remnant of the extensive alkaline fens that used to exist in the area. The moss fen vegetation is a relic and a transitional form between the mountain and highland fens and the boreal zone vegetation, which is why these fens are very important for the preservation of biodiversity. In the case of Stara Siekierka, these are strongly hydrated patches of moss-sedge and moss fen vegetation that overgrow the former water reservoir and which are characterized by a significant share of rushes and water species. On the other hand, Mierziączka is a small area of moss vegetation, subject to strong expansion of trees and shrubs, with a greater share of meadow species. Rare and endangered species can be found here, such as the *Liparis loeselii* or *Carex chordorrhiza*, which has been confirmed only on very few individual sites in southern Poland. In addition, the following species were found: *Epipactis palustris*, *Dactylorhiza incarnata*, *D. majalis*, *Carex dioica*, *Drosera rotundifolia*, *Ranunculus lingua* and mosses – *Limprichtia cossonii* and *L. revolvens*, *Bryum neodamense*, *Campylium stellatum*, *Fissidens adianthoides*, peat mosses – *Sphagnum teres*, *Sph. fuscum* and *Sph. magellanicum*, as well as *Pseudocalliergon trifarium* and *Scorpidium scorpioides* which are absent from southern and central Poland, apart from the Zwoleńka Valley.

The vegetation of the fens is diversified - in the case of the Mierziączka Fen it is made up of *Caricion davallianae* (*Caricetum paniceo-lepidocarpae* association), built mainly of *Carex panicea*, *C. rostrata*, *C. flava*, and *Menyanthes trifoliata* with the occurrence of *Equisetum fluviatile*, *Eriophorum latifolium*, and *Mentha x verticillata*. The moss layer is well developed, quite species-rich with the predominance of *Calliergonella cuspidata*, *Limprichtia cossonii*, *Plagiomnium* spp., and some occurrence of *Campylium stellatum*, *Bryum pseudotriquetrum*, and *Fissidens adianthoides*. Throughout the area, the penetration of the common reed *Phragmites australis* and the succession of trees and shrubs, mainly *Frangula alnus* and *Alnus glutinosa,* are clearly visible, with some *Salix cinerea*, *S. rosmarinifolia*, *Viburnum opulus*, *Pinus sylvestris*, and *Juniperus communis*, with the dwarf forms of pine and juniper being typical for this type of fens. The open patch of the habitat is surrounded by initial forest communities with the dominance of *Alnus glutinosa*, with groundcover of *Phragmites australis*, *Eupatorium cannabinum*, *Urtica dioica*, *Lysimachia vulgaris*, *Peucedanum palustre, Caltha palustris*, *Humulus lupulus and Plagiomnium elatum* in the moss layer, as well as scant presence of typical fen species (*Menyanthes trifoliata*, *Carex echinata*, *Limprichtia cossonii*, and *Fissidens adianthoides*).

The vegetation of the fen has been adversely affected by hydrological changes caused by drainage of the area and abandonment of agricultural use. Currently, only a part of the fen is open and its area is shrinking for the growth of forest communities. The maintenance and improvement of the habitat surface requires the improvement of water conditions and the reduction of secondary succession and expansion of reed, which through shading deteriorates the lighting conditions of the fen.

The vegetation of Stara Siekierka has developed mainly in the former peat extraction areas and, depending on the stage of succession, consists of patches of different plant composition. Initial moss fen communities with a poor herb layer can be distinguished – *Eleocharis quinqueflora*, *Triglochin palustris*, *Chara vulgaris, Ch. delicatula*, and some presence of rush species (*Typha latifolia*, *Carex elata, Thelypteris palustris*), as well as the moss layer composed of brown mosses immersed in water – *Scorpidium scorpioides*, *Pseudocalliergon trifarium* and *Limprichtia revolvens* with clear signs of tufa precipitation. Most common are the moss forms of the *Thelypteridi-Phragmitetum* association with the dominance of *Thelypteris palustris* and with the participation of *Comarum palustre*, *Menyanthes trifoliata*, *Typha latifolia*, and sedges: *Carex lasiocarpa* (sometimes numerous), *C. elata*, *C. acutiformis*, and *C. appropinquata.* The moss layer is of a mosaic character; apart from patches inhabited by species preferring immersion in water, there are also moss fragments with the dominance of peat mosses (mainly the *Sphagnum teres*, much less frequently, in the extreme parts of the fen or in slightly elevated places with some *Sph. squarosum*, *Sph. fuscum*, and *Sph. magellanicum*) as well as patches with the dominance of brown mosses, mostly dense turf of *Limprichtia cossonii* with *Campylium stellatum*, *Bryum pseudotriquetrum*, *Aulacomnium palustre*, *Calliergon giganteum* and others. Deeper exploited peatland areas are occupied by the water communities of the *Potamion* association, while in the edge areas of the fen, alder and willow thickets are penetrating the site. The fen is to a large extent overgrown with trees and shrubs, mainly *Alnus glutinosa*, and *Salix* spp. willows as well as *Frangula alnus*. *Pinus sylvestris* is a rare occurrence. Due to the lack of extensive agricultural use (mowing), the fen is subject to the strong expansion of trees and shrubs.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (see chapter 1.2). Furthermore, hydrological monitoring was carried out here by means of an automatic recorder, together with phytosociological monitoring.

In the period of several years of observation of the Mierziączka Fen, it remained stably hydrated (see Figure below), and only in the summer was a decrease in the groundwater level observed. The water level was near the ground surface – in summer fluctuating even up to 40 cm below the ground surface. Lack of flooding and constant dampness for most of the year is conducive to the persistence of moss vegetation, but the declines during the growing season limit the availability of water to typical fen species, enabling the development of trees whose roots reach much deeper compared to the herbaceous plants. For this reason, the removal of trees and shrubs as well as extensive mowing seem particularly important, but landowners have not given their consent. Significant fluctuations of the water table on the fen can be explained by climatic changes and altered hydrological cycle – in recent years the rainfall was irregular and periods of drought were followed by torrential rains. Within a relatively short period of time, the water level dropped quickly, only to increase significantly after the downpours.

Stara Siekierka was, in turn, highly hydrated for most of the project duration. The groundwater level depends to a large extent on the level of water in the surrounding area, which is not drained at present, favoring stability and continuity of the hydrological conditions. In the patches on the edges of the fen, which did not develop in the exploited peatlands, significant fluctuations were observed during the vegetation season – similar to the Mierziączka Fen.

Stratigraphic studies confirmed the existence of well-preserved peat deposits built by various types of moss, and sedge-moss peats, underlined with calcareous gyttia. The peat profile for the Mierziączka patch is presented below, and it confirms the long-term development of the fen. For technical reasons, drilling was made only up to a depth of 2 m, but the peat deposit is much thicker. Over the years mire have developed in the form of sedge or sedge-moss rushes with a relatively constant share of reed. The period of flooding of the fen area and formation of a water reservoir in this place is noticeable, which is

Fig. 50. Actual vegetation of the Mierziączka Fen.

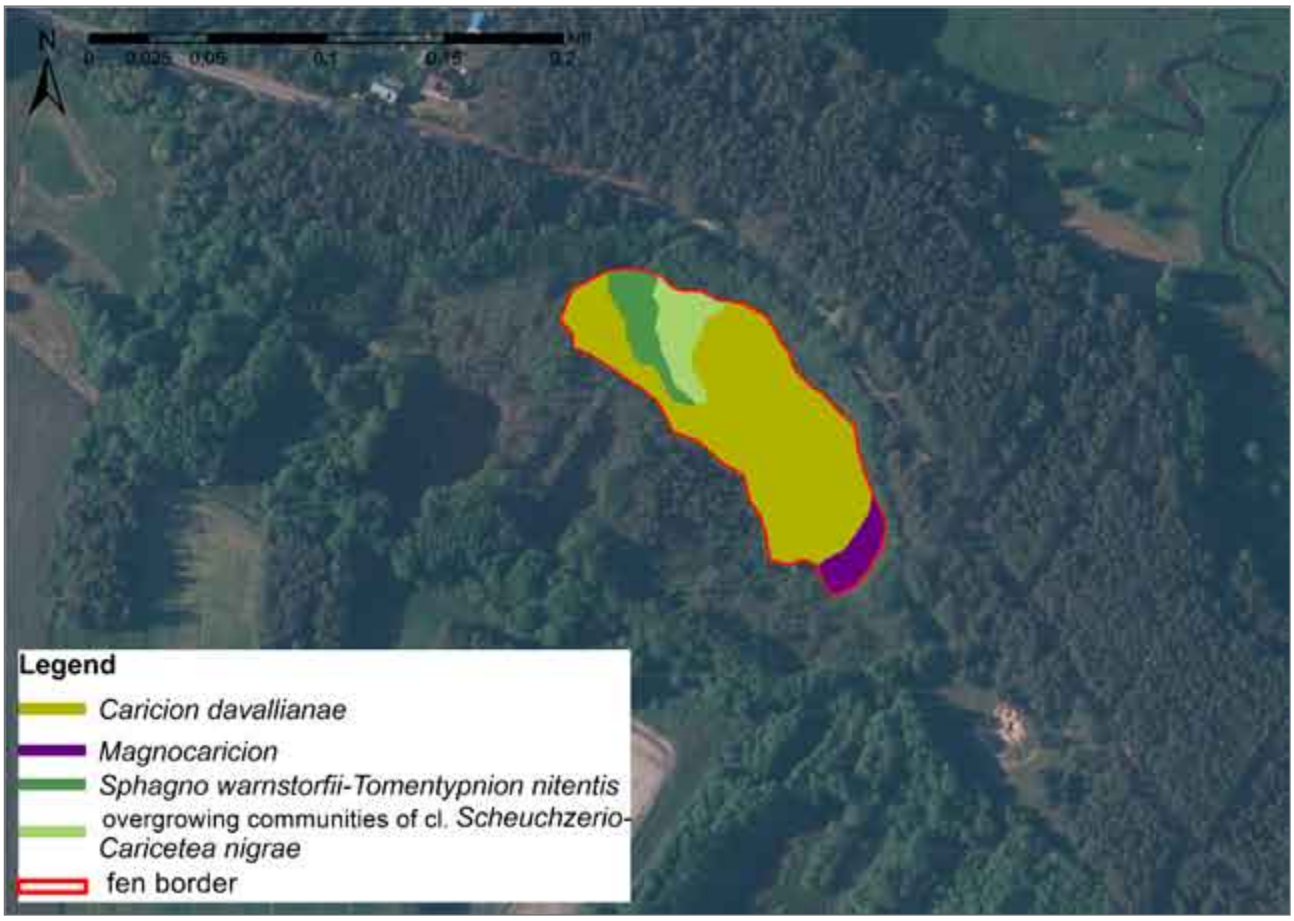


Fig. 51. Actual vegetation of the Stara Siekierka Fen.

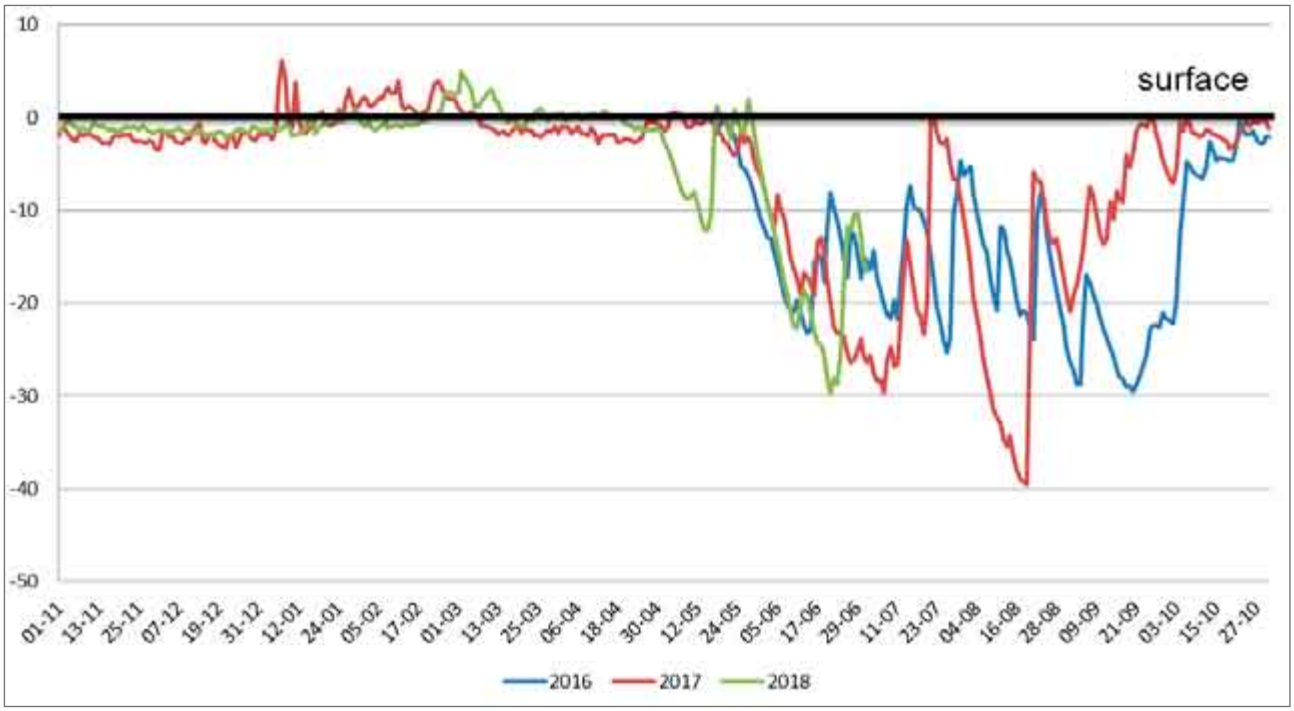


Fig. 52. Changes of groundwater table on the Mierziączka Fen in the hydrological years 2016 – 2018.

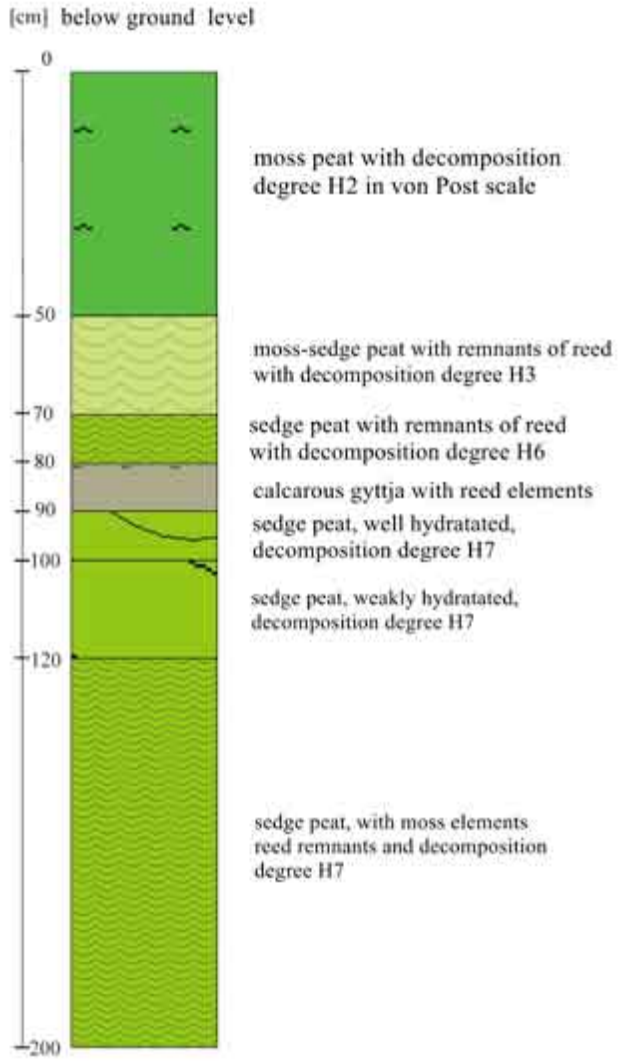


Fig. 53. Peat profile of the Mierziączka Fen.

manifested by the presence of gyttia in the analyzed sediments. After the overgrowth of the reservoir, the fen has further developed to the present day, when most of its area has been occupied by forest communities.

The natural values of the area were mentioned only in the studies by Jarzombkowski and Pawlikowski (2012), Jarzombkowski and Kozub (2011), and Wołejko et al. (2012).

Photo 58. Mierziączka fen (photo E. Gutowska).

Photo 59. Floating mat of *Sphagnum* on Stara Siekierka (photo K. Kotowska).

Photo 60. Stara Siekierka fen (photo K. Kotowska).

The fens of the Siniocha valley are two patches of soligenous low fens with moss-sedge and meadow vegetation related to moss fens, developed in the source section of the river. All of them represent the habitat subtype 7230-2: alkaline fens of southern Poland (excluding mountains) and central Poland.

The sites are located south and south-west of the village of Miączyn (see Fig. 54).

The fens are located in the upper part of the Siniocha Valley (the left-bank tributary of the Huczwa River then discharged into the Bug) and are significantly influenced by groundwater. The area is heavily drained – within each of the patches, or in their immediate vicinity, there is a network of one-way drainage ditches. Due to the significant transformation of the water conditions in the valley, moss fen vegetation is currently only maintained within the exploited peatlands or on lower surfaces; the rest of the area is dominated by meadow communities, where the peat–forming process is no longer taking place. Patches of moss fen vegetation lie in the area intensively used for agriculture, surrounded by grasslands and cultivated fields.

The fens of the Siniocha Valley were used in the past both as hay and pasture meadows and as a source of peat for fuel. For farming purposes, the valley has been heavily drained in the past – it was cut down by a network of one-way drainage ditches, and the river bed itself has been largely regulated. Currently, the wet parts of the valley (including the best-preserved fen fragments) are not used and the neighboring less hydrated post-fen meadows are still mown for the most part. The area is characterized by relatively intensive agricultural management – in the higher areas the fields are largely cultivated.

The existing moss fen patches are sites of rare and valuable species related to alkaline fens such as *C. davalliana*, *C. hostiana*, *Schoenus ferrugineus*, *Drosera anglica*, *Pinguicula vulgaris* ssp. *bicolor*, *Tofieldia calyculata*, *Epipactis palustris*, and *Listera ovata*. The moss layer contains *Campylium stellatum*, including *Campylium stellatum* var. *protensum*, *Limprichtia cossonii* and *L. revolvens*, *Fissidens adianthoides*, *Bryum pseudotriquetrum*, *Warnstorfia exannulata*, and *Palustriella* sp.

Fig. 54. Location of the fens of the Siniocha Valley against the background of an orthophoto map.

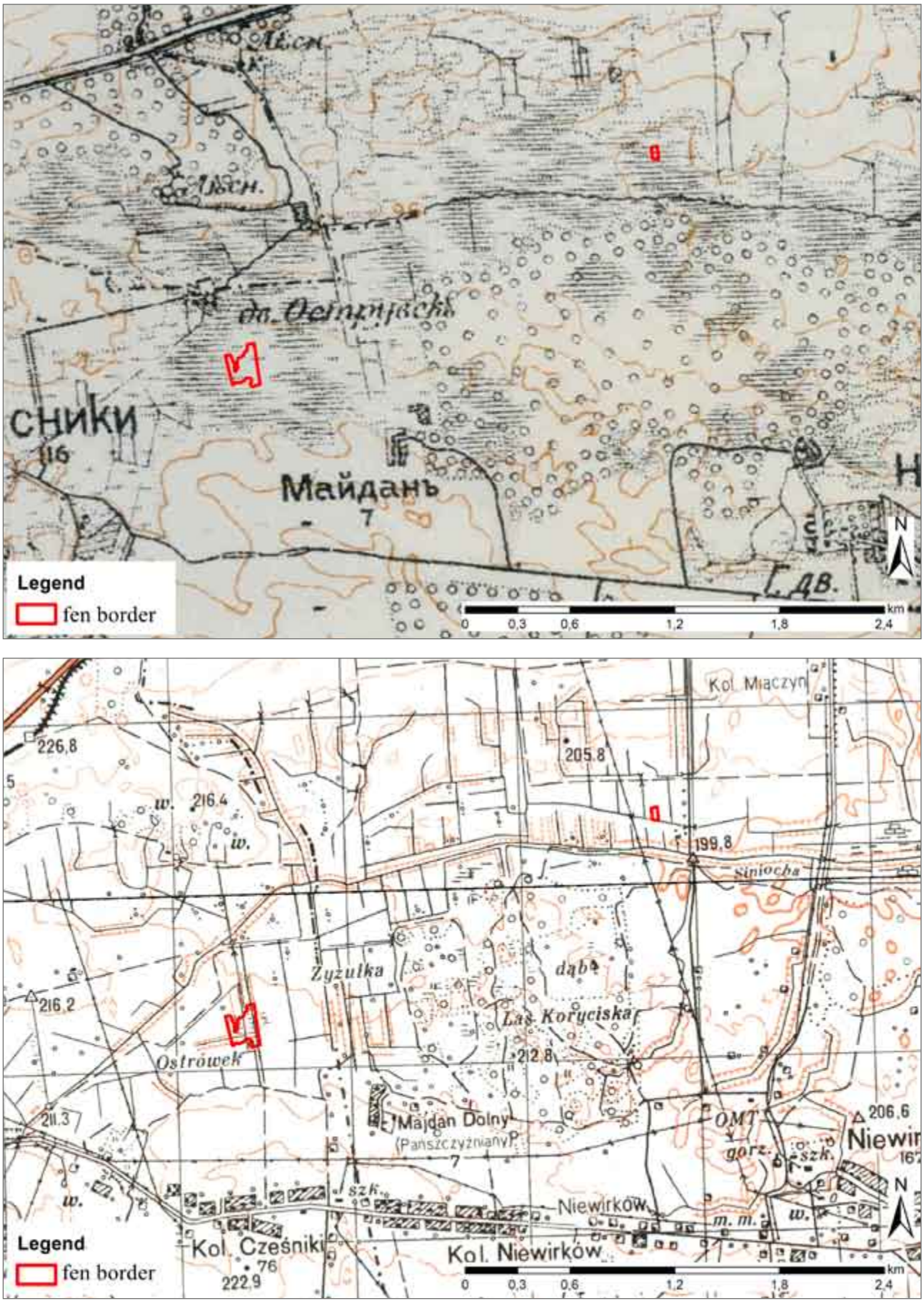


Fig. 55. A fragment of the historical topographic map from 1918 and a contemporary map showing the changes taking place on the fen in Sieniocha valley. Over 100 years, one can see both the significant development of settlement and the drainage systems associated with this process.

The vegetation of the meadow patches is not homogeneous and has a transitional character between the communities of the *Caricion davallianae*, which are mainly concentrated in the exploited peatland hollows, and the meadows of the order *Molinietalia*. The herbaceous layer is formed by *Molinia caerulea, C. panicea*, *C. lepidocarpa*, *C. davalliana*, *C. flava*, *Carex hostiana*, *Potentilla erecta*, *Succisa pratensis*, *Sanguisorba officinalis*, *Salix rosmarinifolia*, *Cirsium rivulare*, *C. palustre*, *C. canum, Eupatorium cannabinum*, and less common – *Carex appropinquata*, *Lysimachia vulgaris*, and *Schoenus ferrugineus.* The moss layer develops mainly in depressions and is formed by brown mosses – *Campylium stellatum*, *C. stellatum* var. *protensum*, *Calliergonella cuspidata*, *Plagiomnium ellipticum*, *Limprichtia cossonii*, *L. revolvens*, *Fissidens adianthoides*, *Bryum pseudotriquetrum*, *Warnstorfia exannulata*, and *Palustriella* sp. Within the meadow vegetation group, one can observe the expansion of *Phragmites australis*, *Molinia caerulea*, and *Eupatorium cannabinum* as well as willow thickets *Salix* sp., and locally – *Rubus idaeus*. Intensive drainage of the habitat also results in the penetration of wet meadow species, mainly *Cirsium* sp. At the turn of 2015 and 2016, one of the moss fen patches (Kolonia Niewirków) was destroyed as a result of fire. The herbaceous layer is poorly regenerated and mainly expansive species (*Phragmites australis*, *Molinia caerulea*, and *Eupatorium cannabinum*) and meadow species have grown back. The moss layer has been preserved only in the most humid areas (former exploited peatland). No previously occurring rare species were observed, such as *Drosera anglica* or *Pinguicula vulgaris* ssp. *bicolor.* In previous years, attempts were also made to make the spring near the border of the patch productive – a small pond was dug out, but the works were abandoned due to difficulties caused by the inaccessibility of the terrain. Within the second patch (Miączyn) unfavorable changes in the vegetation structure due to significant soil drying and unstable water conditions of the habitats are clearly visible. This is reflected in the disappearance of the moss layer, the transition to a meadow habitat, the expansion of *Phragmites australis* and *Molinia caerulea*, and the low proportion of species characteristic of alkaline fens.

Fig. 56. Actual vegetation of the Kolonia Niewirków Fen.

The fens in the Górna Siniocha valley have different hydration levels, which is reflected in the significant drop in the groundwater table during the growing season. Due to the extensive one-way drainage system and strong drainage of the area, after the winter the melting waters are quickly drained away, which limits the soil retention and lowers the water table. The diversity of land ownership and the lack of appropriate legal regulations make water management in the area significantly more difficult.

Stratigraphic studies confirmed the presence of relatively well-preserved peat deposits built by various types of moss-sedge and sedge peat. The nature of the peat deposits is similar to those described for the Sieniocha Valley and indicates two most important stages of its development. Here, too, the relatively high degree of peat decomposition indicates that the top layers of the fen are drying out and that peat-forming processes are likely to be limited nowadays.

The natural values of the area were mentioned in the studies by Wołejko et al. (2012) – in addition, the monitoring of natural habitats 7230 and 6410 was carried out, as well as the monitoring of the marsh angelica Ostericum palustre as part of the National Environmental Monitoring.

Fig. 57. Actual vegetation of the Miączyn Fen.

Photo 61. „Kolonia Niewirków" fen (photo K. Kotowska).

Photo 62. Draining ditch on the verge of „Kolonia Niewirków" fen (photo K. Kotowska).

Photo 63. „Miączyn" fen (photo K. Kotowska).

Natura 2000 site Dolina Sieniochy PLH060025

The fens of the Sieniocha Valley are of a soligenous nature, but due to the significant transformation of water conditions in the valley, the moss fen vegetation or the vegetation related to it is currently maintained only within the exploited peatlands or in the hollows of the terrain. The remaining area is dominated by meadow communities where the peat-forming process is no longer taking place. They represent the habitat subtype 7230-2: alkaline fens of southern Poland (excluding mountains) and central Poland.

The sites are located between Perespa in the east and Antoniówka in the west (see Fig. 58).

The moss fens are located in the upper and middle part of the Sieniocha Valley (the left-bank tributary of the Huczwa River then discharged into the Bug) and are significantly influenced by groundwater. In the immediate vicinity of each of the sites there is a network of one-way drainage ditches, and the Sieniocha River itself has the character of a regulated canal. The area is heavily drained and relatively intensively used for agriculture. All patches of the habitat lie partly on agricultural land (mostly grassland and to a lesser extent on arable land) and partly also on abandoned meadows, pastures, and former peat excavations overgrown with shrubs. The fens of the Sieniocha Valley, apart from being used as hay production meadows and pastures, were also treated as a source of fire peat.

The alkaline fens of the Sieniocha Valley are extremely valuable habitats for many rare and protected species, both nationally and in the scale of Europe. The origins of the area and the extensive use made it possible to develop characteristic florist-rich fen and meadow plant communities with rare species composition. The mosaic character of the area's vegetation is made up of fens with a low, loose groundcover and a rich moss layer formed within the former shallow peat extraction areas, water and rushes plant communities associated with deeper peat excavations filled with water, and extensive patches of vegetation of variable-hydration and wet meadows with a diversified proportion of species characteristic of the fens.

Fig. 58. Locations of the fens in the Sieniocha Valley against the background of an orthophoto map.

A significant share of the flora of fens of the Sieniocha Valley are rare, endangered, and protected species. Among them are orchids: *Liparis loeselii*, *Dactylorhiza incarnata* and its variety *Dactylorhiza incarnata* ssp. *ochroleuca*, *Epipactis palustris*, *Gymnadenia conopsea* ssp. *densiflora*, as well as sedges – *Carex davalliana*, *C. hostiana*, *C. umbrosa*, *Schoenus ferrugineus*, and *Schoenus nigricans* as well as *Eleocharis quinqueflora*. There are also many other species – *Pinguicula vulgaris (P. vulgaris* ssp. *vulgaris*, and *P. vulgaris* ssp. *bicolor)*, *Tofieldia calyculata*, *Pedicularis sceptrum-carolinum*, and the very rare (only a handful of localities in Poland) *Swertia perennis*, whose population on the spring dome near Śniatycze is estimated to be several thousand individuals. Also noteworthy are the species associated with meadow habitats, such as *Phyteuma orbiculare*, *Dianthus superbus*, *Trollius europaeus*, *Veratrum lobelianum*, *Gentianella amarella, Utricularia vulgaris*, *U. minor*, *Sparganium minimum*, *Cladium mariscus*, and the *Chara* spp. Of the rare shrub species, *Salix lapponum* has been reported. Among the brown mosses, there is the abundant *Limprichtia cossonii*, *Scorpidium scorpioides*, and less frequently *Limprichtia revolvens*, *Bryum pseudotriquetrum*, and *Pseudocalliergon lycopodioides*.

The described fens are the remnants of the extensive fen complexes that developed in the valley of the River Sieniocha, once occupying large areas but currently limited to relatively small beds concentrated in the upper, spring, and middle part of the river. As a result of strong hydrological transformations associated with agricultural development and peat extraction, most of the fens originally found in this area have disappeared. They were partially replaced by grassland and arable land; in the part of the area where farming ceased, rushes, forests, and willow thickets were formed as a result of secondary succession. Moss fens have been preserved in places with higher water content and, in the exploited peatland, where the ground level has been significantly lowered as a result of the extraction of peat deposits. Currently, the fens of the Sieniocha Valley are characterized by a high degree of fragmentation, and their vegetation is a mosaic of intermingling meadow, moss, and rushes communities. The unusual physiognomy of the fens in this area was also influenced by the specific management method – burning of dead organic matter accumulated as a result of extensive use of land of lower agricultural value. Spring fires had little effect on habitat fertility and limited the development of shrub species and resulted in grass renewal,

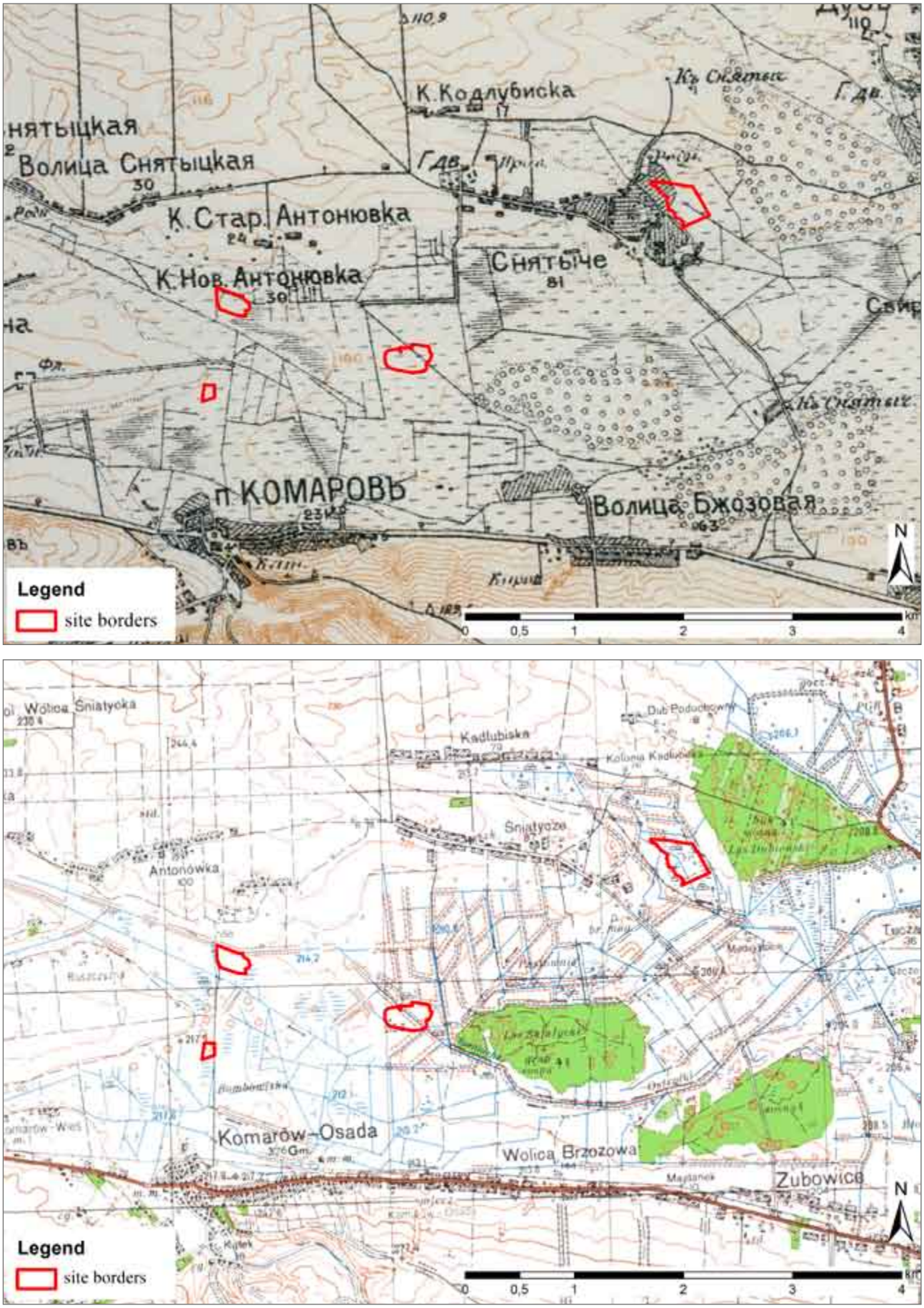


Fig. 59. A fragment of the historical topographic map from 1918 and a contemporary map showing the changes taking place on selected fens in Sieniocha Valley. Over the course of 100 years, a significant development of the drainage system and the breeding ponds established in the area have been observed.

which was of feed value only at a young stage (mainly *Molinia caerulea*, which was predominant there). As a result of the fires, in humid areas a low sedge, loose groundcover with open soil patches was formed, which was inhabited by fen-specific species.

The vegetation of the fens is not homogeneous, with the predominance of the patches of variable-hydration meadows with the predominance of *Molinia caerulea* and the occurrence of *Succisa pratensis* and *Sanguisorba officinalis*, locally referring to alkaline fens. The hollows remaining after peat extraction are occupied by the communities of *Caricion davallianae* alliance, depending on the patch with different proportions of sedges – *Carex panicea*, *C. davalliana*, *C. lasiocarpa,* and less frequently *C. lepidocarpa* and *C. hostiana*, *Eriophorum latifolium* and *E. angustifolium, Schoenus ferrugineus, Potentilla erecta*, *Salix rosmarinifolia,* and meadow species of the order *Molinietalia*. In the more heavily hydrated patches, *Eleocharis uniglumis* is found, and the deeper, small water-filled exploited peatland hollows contain loose *Phragmites australis*, *Nymphaea alba, Utricularia minor*, and *Chara* spp. There are some sedges – *Carex rostrata*, *C. paniculata*, *Typha latifolia, Schoenoplectus tabernaemontani*, and *Cladium mariscus*. Meadow and herbaceous species such as *Cirsium palustre* and *C. rivulare*, *Crepis paludosa, Senecio congestus*, *Succisa pratensis*, *Sanguisorba officinalis*, *Galium boreale* and *G. verum*, and *Eupatorium cannabinum Filipendula ulmaria* are increasing in proportion in the dried areas. The moss layer is loose, built by *Campylium stellatum*, *Bryum pseudotriquetrum*, *Plagiomnium elatum*, *Pseudocalliergon lycopodioides*, *Limprichtia revolvens*, *L. cossonii*, *Calliergon giganteum*, *Calliergonella cuspidata*, and *Scorpidium scorpioides*. Occasionally, the habitat is penetrated by *Phragmites australis* and *Molinia caerulea*, as well as *Eupatorium canabinum*. Fresh meadow and sward species (e.g., *Phyteuma orbiculare*, *Campanula glomerata*, *Salvia pratensis*, *Primula* sp., *Polygala* sp., and others) are present in the higher elevated parts of the area.

It is worth mentioning that in the area there is a cupola fen - an unique site in Poland and Europe, the value of which, apart from flora and moss vegetation, consists of, among others, accumulated peat resources and the way it works. The vegetation of this patch is shown in Fig. 62, and in addition to rare phytocoenoses from *Caricion davallianae* alliance also includes patches with *Cladium mariscus* and meadows with numerous references to mires. The presence of fen species is directly related to the way of feeding the ecosystem, in which peripheral waters allowed the formation of the peat cupola. Unfortunately, due to human activities, such systems now account for less than 1% of all peatland resources in Poland. In the history of development of the Kopuła Śniatycze fen, four main stages have been distinguished, based on detailed peat studies (see Fig. 60). Detailed research within this site has been conducted in the last few years, and the results of this work have been published - see Dobrowolski et al. (2016). A full record of sedimentary sequences with an excellent degree of peat conservation allows researches not only on a local scale, but also make them compatible with other research sites in Europe, including the sequences contained in the cores collected from Greenland. This enables the reconstruction of accurate paleoclimatic reconstructions conditions in the last 10,000 years.

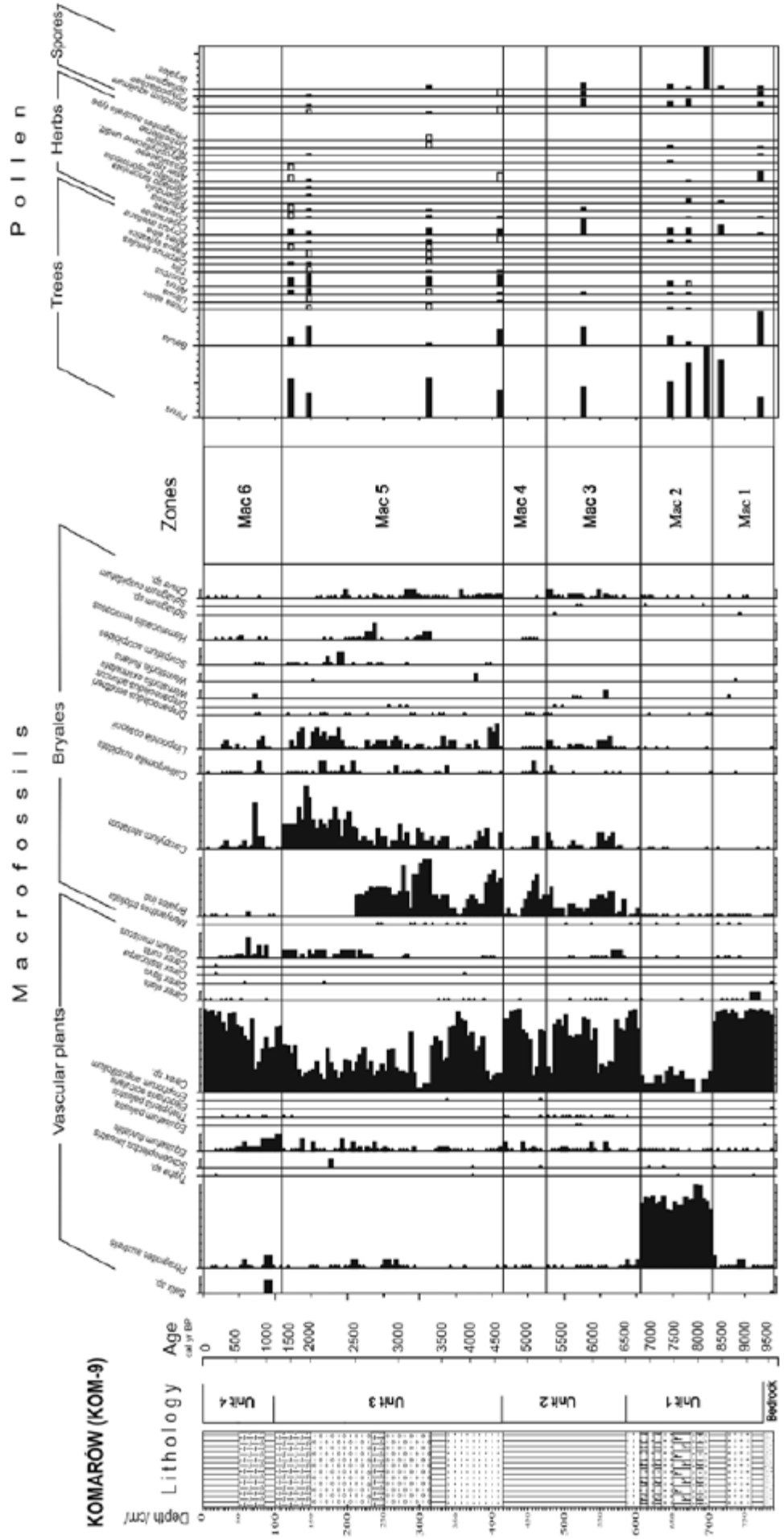


Fig. 60. Results of detailed research on Kopuła Śniatycze/Komarów fen (Dobrowolski et al. 2016).

The observations indicate unfavorable processes taking place in the vegetation of the Sienocha Valley, resulting from secondary succession and expansion of undesirable species caused by anthropogenic factors - intensive drying of the area through extensive one-way irrigation infrastructure, as well as occasional use, largely limited to burning dry patches, which deepens the habitat degradation.

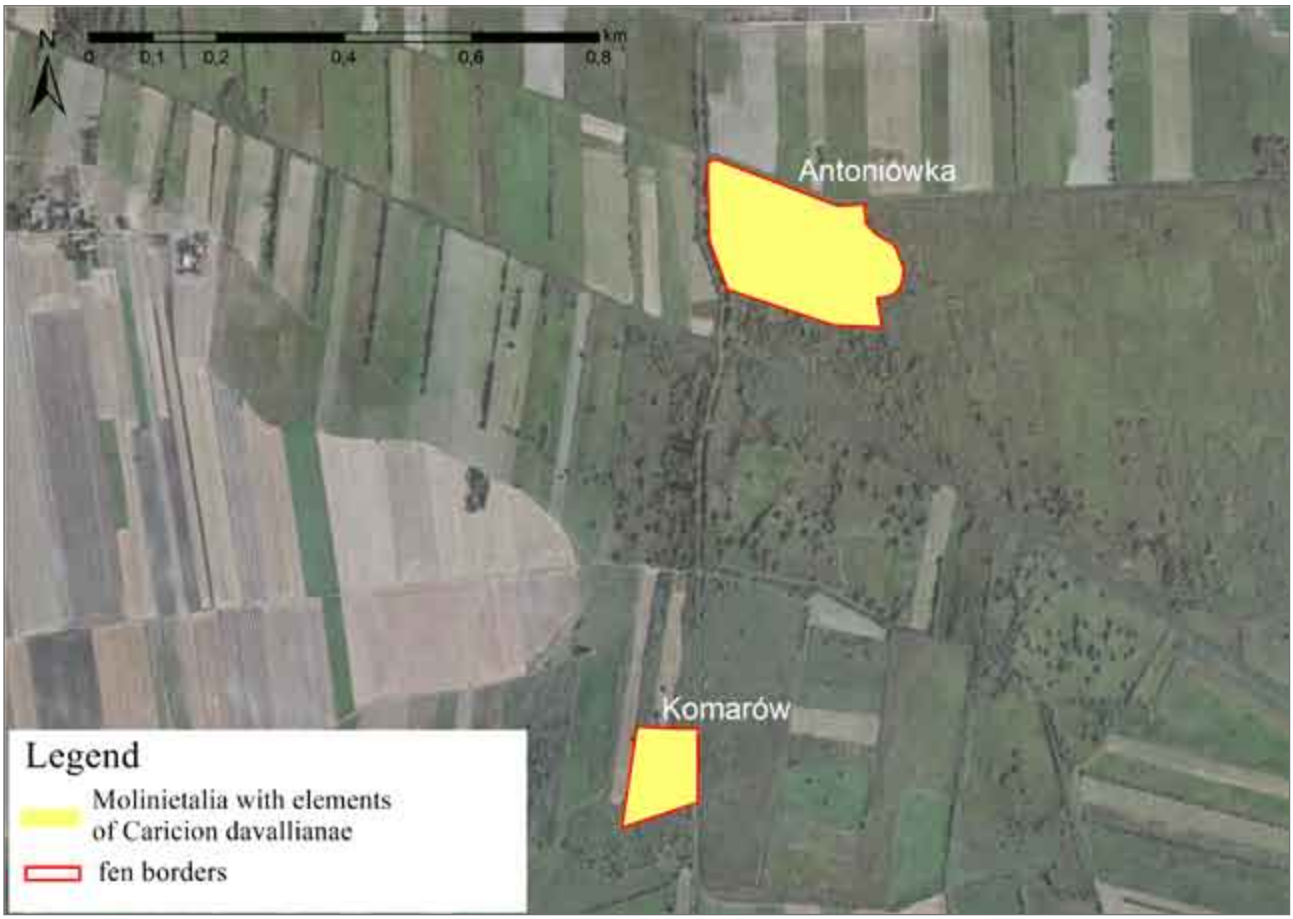


Fig. 61. Actual vegetation of the Antoniówka and Komarów Fens.

Photo 64. Aerial view on fen on Kopuła Śniatycze (photo R. Stańko).

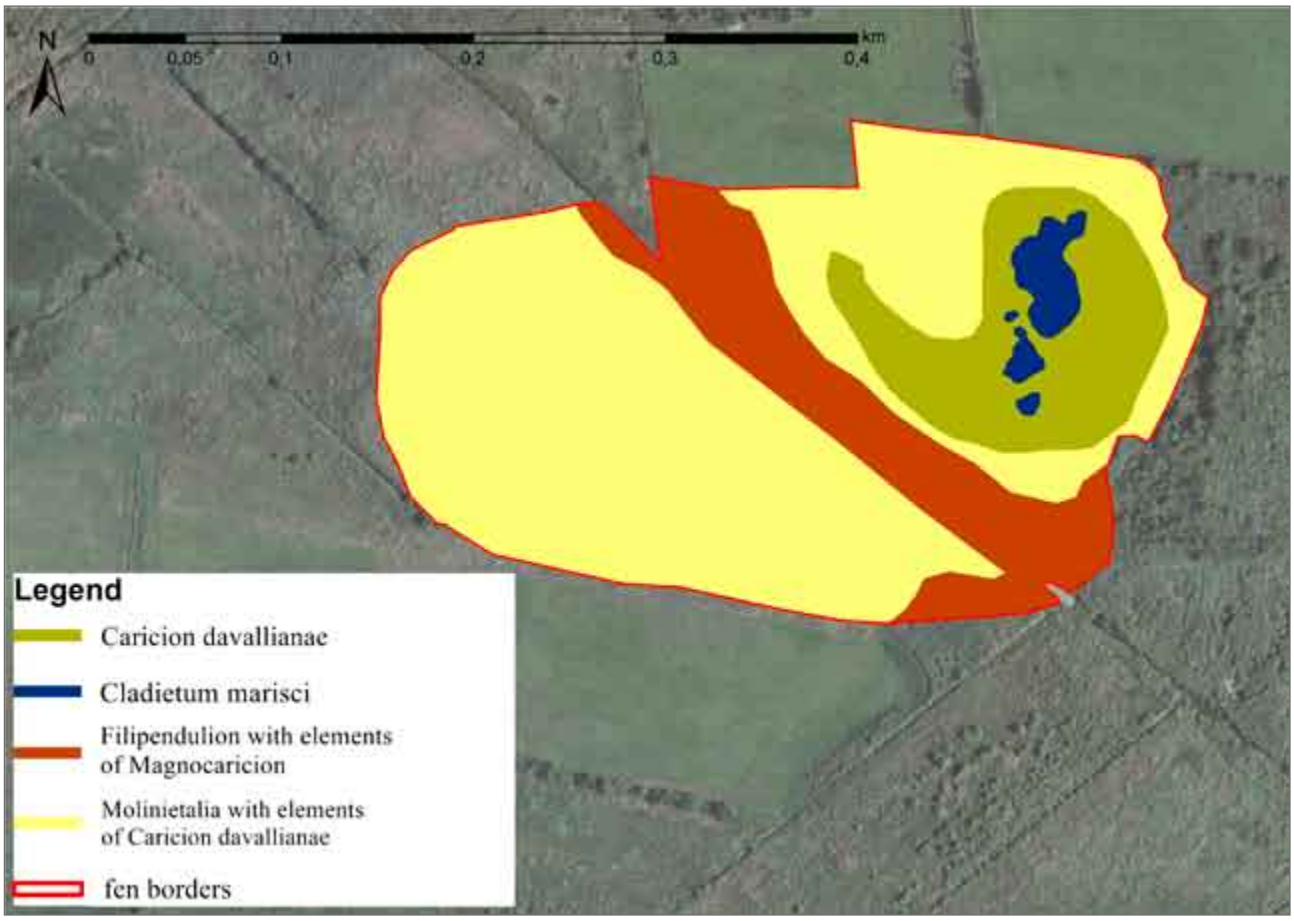


Fig. 62. Actual vegetation of the Kopuła Śniatycze Fen.

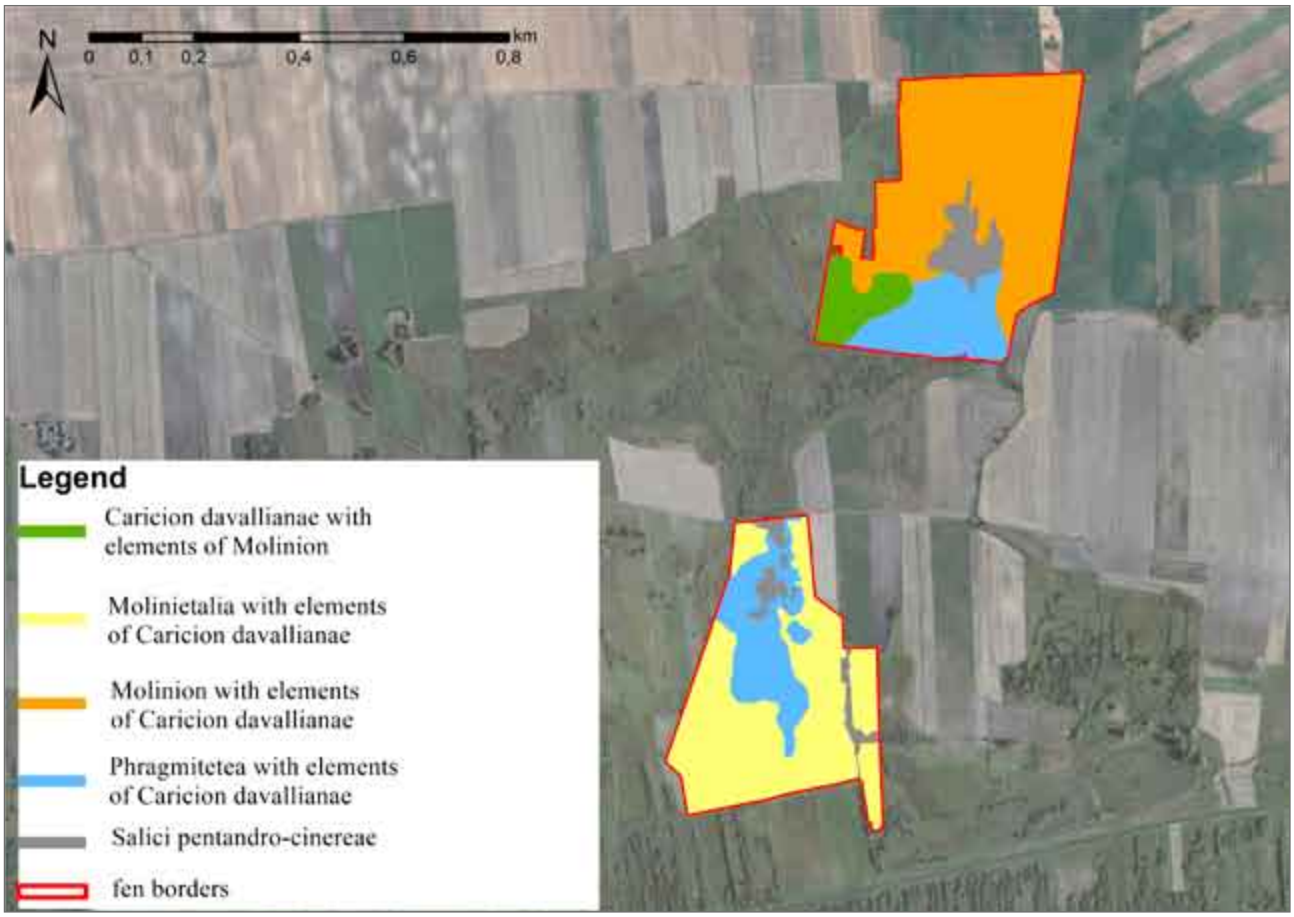


Fig. 63. Actual vegetation of the Rudka and Perespa Fens.

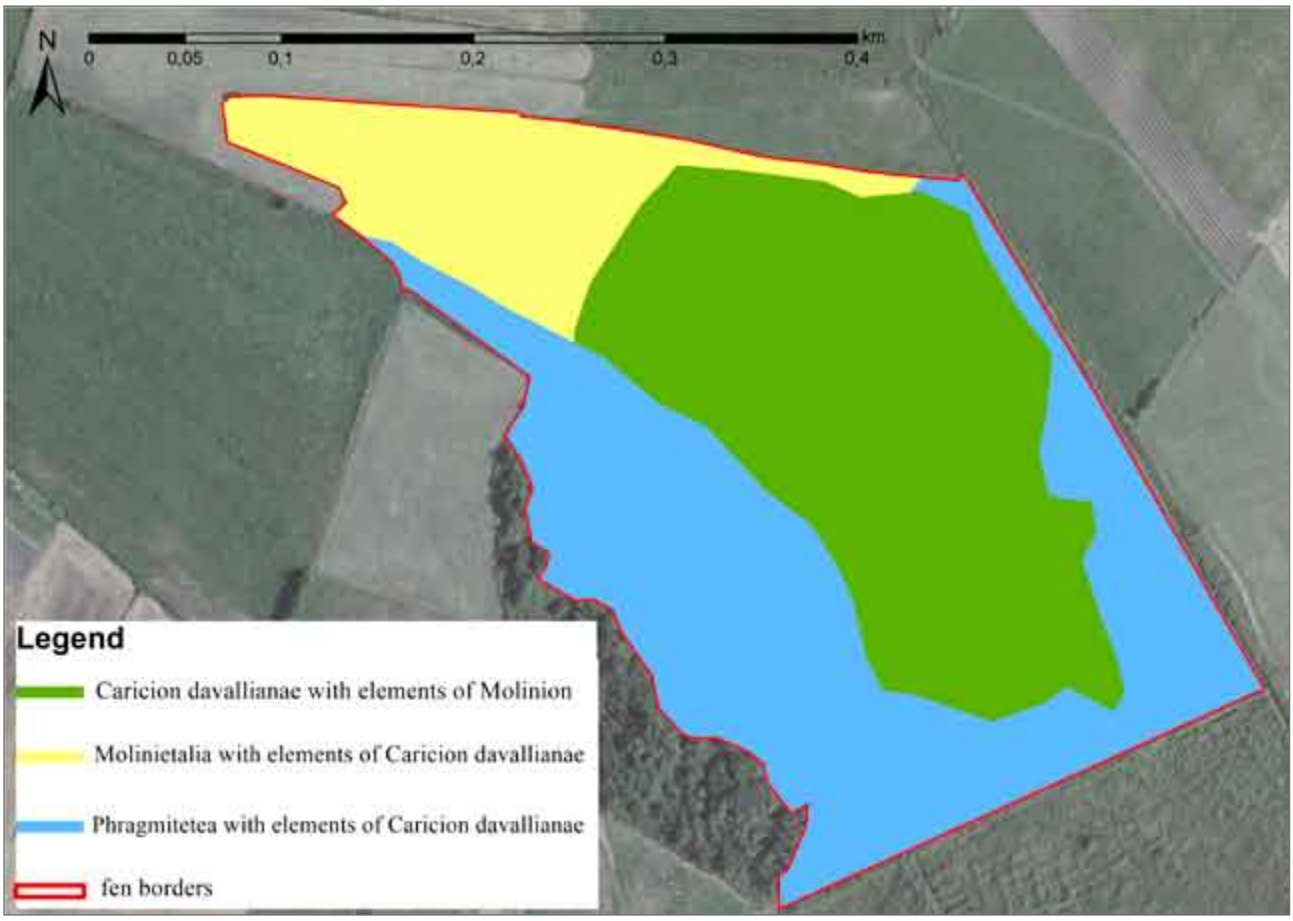


Fig. 64. Actual vegetation of the Śniatycze-Swaryczów Fen.

Photo 65. Aerial view on Perespa fen (photo R. Stańko).

Photo 66. Aerial view on Śniatycze Swaryczów (photo R. Stańko).

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen. At present, only activities at the Perespa site have been carried out to improve water conditions, i.e. "biological damming" and throttling culverts. In the other sites we hope that the activities will be still implemented (see Chapter 1.2).

The Śniatycze-Swaryczów Fen was characterized by variable water content during the period of several years of observation (see Figure below). During the growing season there are significant drops in the groundwater table, which are stabilized by the activity of beavers. Unfortunately, their dams do not always provide the correct level of damming, which sometimes leads to flooding, and for this reason they are regularly dismantled. This activity causes ground water table drops of even up to about 30 cm below the surface of the area. Unfortunately, the owner of

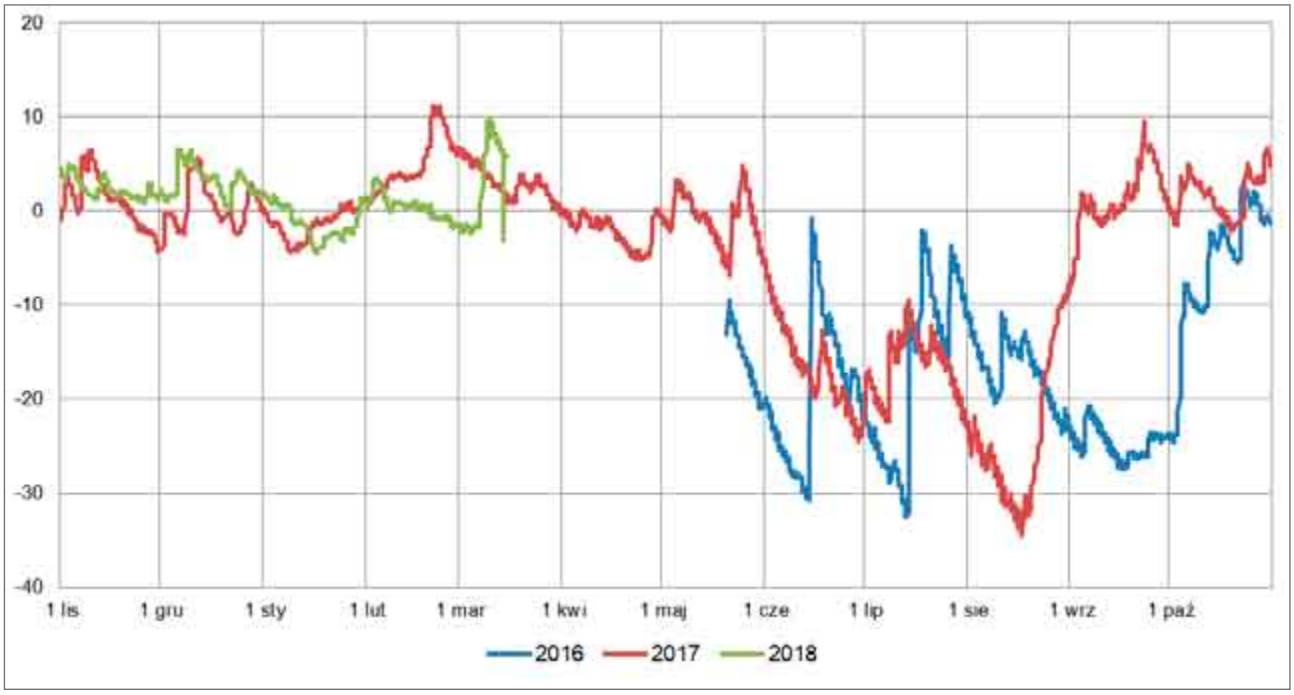


Fig. 65. Changes of the groundwater table on the Śniatycze-Swarycze Fen in the hydrological years 2016 – 2018.

the area did not agree to the restoration of the irrigation and drainage infrastructure, which would enable the regulation of the water level and which would neutralize the activity of beavers.

Stratigraphic studies confirmed the presence of relatively well-preserved peat deposits built by various types of moss-sedge and sedge peat. The peat profile for the Śniatycze-Swarycze Fen is presented below, and it confirms the long-term development of the fen. For technical reasons, drilling was made only up to a depth of 2 m, but the peat deposit is much thicker. The two most important phases of its development can be observed on the fen, which has also been confirmed on other fens occurring in the area. Until about 1000 years ago, the fen developed in the form of sedge reeds with a significant share of reeds overgrowing a terrestrializing water reservoir, as evidenced by the elements of shells and wood. After this period, moss-sedge vegetation development where a predominance of sedges and a decreased share of reeds is observed. The relatively high degree of peat decomposition to a depth of approx. 30 cm indicates that the top layers of the fen are drying out and that peat-forming processes are likely to be limited nowadays.

The natural values of the area were discussed, among others, in the studies by Krasicka-Korczyńska (2008), Michalczuk (2003, 2004), Michalczuk and Stachyra (2003), Michalska-Hejduk and Kopeć (2010), Nobis and Piwowarczyk (2008), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012).

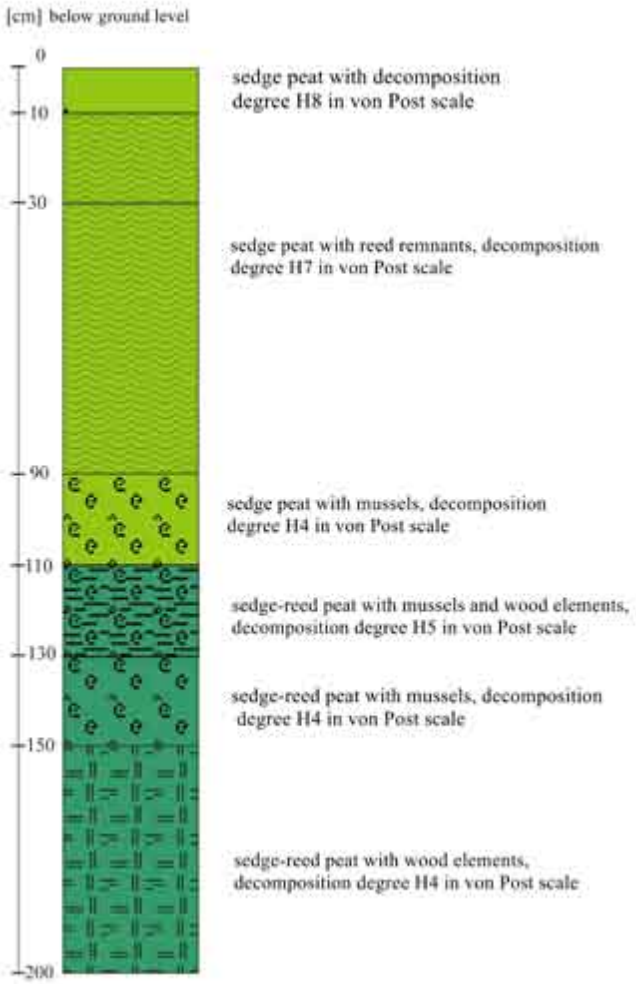


Fig. 66. Peat profile of the Śniatycze-Swaryczów Fen.

Photo 67. Antoniówka fen (photo K. Kotowska).

Photo 68. Perespa fen (photo K. Kotowska).

Photo 69. Perespa fen after conducting conservation measures (photo T. Bąkowski).

Photo 70. Rudka fen (photo K. Kotowska).

Photo 71. Rudka fen after conservation measures (photo K. Kotowska).

Photo 72. Patches of *Schoenus ferrugineus* on Śniatycze – Swaryczów fen (photo K. Kotowska).

Photo 73. Śniatycze – Swaryczów fen (photo K. Kotowska).

Photo 74. Traces of burning on Śniatycze – Swaryczów fen (photo K. Kotowska).

Photo 75. *Swertia perennis* - Kopuła Śniatycze fen (photo D. Horabik).

Photo 76. Kopuła Śniatycze fen (photo E. Gutowska).

Photo 77. Kopuła Śniatycze fen – the top of the cupola with *Cladium mariscus* (photo K. Kotowska).

The fens of the Szyszła Valley (two preserved patches with moss fen vegetation and the related vegetation) are soligenous low fens with moss-sedge and meadow vegetation, related to moss fen vegetation. They represent habitat subtype 7230-2: alkaline fens of southern Poland (excluding mountains) and central Poland.

Patches of habitat 7230 are located between Dyniska Stare in the east and Jarczów in the west (see Fig. 67).

The fens have developed in the middle of the Szyszła Valley (a tributary of the Rzeczyca River, which then flows into the Bug) and are significantly influenced by groundwater. The river channel is regulated and the land in the vicinity of the fens is partly used for hay production or grazing and partly unused (abandoned meadows, pastures, and former peat excavations overgrown with shrubby vegetation). The area is heavily drained (apart from the dams made as part of the project, there are no facilities for limiting the outflow of water) and relatively intensively used for agriculture – cultivated fields prevail in the higher-lying areas. In the past, the fens of the Szyszła Valley were used for hay production, as pasture meadows, and as a source of peat for fuel.

The meadow vegetation of the fens of the Szyszła Valley has survived in the form of meadows with the occurrence of numerous rare and endangered species of flora, such as *Liparis loeselii*, *Epipactis palustris*, and *Dactylorhiza incarnata*. In loose turf patches built mainly by low sedges, in places more hydrated together with *Eleocharis quinqueflora*, the following can be found: *Pinguicula vulgaris* ssp. *bicolor, Drosera rotundifolia*, and *D. anglica*. In small hollows filled with water or in exploited peatland hollows, one can find: *Utricularia minor, Chara* spp., *Sparganium minimum*, and *Cladium mariscus*. Among the rare sedges, *Carex davalliana* and *C. hostiana Schoenus ferrugineus* were recorded, locally with *Menyanthes trifoliata*. In addition, there are the very rare, only found in south-eastern Poland species: *Senecio macrophyllus*, *Tofieldia calyculata*, *Phyteuma orbiculare*, and *Dianthus superbus*. In the moss layer, the following were confirmed: *Drepanocladus sendtnerii* and *Limprichtia cossonii*.

Fig. 67. Location of the fens of the Szyszła Valley against the background of an orthophoto map.

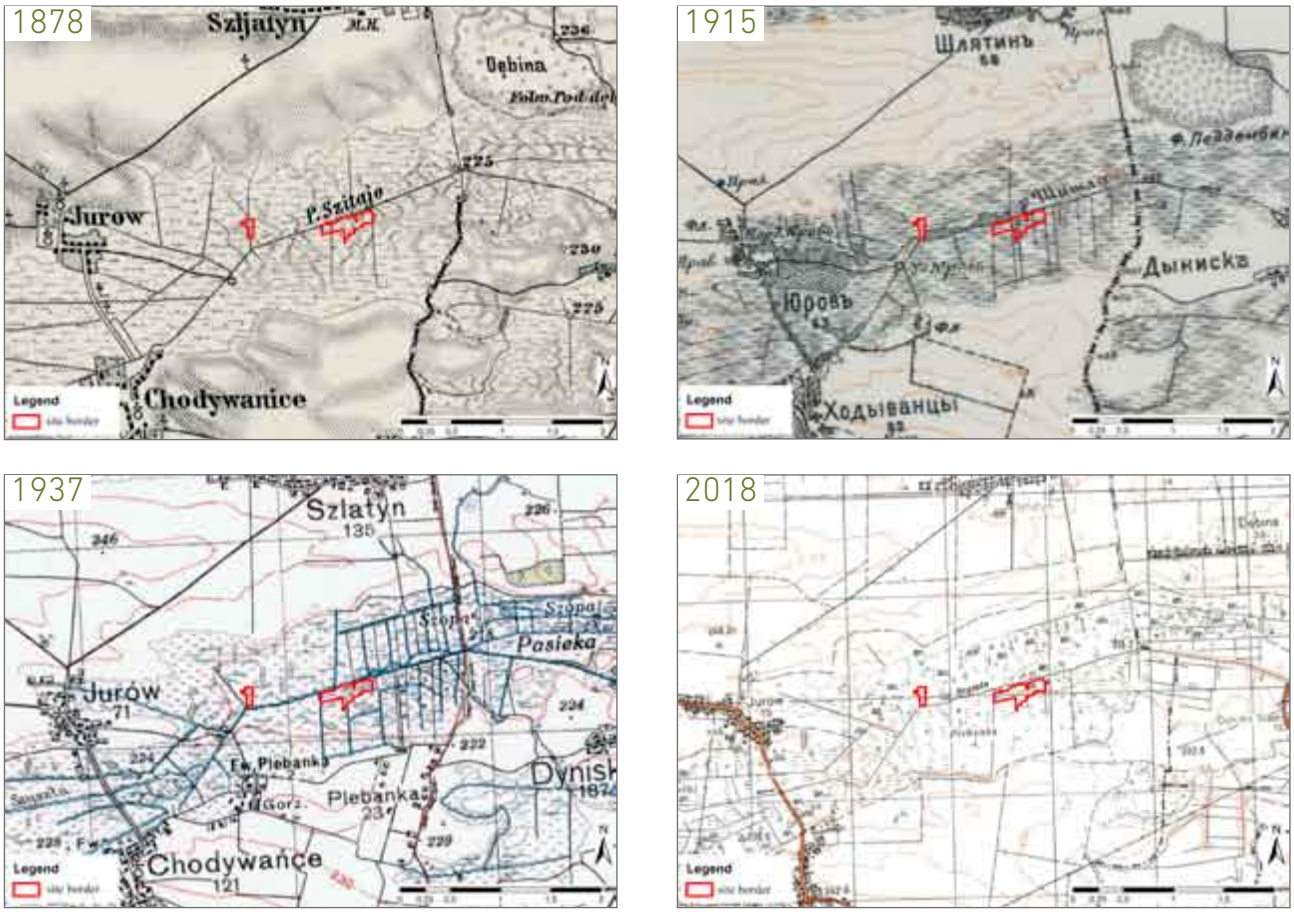


Fig. 68. Fragments of historic topographical maps from 1878, 1915 and 1937, as well as present maps showing how the valley was changed in terms of peat extraction, as well as the development of the drainage network, where all existing ditches have not been marked on the contemporary map. It should be noted that the preserved patches of habitat 7230 survived only in the former peat post-mine.

The vegetation has a heterogeneous character and is formed by the communities of the *Caricion davallianae* alliance in a mosaic with patches with characteristics of meadows of the order *Molinietalia* and of the *Molinion caeruleae* association, and of the communities related to *Magnocaricion* high sedge rushes. The fen vegetation is concentrated mainly in the area of the old exploited peatland hollows of different depths that are numerous throughout the area. The herbaceous layer is mainly composed of sedges with variable presence in the individual patches – *Carex appropinquata*, *C. rostrata*, *C. panicea*, *C. lepidocarpa*, *C. flava*, *C. flacca*, *C. davalliana, C. acutiformis* as well as *Schoenus ferrugineus*, *Equisetum palustre*, *Mentha* sp., *Eriophorum angustifolium* and *E. latifolium*, *Valeriana simplicifolia*, *Ranunculus lingua*, *Lysimachia vulgaris*, *Menyanthes trifoliata*, *Pinguicula vulgaris* ssp. *bicolor*, *Epipactis palustris*, *Potentilla erecta*, and in the water – *Utricularia minor* and *Chara* sp. In drier locations, the proportion of wet meadow species increase, such as *Cirsium rivulare*, *C. canum*, *C. palustre*, *Caltha palustris*, *Valeriana officinalis, V. simplicifolia*; locally, one can observe the penetration of *Eupatorium cannabinum* and the variable-hydration meadow species – *Molinia caerulea*, *Succisa pratensis*, *Pimpinella saxifraga*, *Galium album*, *Sanguisirba officinalis*, and others. The moss layer is varied, with the presence of *Scorpidium scorpioides*, *Limprichtia revolvens* and *L. cossonii*, *Palustriella* sp., *Campylium stellatum*, *Bryum pseudotriquetrum*, *Fissidens adianthoides*, *Plagiomnium ellipticum*, *Calliergonella cuspidata*, *Drepanocladus sendtnerii* and *D. aduncus*, *Warnstorfia exannulata*, as well as *Calliergon giganteum*.

Some of the exploited peatland hollows are occupied by *Carex acutiformis* rushes, and in some places secondary succession is observed: the shrubs of *Salix myrsinifolia*, *Betula pubescens* and *B. pendula*, *Populus tremula*, as well as *Pinus sylvestris* penetrate the site. There is also a noticeable expansion of *Phragmites australis* and *Molinia caerulea* and, to a lesser extent, of *Calamagrostis epigejos*.

Active protection activities focused mainly on removing shrubs and mowing open patches of the moss fen (c.f. Chapter 1.2). Within Plebanka fen – on surronding ditches (from Estern and Western side and on transverse ditches) 11 throtlling culverts were installed, which serve lowering the water outflow from the mire. Furthermore, hydrological monitoring was carried out here by means of an automatic recorder, together with phytosociological monitoring.

The surface of fens in the Szyszła Valley was characterized by variable water content during the period of several years of observation (see Figure below). In 2016, the Plebanka Fen was relatively well hydrated (the water level ranged from approx. -10 cm to approx. a few cm above the ground surface), while in 2017 the removal of beaver dams on the Szyszła River was observed, which is probably reflected in the drop in the water table also on the fen. By spring 2018 the

Photo 78. Fen complex of Szyszła valley (photo R. Stańko).

Photo 79. Fen complex of Szyszła valley – close up (photo R. Stańko).

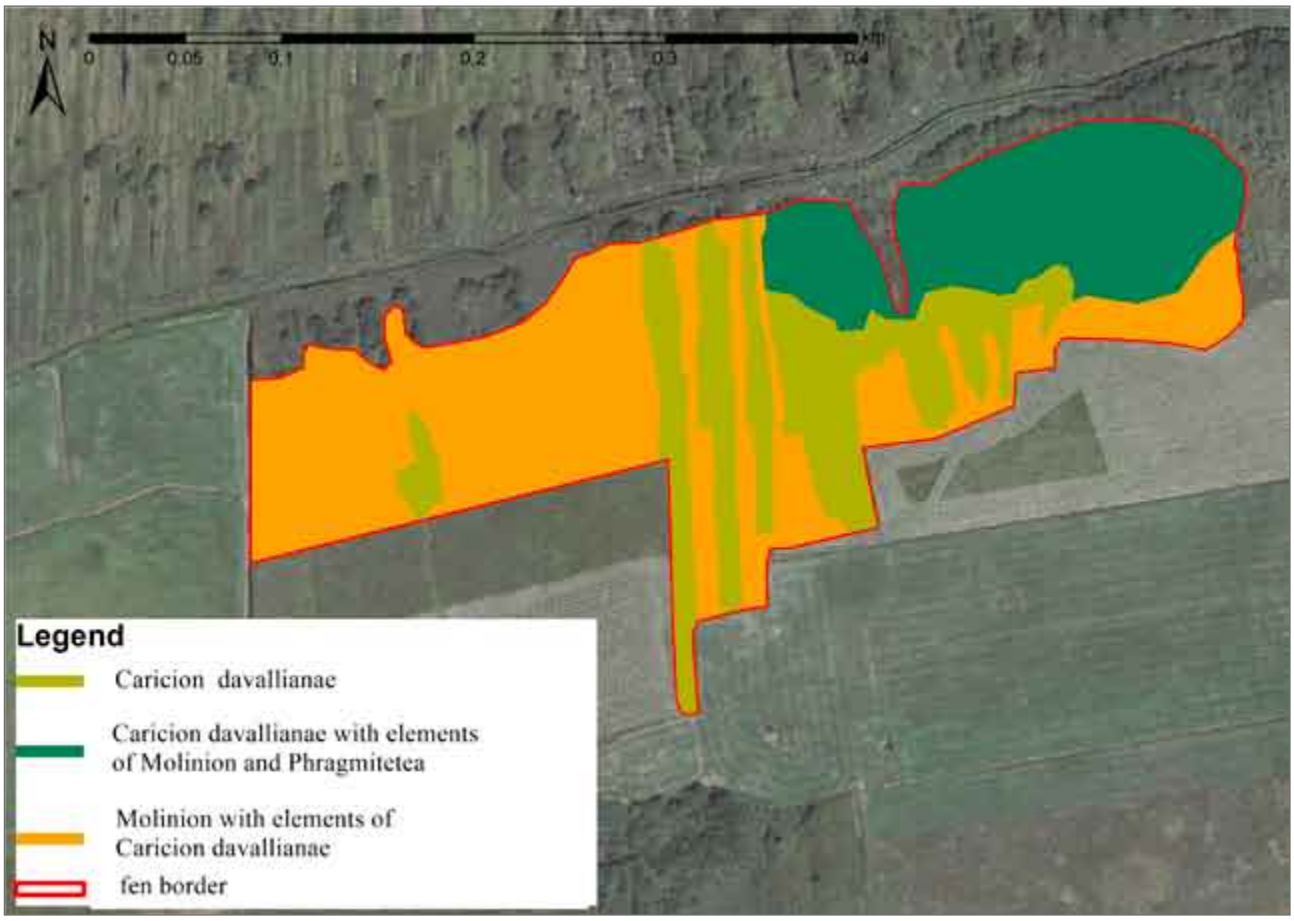


Fig. 69. Actual vegetation of the Plebanka Fen.

Fig. 70. Actual vegetation of the Jurów Fen.

Photo 80. Throtlling pass (1 of 11 pcs.) on Plebanka fen (photo D. Horabik).

dams were completely removed, which resulted in significant drops in water levels and drying out of habitat already before the vegetation period. Persistently low groundwater levels altered the proper functioning of the ecosystem; however, the construction of throttling culverts in the summer of 2018 should reduce these adverse phenomena.

Stratigraphic studies confirmed the presence of relatively well-preserved peat deposits built by various types of moss-sedge and sedge peat. The peat profile for the Plebanka Fen is presented below, and it confirms the long-term development of the fen. For technical reasons drilling was made only up to a depth of 2 m, but the peat deposit is much thicker. The two most important phases of its development can be observed on the fen. Until about 1,000 years ago, the fen developed in the form of sedge reeds with a significant share of reeds, overgrowing a terrestrial-

Fig. 71. Changes of the groundwater table on the Plebanka Fen in the hydrological years 2016 – 2018.

izing water reservoir, as evidenced by the elements of shells and wood. After this period, moss-sedge vegetation with a reduced share of reed can be observed. The relatively high degree of peat decomposition to a depth of approx. 30 cm indicates that the top layers of the fen are drying out and that peat-forming processes are likely to be limited nowadays.

The natural values of the area were mentioned only in the studies by Michalczuk (2005), Michalczuk and Stachyra (3002), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012).

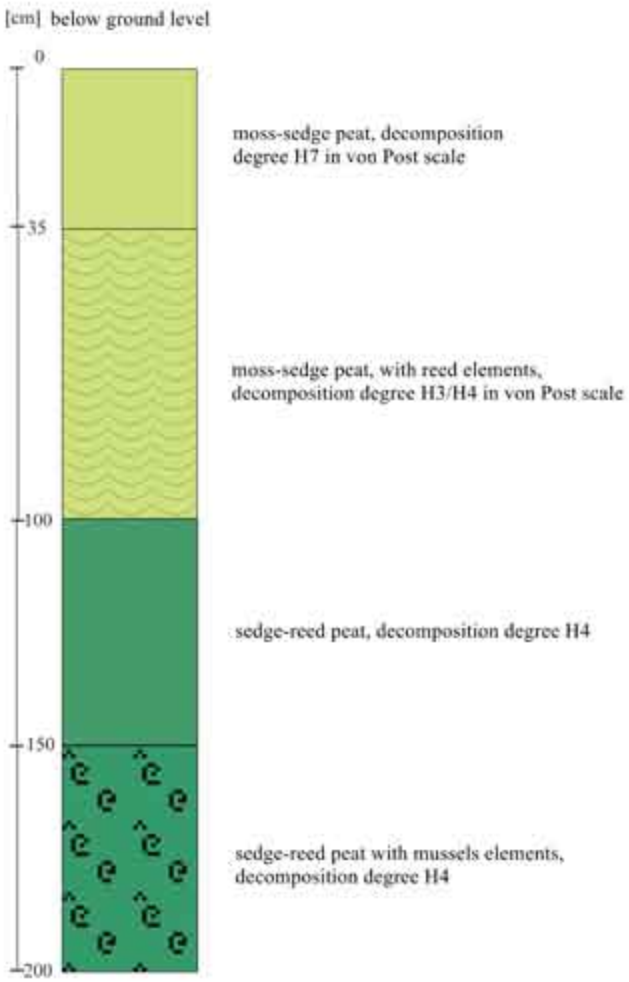


Fig. 72. Peat profile of the Plebanka Fen.

Photo 81. Plebanka fen (photo K. Kotowska).

Photo 82. Plebanka fen (photo K. Kotowska).

Photo 83. Jurów fen (photo K. Kotowska).

Photo 84. Jurów fen (photo K. Kotowska).

Natura 2000 site Uroczyska Roztocza Wschodniego PLH060093

The Siedliska Fen is a soligenous low fen with meadow vegetation related to a moss fen, developed in a valley of a medium-sized upland river, on the source section of a tributary of the Sołokia. It represents the habitat subtype 7230-2 alkaline fens of southern Poland (excluding mountains) and central Poland.

The site is located in the Prutnik Valley, north of Jalinka, close to the border with Ukraine (see Figure below).

The Siedliska Fen is located in the vicinity of the regulated Prutnik river bed (a tributary of the Sołokia, which flows into the Bug), which supplies fish breeding ponds located next to it. Within and around the fen there is a network of uncleaned, gradually overgrowing and terrestrializing drainage ditches. The surroundings are dominated by unused land – abandoned meadows, pastures, and former arable fields, now overgrown with shrubs and trees and bog forests. In the past, the fen area in the Prutnik Valley was mainly used as hay meadows (and partly as pastures). In recent years, however, most of the agricultural land in the area has been abandoned and is now undergoing a process of succession towards thicket and forest communities.

The fen is of a soligenous origin, but due to the significant transformation of the water conditions in the valley, moss fen vegetation is currently only observed at lower altitudes. Most of the area is dominated by meadow communities, where the peat-forming process is no longer taking place.

Vegetation of the Siedliska Fen takes the form of species-rich meadow patches with the occurrence of species characteristic for fens, as well as communities of wet and variable-hydration meadows. Within the site, there is a position of a large population of *Dactylorhiza majalis* and *D. incarnata*. In addition, there are species such as *Epipactis palustris*, *Liparis loeselii* (recently unconfirmed), *Carex davalliana*, *Parnassia palustris*, as well as mosses under partial protection – *Tomentypnum nitens* and *Climacium dendroides*.

The formerly extensive area of the fen complex has been significantly reduced due to drainage and the productive use of wetlands. A fragment of fen

Fig. 73. Location of the Siedliska Fen against the background of an orthophoto map.

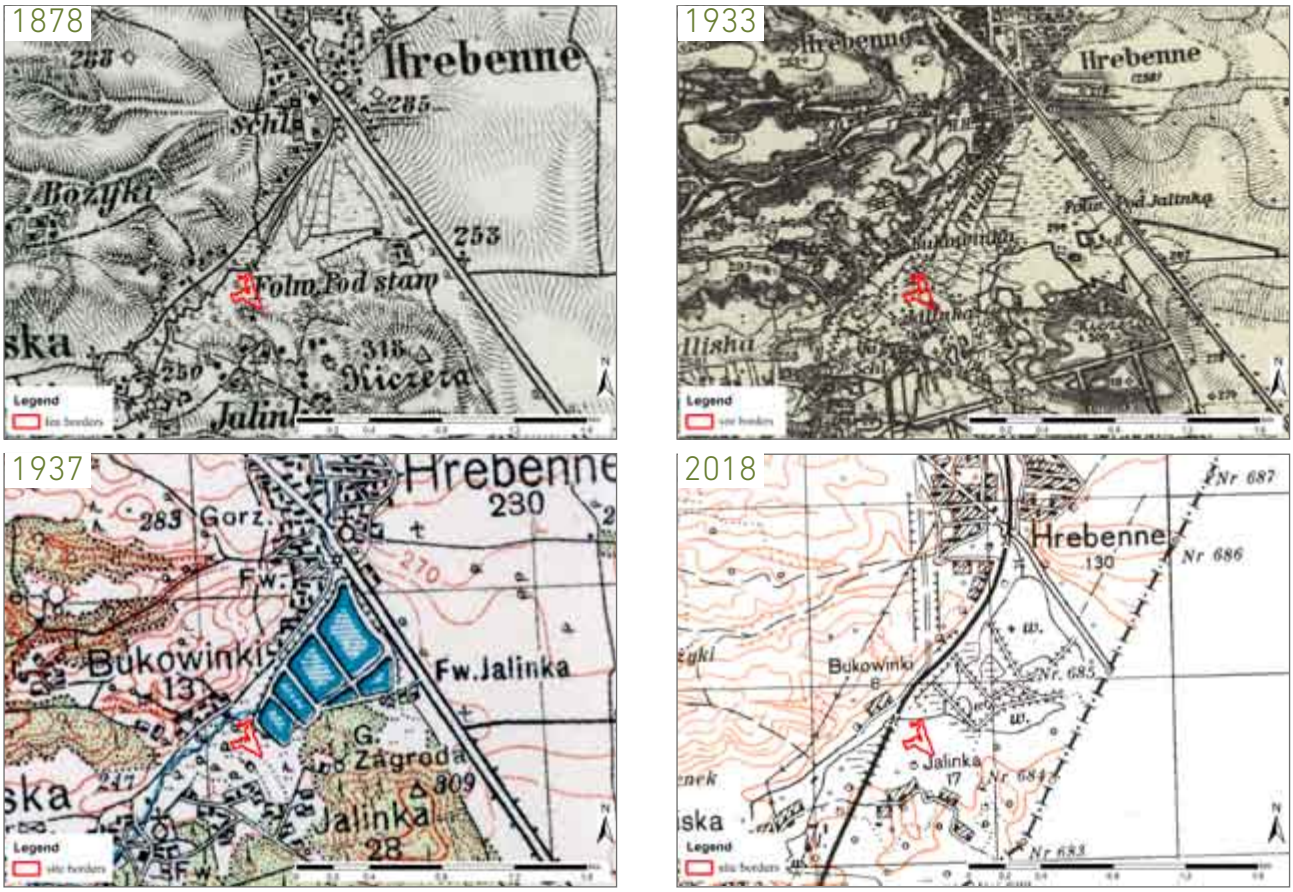


Fig. 74. A fragment of topographic maps from years 1878, 1933, 1937 and present showing changes in Siedliska fen. Draining system exists on this area for over 140 years but the most adverse changes occurred in 1930s when ponds were dug and after II World War when railway was built.

vegetation has been preserved only in the most humid places – and its condition is bad. The fen vegetation of the habitats consists of plant communities with meadow physiognomy related to moss fens *(Caricetum paniceo-lepidocarpae)*, but also of well-developed, species-rich wet meadow patches of the *Calthion palustris* association, partly of a herbaceous nature (*Filipendulion* alliance) as well as other communities of the order *Molinietalia*. The proportion of tall sedges is locally visible (at the sites of secondary bogging). The herbaceous layer is mainly composed of: *Molinia caerulea*, *Filipendula ulmaria*, *Carex panicea, C. davalliana, Geum rivale*, *Caltha palustris*, and *Crepis paludosa*. The following are visible: *Dactylorhiza majalis*, *D. incarnata*, *Scirpus sylvaticus*, *Equisetum palustre*, *Ranunculus acris*, *Sanguisorba officinalis*, *Cirsium rivulare*, *Valeriana simplicifolia*, and tall sedges – *Carex acutiformis* and *C. appropinquata*. In the moss layer, *Calliergonella cuspidata*, *Climacium dendroides* and *Plagiomnium ellipticum* are predominant, rarely – *Warnstorfia exannulata* and, locally in willow thickets, *Tomentypnum nitens*. The habitat is subject to the strong expansion of herbaceous species, mainly *Filipendula ulmaria*, *Phragmites australis*, and *Molinia caerulea*. The processes of secondary succession are locally visible. *Salix cinerea* thickets are found in parts of the area.

Within the boundaries of the site, butterflies of the genus *Phengaris* were found.

Active protection measures focused mainly on removing shrubs and mowing open patches of the moss fen; 8 dams were also made on anthropogenic field rills occurring in both areas (see chapter 1.2).

The surface of the fen remained stable in the period of several years of observations in spring, and in summer a decrease in the groundwater level was observed. The water level fell to several dozen cm below the ground surface, which had an impact on the shape of the vegetation – the predominance of wet and variable-hydration meadow species, with a small share of alkaline fen species. The amplitude of the groundwater level until the gates were built did not change much – after their construction, in spring 2018, despite little snow cover in winter and lack of rainfall in spring, a well hydrated fen surface was observed, which may indicate an improvement in the water balance.

Stratigraphic studies confirmed the existence of a well-preserved peat deposit composed of various types of sedge-moss and sedge fen peats.

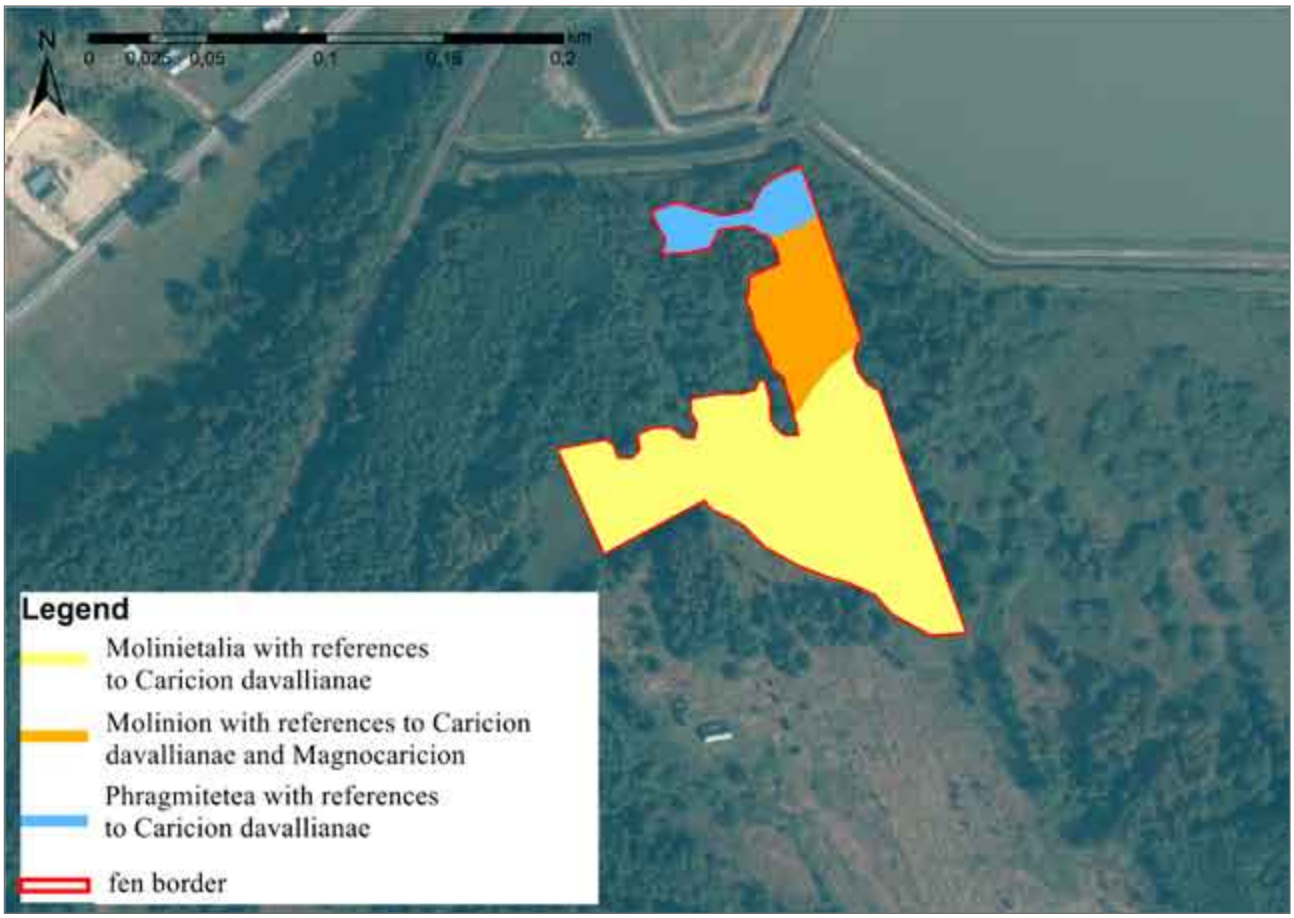


Fig. 75. Actual vegetation of the Siedliska Fen.

Photo 85. Siedliska fen (photo E. Gutowska).

Photo 86. Siedliska fen (photo E. Gutowska).

Photo 87. One of the dams built on Siedliska fen (photo D. Horabik).

The natural values of the area were discussed, among others, in the studies by Ćwikliński and Głowacki (1984), Falkowski et al. (2005), Falkowski et al. (2009), Grzyb (1990, 1993), Jarzombkowski and Kozub (2011), Jarzombkowski and Pawlikowski (2012), and Wołejko et al. (2012).

Natura 2000 site Ostoja Magurska PLH180001

The area covers a surface of 20,084 ha and mostly includes the central part of the Low Beskids, in the upper part of the Wisłoka River Valley. The Low Beskids is the lowest and at the same time the most extensive part of the Beskids and the entire arch of the Carpathians. The highest peak is Lackowa (997 m above sea level) and the largest rivers are the Osławica, Wisłok, and Jasiołka.

Within the area of Ostoja Magurska, there are six sites included in the project. They occur in dispersion, in small complexes, together with the surrounding wet meadows and reeds of tall sedges. They are located both in local terrain depressions and on slopes with a low gradient or on floodplains in river valleys. The whole area is quite natural due to its small population and extensive farming practices. It is distinguished by large forest complexes, intersected by rivers, over which meadows, pastures and mid-forest glades stretch, remaining from the former common grazing use. Rivers and valleys are mostly natural or very close to natural.

Flush mires develop here in places of groundwater seepage. These are sites with a typical, small surface area from 0.04 ha to 0.39 ha. However, due to their characteristic vegetation, the presence of *Eriophorum latifolium* stands out from the neighboring wet meadows. Purple *Cirsium oleraceum* meadows in a mosaic with white flush mires create a very picturesque landscape.

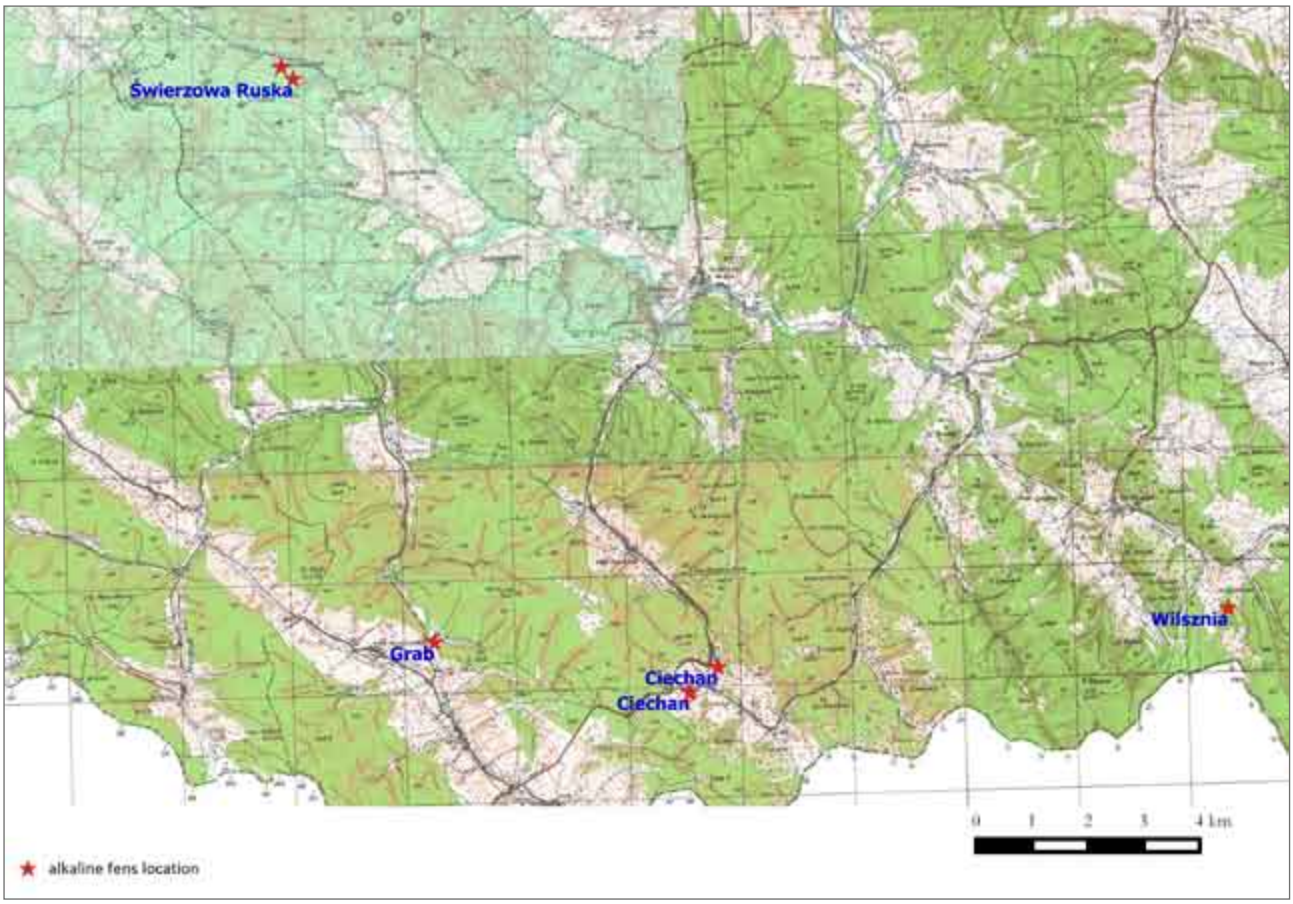


Fig. 76. Locations of the sites in the area.

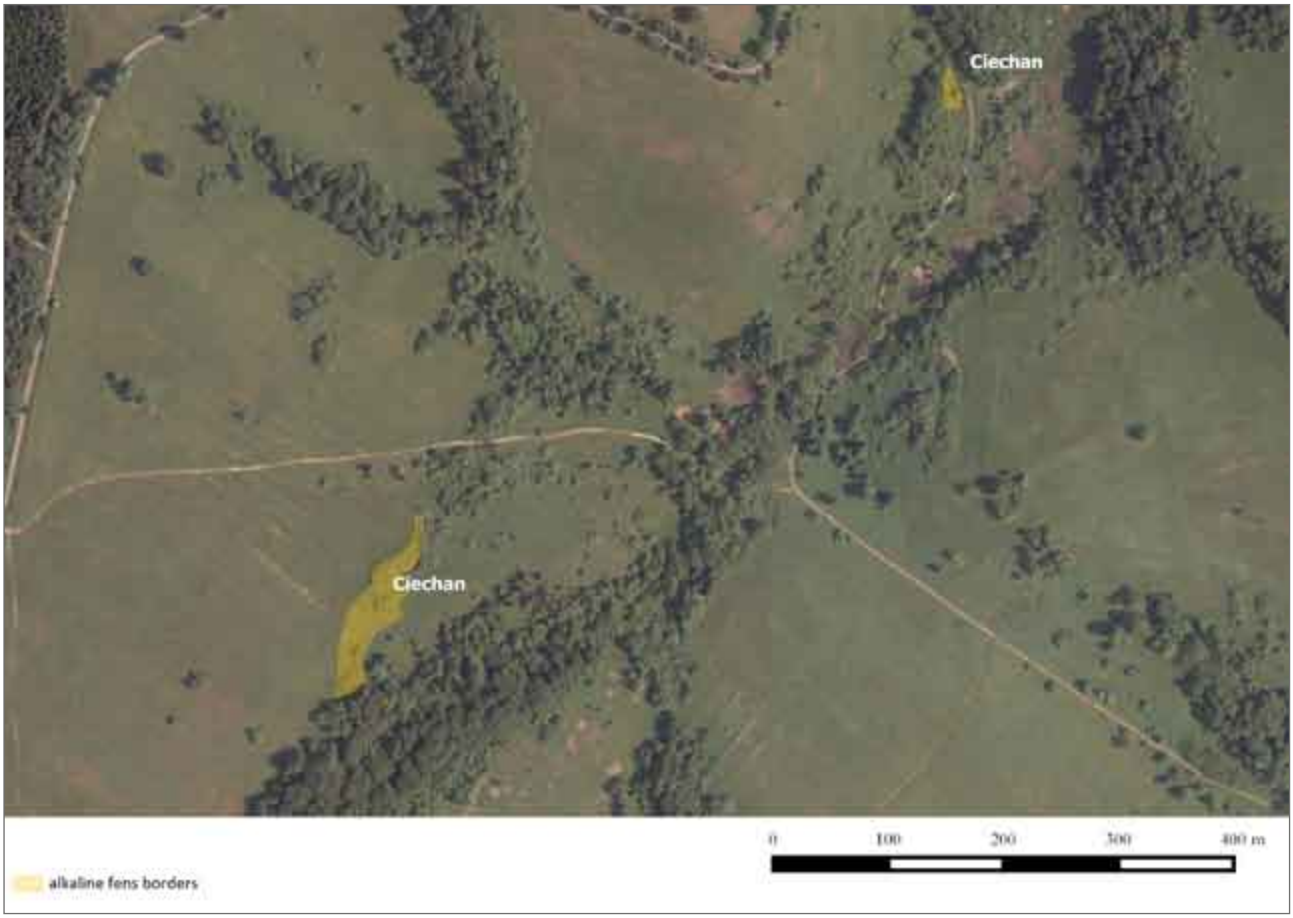


Fig. 77. Localisation of Ciechan sites.

Fig. 78. Localisation of Wilsznia site.

Photo 88. Ciechan fen (photo M. Bregin).

Photo 89. Grab fen (photo M. Bregin).

Photo 90. Grab fen (photo M. Bregin).

Photo 91. Tufa precipitation on one of the mountain flush mires in the Magura National Park (photo D. Horabik).

In the area of the sites, 55 plant species were observed, including 49 vascular plants and 6 species of bryophytes. Four species are protected: *Epipactis palustris, Dactylorhiza majalis, D. incarnata*, and *D. maculata*. In most of the sites there is a mosaic of plant communities, in which the valerian-sedge flush mire dominates. On the edges, on the border of the forest, there are herbs or communities with *Petasites kablikianus* and *P. albus*. Some of the sites are directly adjacent to wet meadows of the *Calthion* association and fresh meadows, which causes meadow species to permeate the area of the flush mire. The *Valeriano-Caricetum flavae*, alliance is predominant on most of the sites; it develops in its typical form with a two-layer structure.

The water conditions in most sites are appropriate, but there are local droughts that result in the ingress of species unusual for the habitat and disturbing the structure of the phytocenosis. Subsoil hydration is also strongly linked to the amount of precipitation and increases with the intensity of precipitation. There are no permanent watercourses in any of the sites.

The peat deposits are very shallow (up to a few centimeters) and in most sites they hardly form at all.

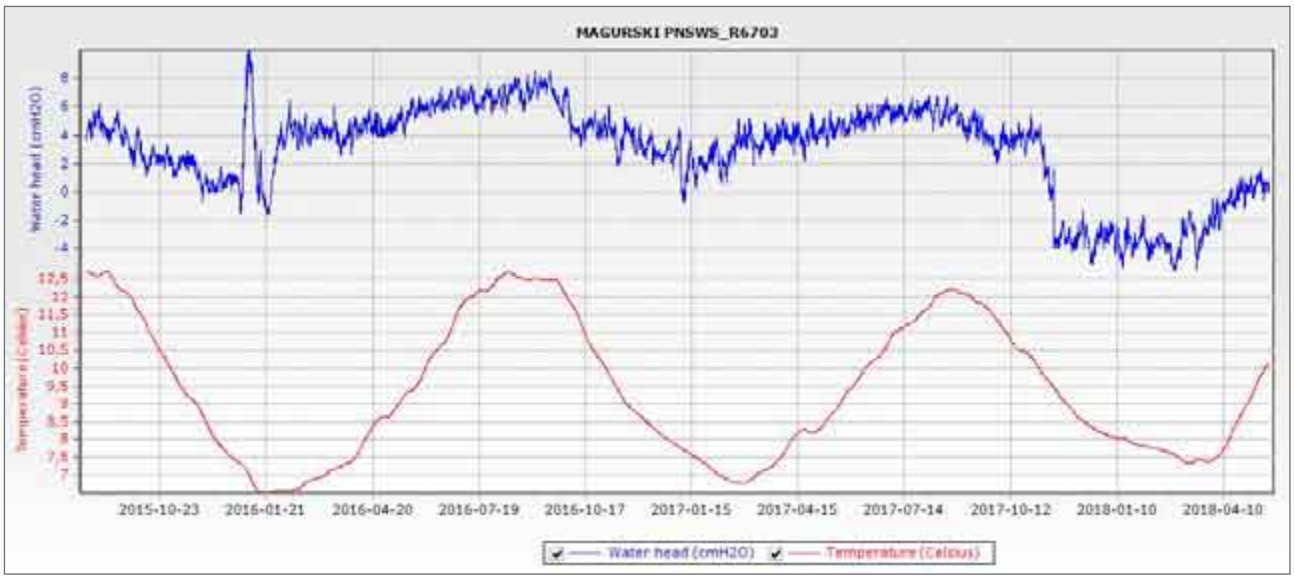


Fig. 79. Diagram of water level fluctuation on one of the fens in the Magura National Park.

Photo 92. Implementing protective measures in the Ciechan site (photo D. Horabik).

On one of the flush mires, in the second year of the project's implementation, automatic measurements of fluctuations in groundwater table level were carried out. The flush mire, due to its very good state of preservation, was not included in the activities in the scope of active protection. Among the many natural values, the active process of tufa precipitation on one of the flush mires should be noted.

The areas where the flush mires are found have been used in the past; extensive herding use was carried out and some of them have been mown for feed and litter for cattle. As part of the project, mowing and shrub removal operations were carried out. This contributed to the improvement of light conditions and inhibited the expansion of undesirable species. After the end of the project, the conservation activities will be continued by the Magura National Park.

The implemented protective measures significantly improve the condition of the habitat in terms of the occurrence of trees and shrubs and water conditions. Positive changes in flora and fauna can only be observed after a period of at least 3 – 4 years, in which mowing is carried out on a regular basis.

Photo 93. The Wilsznia site just after the protective measures have been carried out (photo D. Horabik).

The area covers the surface of 2743.8 ha and is located in the Low Beskids, between the Wisłoka Valley in the west and the Iwełka (Iwielka) stream in the east. The highest hills are: Dania (696 m above sea level), Polana (651 m above sea level) and Łysa Góra (641 m above sea level). The area is of forest character – 93% of the area is covered by forests, the remaining area is covered mainly by meadow and plant ecosystems.

There are three sites in the area, named for the purpose of the project: Łysa Góra 1, Łysa Góra 2, and Łysa Góra 3; their area varies from 0.02 to 0.5 ha. They are located on slopes with a slight inclination, descending down the valleys of mountain streams. The geological background is made up of Cretaceous and Tertiary formations, the so-called Carpathian flysch, the series of which overlapped in nappes. Flush mires develop in hollows where the ground is poorly permeable, which favors local stagnation and bogging – this leads to the initiation of peat-forming processes. However, the peat deposits are very shallow. There are no surface watercourses in the sites. In terms of water conditions, the entire site must be considered as being in an appropriate state of conservation. There are no drainage ditches which could significantly affect the degree of water content of the subsoil. Local water conditions deteriorate slightly as a result of ruts from passing agricultural machines (this applies only to the patches remaining in the vicinity of mechanically mown meadows). Some fragments of fens are characterized by slightly deteriorated water conditions, which may probably result from temporary rainfall shortages. In the past the sites were mown, but now in most of the patches extensive use has been abandoned, which is why the area of the habitat is slowly decreasing. Within almost all patches the expansion of shrubs – mainly willows – was observed.

The habitat of mountain alkaline fens in this area is represented by the *Valeriano-Caricetum flavae* valerian-sedge flush mire complex, with a high proportion of species typical of habitat 7230.

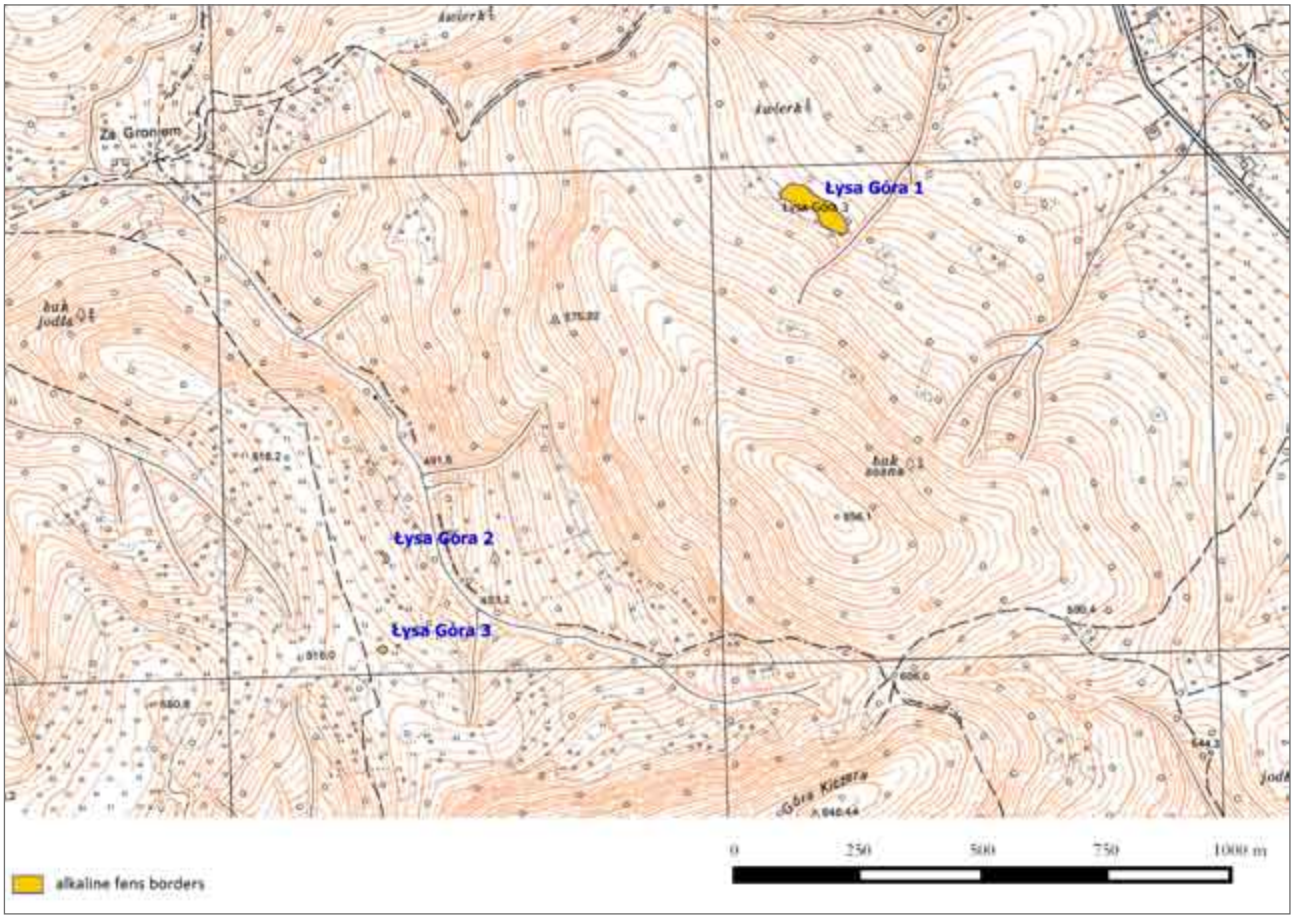


Fig. 80. Locations of sites in the Łysa Góra area.

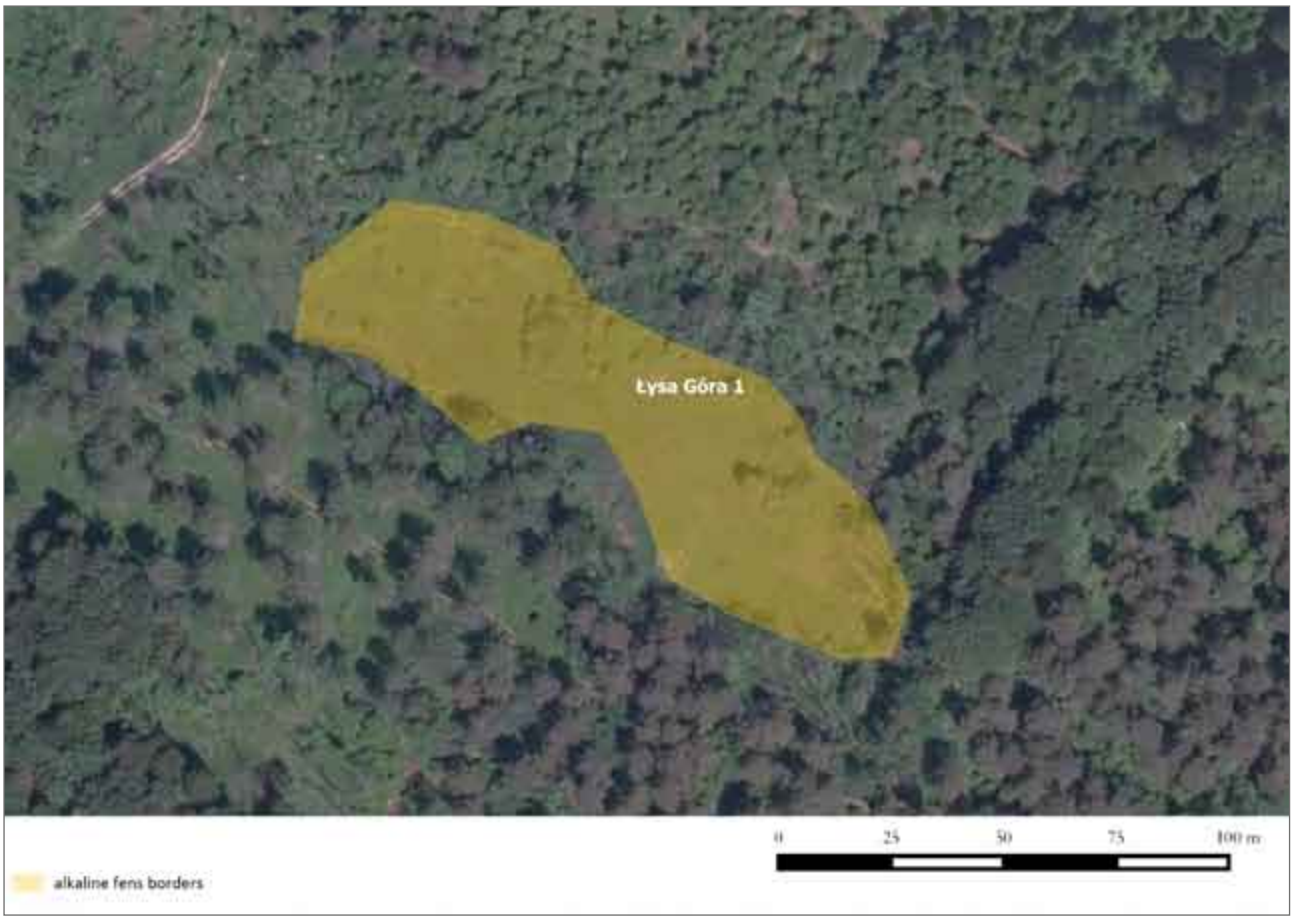


Fig. 81. Łysa Góra 1 site.

Photo 94. Łysa Góra 1 fen (photo M. Bregin).

Photo 95. Łysa Góra 2 fen (photo M. Bregin).

During the flora surveys and analysis, 83 plant species were recorded in the area, including 78 vascular plant species and 5 species of bryophytes. The vegetation within habitat 7230 is dominated by the *Valeriano-Caricetum flavae* valerian-sedge flush mire complex. On the edges of the community, the most common are herbaceous plants, with a predominance of *Filipendula ulmaria*, *Mentha longifolia*, and *Scirpus sylvaticus*. In places, where the water stagnates above the surface of the ground, patches of *Petasitetum albi* are formed, with the dominance of white butterbur. In the described sites, numerous species characteristic for the habitat were found such as *Carex davalliana, C. flava, Dactylorhiza majalis, Parnassia palustris, Valeriana dioica*, *V. simplicifolia*, *Epipactis palustris*, and *Eriophorum latifolium*. The habitat is characterized by a relatively low species diversity of bryophytes (which may, however, be due to regional circumstances). Among the species of brown moss, common species of the genus *Plagiomnium*, *Brachythecium*, and *Calliergonella cuspidata* dominate. In places with greater fluctuations in the water level, there is a more pronounced presence of *Juncus effusus*, as well as species characteristic for meadows.

Photo 96. The Łysa Góra site after carrying out protective measures (photo D. Horabik).

The peat deposits are very shallow and do not occur in all sites; they reach the thickness of just a few centimeters. The soligenous fens and flush mires found here are characterized by a relatively constant, stable, and high level of the groundwater table, rich in calcium and magnesium compounds.

One of the main threats to the habitat in this area is the succession of vegetation, as well as the expansion of the growth of trees and shrubs – mainly willows. Therefore, in the area of one of the sites (Łysa Góra 1), protective measures were implemented, consisting in cutting down shrubs and a one-off mowing, which should prevent the flush mire patch-

es from becoming overgrown. The implemented measures also improved the light conditions of the habitat and stabilized the water conditions. However, a significant improvement in the condition of the habitat will be possible if extensive hay production continues. An opportunity here is the declaration of the land manager – the Dukla Forest Inspectorate – which intends to protect the habitat by making an agri-environment-climate commitment.

In the area of the other two sites, it was not necessary to carry out any protective measures consisting in preparatory mowing, as the owners themselves carry out extensive hay production as part of the implementation of the agri-environment-climate package.

Natura 2000 site Ostoja Jaśliska PLH180001

An area of 29,286.8 ha protecting diverse habitats, located in the Low Beskids between the Łupków Pass in the east and the Sarbowska Pass in the west. The subsoil is made up of Carpathian flysch, usually composed of alternating strata of conglomerates, sandstones, and clay shale. Apart from the Natura 2000 area, nature is also protected here in the Jaśliska Landscape Park and in three nature reserves – Źródliska Jasiołki, Kamień nad Jaśliskami, and Przełom Jasiołki.

One site representing a mountain habitat and lowland alkaline fens of the character of a flush mire, sedge, and moss fens – 7230 – was included in the project area. It is located in the central part of Ostoja Jaśliska, in the Źródła Jasiołki Reserve, at an altitude of 580 m above sea level. It is located in the valley of the Jasiołka River, not far from its bed, in the spring area. The fen has developed in a drainless basin that is located within a floodplain terrace. Around the site there is a complex of high reed and reed rushes, as well as wet meadows and willow and birch thickets.

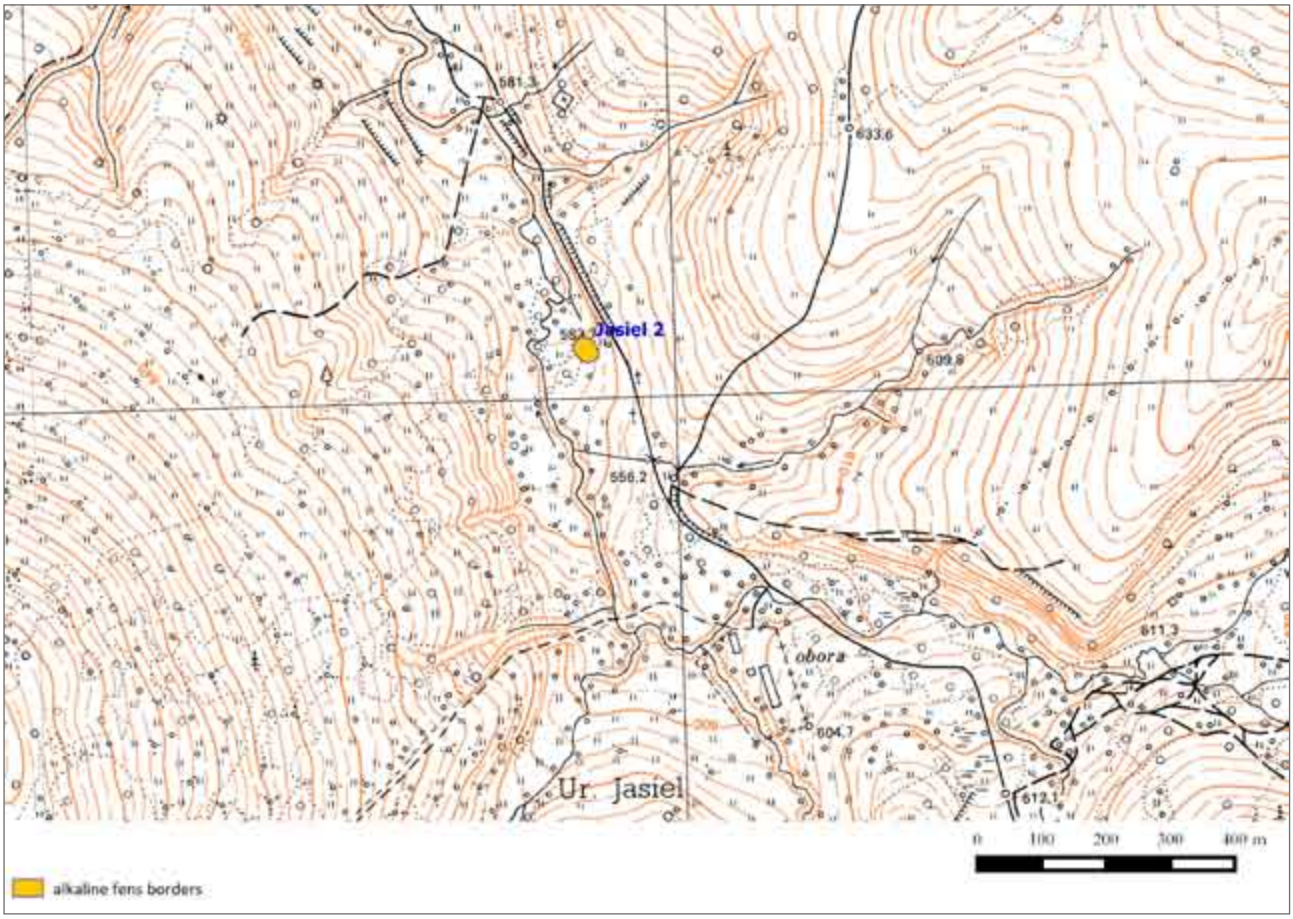


Fig. 82. Location of the sites.

Fig. 83. Jasiel 2 site boundary.

Photo 97. *Epipactis palustris* on Jasiel 2 (photo M. Bregin).

In the surveyed area, 31 plant species were recorded, including 26 vascular plant species and 5 species of bryophytes. Two of these species are under strict protection: *Epipactis palustris* and *Carex davalliana*. The vegetation is dominated by the *Valeriano-Caricetum flavae* valerian-sedge flush mire complex and *Caricetum davallianae* sedge. The *Valeriano-Caricetum flavae* complex is distinguished by a fairly well-developed moss layer, dominated by such species as *Calliergonella cuspidata* and *Aulacomnium palustre*. The herbaceous layer is dominated by low sedges: *Carex flava* and *C. echinata,* as well as *Eriophorum latifolium. Epipactis palustris* is abundant. The *Caricetum davallianae* association is distinguished by the dominance of *Carex davalliana*. Its physiognomy is quite similar to that of *Valeriano-Caricetum flavae*, but it differs in the smaller proportion of *Valeriana simplicifolia.* In both plant communities, a high share of *Equisetum fluviatile* can also be observed. Part of the site is covered by wet meadows classified to the *Calthion* alliance and the *Cirsietum rivularis* association. Individual shrubs of *Salix* sp. grow on the flush mire.

Photo 98. General view of the fen (photo M. Bregin).

Photo 99. Protective measures implemented on the site (photo D. Horabik).

This area is not used. The condition of the habitat is unsatisfactory. This is mainly due to the expansion of various species of willows and herbs. As part of the project, mowing and shrub removal operations were carried out (details in chapter 1.2). These activities improved the light conditions and limited the expansion of undesirable species. However, the restoration of the habitat requires the continuation of conservation measures in the future.

Natura 2000 site Bieszczady PLC180001

The Polish part of the Bieszczady Mountains belongs to the Western Beskids, which are part of the Outer Eastern Carpathians. The area consists of mountainous and sub-mountainous terrain with a low population density. At the top, over 1150 m above sea level, there are meadows of the pastures type, below them there are green alder shrubs spreading, and below these there are forests with the prevailing Carpathian beech. Below the forest zone there is a belt of valleys which were used for agricultural purposes some time ago. Currently, most of the land is not used in any way.

Due to its natural and economic conditions, the Bieszczady abound in flush mires. As part of the project, the protection was extended to sites Torfowiska Ostry 2,3 located along an asphalt road, which leads to Liszna and Młaki za cmentarzem w Wołosatym located in a complex of wastelands in the Bieszczady National Park. Currently, the site is being mown, which prevents the expansion of trees and shrubs. The habitats included in the projects are typical flush mires forming on wet ground-gley soils with a shallow organic layer.

The surveys conducted during the project confirmed the presence of 61 plant species, including 54 vascular plant species and 7 species of bryophytes.

Młaki za cmentarzem w Wołosatym – a large site located on the outskirts of the village of Wołosate, in the valley of a small stream flowing into the Wołosatka River. The type of groundwater supply is predominant here. The vegetation character is also influenced by periodical flooding by the stream. A mosaic of flush mires, wet meadows, and

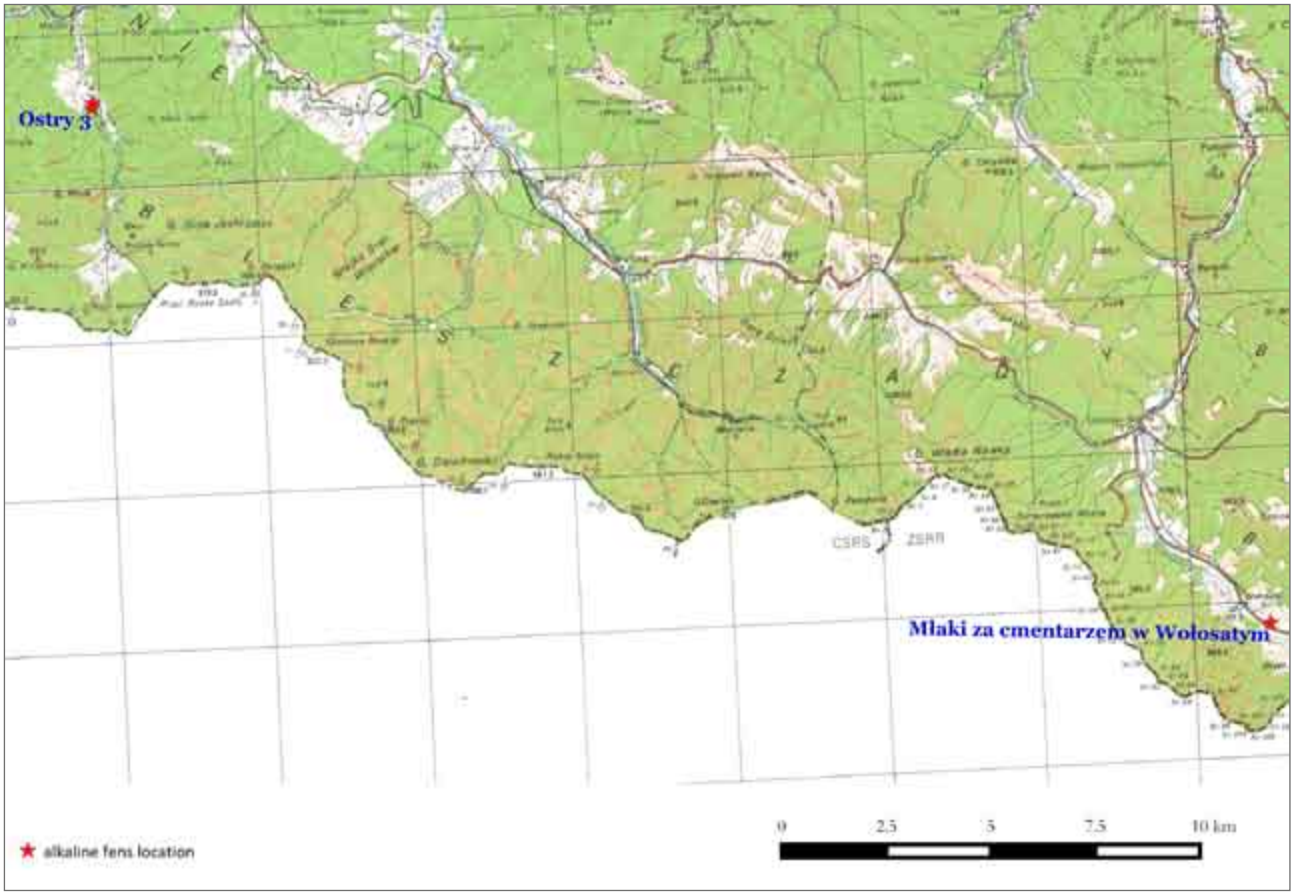


Fig. 84. Locations of flush mires in the area of the Bieszczady PLC180001.

Fig. 85. Młaki za cmentarzem w Wołosatym site.

sedge patches occupies the entire depression along the stream.

Closest to the banks of the stream, patches of wet meadows of the *Calthion palustris* alliance form, with a large share of *Caltha laeta*, *Juncus effusus*, and *Mentha longifolia.* Grasses such as *Deschampsia caespitosa* and *Alopecurus pratensis* are also found. These plant communities form a local mosaic with the *Caricetum rostratae* community.

Much of the area is covered by wet meadows, dominated by the *Cirsietum rivularis*, where *Cirsium rivulare* plays an important role. In the lower layer of this phytocenosis, species from the *Calthion* association can be found, such as the *Caltha laeta*, *Lathyrus palustris*, and *Crepis paludosa.* The nettle *Urtica dioica* grows on dry spots.

Photo 100. A community of *Caricetum rostratae* (photo M. Bregin).

Photo 101. *Cirsietum rivularis* meadow (photo M. Bregin).

Photo 102. *Menyantho trifoliatae-Sphagnetum teretis* association (photo M. Bregin).

Habitat 7230 is represented here by the two communities of *Menyantho trifoliatae-Sphagnetum teretris* Warén 1926 and *Caricetum rostratae* Rübel 1912. The community of *Caricetum rostratae* is distinguished by a significant share of *Carex rostrata*, with the addition of other species from the *Magnocaricion* alliance such as *Lysimachia thyrsiflora*, *Galum palustre*, and *Scutellaria galericulata*. *Carex rostrata* forms quite dense patches, parallel to the stream. The main syntaxon representing the 7230 habitat is the *Menyantho-Sphagnetum teretis.* It occupies about 30% of the surface of the site and develops from the bottom of the valley up to its edges. The association is characterized by a very high proportion of *Menyantes trifoliata* with the addition of *Carex nigra*, *Eriophorum latifolium*, and *Valeriana simplicifolia*. There are also numerous meadow species, e.g., *Crepis paludosa*, *Briza media*, and *Trisetuum flavescens*. The moss layer is well formed, dominated by *Sphagnum teres* and *Aulacomnium palustre*.

As part of the project, the site was mowed and shrubs were removed, which significantly impeded the expansion of undesirable species.

Ostry 2,3 – two small sites located at the bottom of the Roztoczka River Valley. They are formed on flat stretches of land, in places of groundwater seeps; its outflow is limited by a poorly permeable subsoil. In the past the area was used for hay production. The Ostry 2 site is small and the habitat 7230 is largely occupied by willow shrubs.

In the area of the Ostry 2 site, a truncated form of a mountain flush mire develops, with a significant share of wet meadow species that dominate the groundcover layer. Dominant are: *Scirpus sylvaticus* and *Mentha longifolia*, as well as *Alchemilla* sp. Of the species typical for alkaline fens, only *Valeriana simplicifolia* was recorded here. The moss layer is rather poorly formed and is dominated by *Calliergonella cuspidata* and *Climacium dendroides*. In the area of the Ostrava 3 site, the habitat is represented by the *Valeriano-Caricetum flavae* phytocenosis. There are many low sedges present: *Carex flava* and *C. panicea*. *Valeriana simplicifolia* is equally numerous, as are species of the order *Caricetalia nigrae* such as *Carex nigra* and *C. echinata*. *Menyantes trifoliata* is locally very common. The moss layer is quite dense,

Photo 103. Młaki za cmentarzem w Włosatym after carrying out protective measures (photo T. Bąkowski).

Fig. 86. Locations of the Ostry 2 and 3 sites.

Photo 104. Ostry 3 site (photo M. Bregin).

with taxa such as *Calliergonella cuspidata* or *Philonotis fontana*. *Salix sp.* willow shrubs are present within the area of the site. As part of the project, the site was mowed and part of the shrubs were removed. These activities improved the lighting conditions and stopped the expansion of the thickets. However, significant improvements in habitat status require the continuation of the implemented measures.

Photo 105. Ostry 3 site after implementing protective measures (photo T. Bąkowski).

Natura 2000 site Moczary PLH180026

The area lies in the eastern part of the Polish section of the Outer Carpathians arch and includes a fragment of the Low Bieszczady Mountains, which are adjacent to the Słonne Mountains. To the west, the refuge adjoins meadows belonging to the village of Moczary, and to the east – the border with

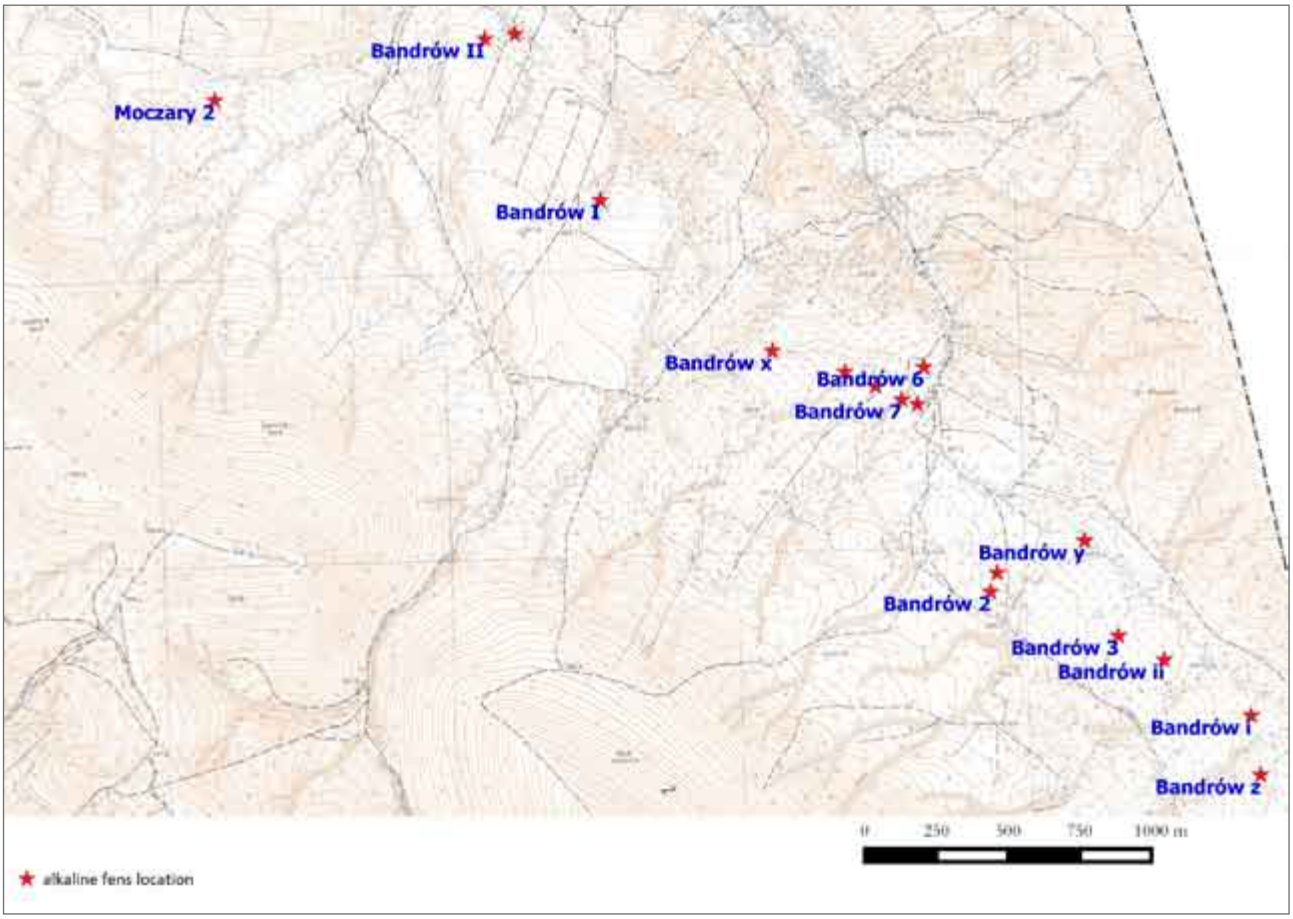


Fig. 87. Locations of sites in the Moczary area.

Photo 106. Stream floodplains caused by beaver activity (photo M. Bregin).

Ukraine. There are many natural and artificial water reservoirs here, and the Królówka River creates numerous meanderings and bends, often spilling over a large area. The refuge is distinguished by a significant area of meadows and pastures that are still in use.

In the area of Moczary, there are 16 sites included in the project, with the surface area from a few ares to 1.5 ha. The sites Moczary 1 and 2 are located in the vicinity of small streams. The remaining sites, located in the eastern part of the refuge, are very close to each other, which results from the strip nature of the water seeps determining their formation. There is a specific mosaic of fresh meadows, wet meadows, rushes, and tall sedges in the area of the refuge. Flush mires form in a complex with these habitats, often intertwined with them. They occur in various geomorphological systems, regardless of altitude and exposure. The condition of their occurrence is a poorly permeable subsoil, which slows down the outflow of groundwater supplying these sites.

In the valley of the Krolówka River, flush mires form in the bends of floodplains and along its tributaries. Often near rushes and tall sedges formed in areas flooded by beavers. Outside the valley bottom, the flush mires are also found on the slopes of the surrounding hills, forming in terrain concavities and edges, drainless basins, usually surrounded by fresh meadows. A specific type of the flush mire develops within the spring areas and their related watercourses.

The flush mires in the area of Moczary contain 91 species of plants, including 79 vascular plants and 12 species of bryophytes. There are 5 protected vascular plant species, two of which are under strict protection: *Epipactis palustris* and *Gymnadenia conopsea*, and three under partial protection: *Dactylorhiza majalis, Listera ovata* and *Menyanthes trifoliata.* Three species are included in the Red List of Plants and Fungi in Poland (Mirek et al. 2006) and are assigned the NT (near threatened) category.

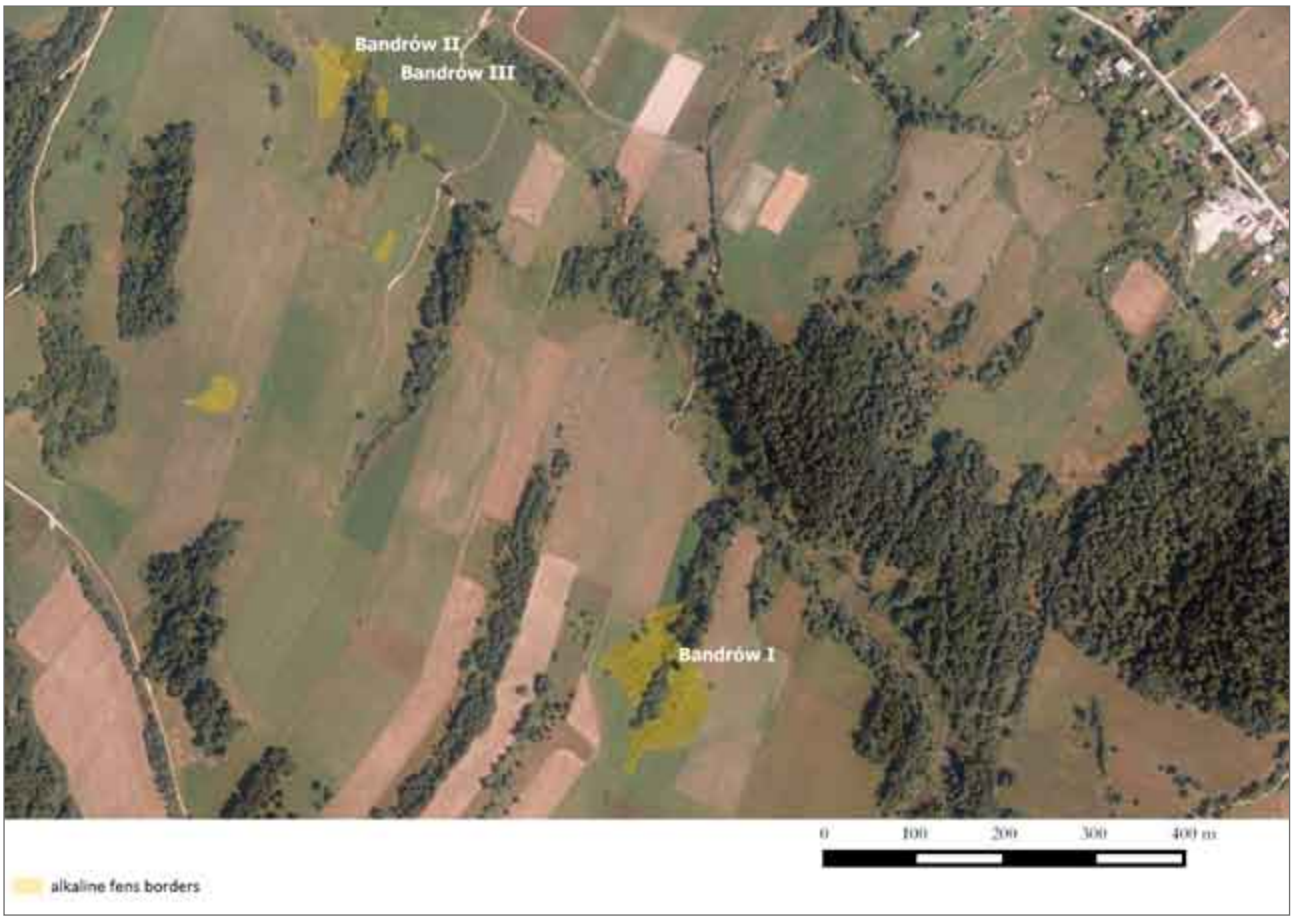


Fig. 88. Locations of the sites.

Photo 107. *Gymnadenia conopsea* at the Bandrów 7 site (photo M. Bregin).

Within habitat 7230 in this area, two types of plant communities predominate. As in most mountain areas, the predominant syntaxon is the *Valeriano-Caricetum flavae* valerian-sedge flush mire association. It usually develops in a classic form, with a two-layer system of herbaceous vegetation. The higher layer is dominated by cottongrass with a predominance of *Eriophorum latifolium*, as well as *Juncus effusus* and horsetails: *Equisetum fluviatile* and *E. palustre*. In some places there is a higher proportion of *Carex rostrata*, which forms quite dense patches. The lower layer is dominated by low sedges, with different numbers of *Carex flava*, *C. nigra*, and *C. panicea*. In addition, *Valeriana simplicifolia* can be numerous, and *Epipactis palustris* is sometimes found in the meadows. The moss layer is well formed in sites with stable water conditions and reaches about 70 – 90% coverage. In sites with altered hydrological conditions, bryophytes are less abundant. Species such as *Calliergonella cuspidata*, *Aulacomnium palustre,* species of the genus *Drepanocladus*, and *Climacium dendroides* are predominant. The moss layer of the flush mires growing on spring areas is dominated by species of the genus *Cratoneuron sp.*

Photo 108. Flush mire patches with a large share of *Eriophorum* at the Bandrów x site (photo M. Bregin).

Photo 109. *Valeriano-Caricetum flavae* valerian-sedge flush mire at the Bandrów i site (photo M. Bregin).

Photo 110. A patch of *Menyantes trifoliata* in the Bandrów y site (photo M. Bregin).

Photo 111. A community of *Menyantes trifoliata* at the Bandrów y site (photo M. Bregin).

The second type of phytocoenosis is a community with *Menyanthes trifoliata*. It is related to *Menyantho trifoliatae-Sphagnetum terestis*, but differs from its typical form in the absence of *Sphagnum teres*. The moss layer consists only of brown mosses such as the *Plagiomnium* genus, *Calliergonella cuspidata*, and *Campylium stellatum*. In the herbaceous layer there is a large number of *Menyanthes trifoliata* which locally form almost single-species, dense patches. It is accompanied by *Valeriana simplicifolia* and *Caltha laeta*. The higher layer of this phytocenosis is dominated by *Eriophorum latifolium*. Some of the patches are strongly overgrown with *Salix pentandra* and *S. cinerea* willow thickets. The habitat has been developing for a long time under the canopy of dense thickets in these areas.

Flush mires in the area are characterized by highly variable hydrological conditions. The level of groundwater in flush mires is subject to strong fluctuations due to rainfall and subsequent periods of drought. For this reason, the possibility of peat accumulation is very limited here. As a rule, there is no peat-forming process and the predominant type of soil is peat-gley soil.

Within the framework of the project, the mowing and cutting down of shrubs and undergrowth of trees were carried out in the area, which significantly inhibited the unfavorable processes of succession of thicket and forest vegetation. Protective measures (details in chapter 1.2) were carried out within 3 sites (Bandrów I – III). In the case of the other sites, the owners carry out extensive hay production resulting from the implementation of the agri-environment-climate programme, which was commenced in the first years of the project implementation. In the case of the flush mires managed by the State Forests, according to the data obtained from the manager, they were leased out to private individuals.

Photo 112. Bandrów I site after implementing the protective measures (photo T. Bąkowski).

Photo 113. Bandrów II site after implementing the protective measures (photo T. Bąkowski).

Photo 114. Bandrów III site after implementing the protective measures (photo T. Bąkowski).

Table 2. List of chosen, rare, protected and endangered plant species present on Natura 2000 sites within the LIFE13 NAT/PL/000024 project.

Species name	Conservation status: Ministry of Environment Decree of 9.10.2014 concerning plant species protection – partial	Conservation status: Ministry of Environment Decree of 9.10.2014 concerning plant species protection – strict	Conservation status: Red List of plants and fungi of Poland (Kaźmierczakowa et al. 2016). Red List of mosses of Poland (Żarnowiec et al. 2004)	Conservation status: Polish Red Book of Plants (Kaźmierczakowa et al. 2014)	Site name: Moczary	Bieszczady	Ostoja Jaśliska	Łysa Góra	Ostoja Magurska	Uroczyska Roztocza Wschodniego	Łąki nad Szyszłą	Dolina Sieniochy	Dolina Górnej Siniochy	Dolina Zwoleńki	Pakosław	Bagna Orońskie	Ostoja Szaniecko - Solecka	Ostoja Nidziańska	Dolina Mierzawy	Łąka w Bęczkowicach	Torfowiska nad Prosną	Ostoja Popradzka	Małe Pieniny	Ostoja Gorczańska	Lipienniki w Dąbrowie Górniczej	Beskid Żywiecki	Beskid Śląski	Karkonosze
Botrychium lunaria			VU																		•							
Bryum neodamense		▪												•														
Carex chordorrhiza		▪	VU	VU										•														
Carex davalliana		▪	VU				•		•	•	•	•	•	•		•	•	•	•	•			•	•	•	•		
Carex dioica	▪		VU											•		•	•	•	•									
Carex limosa			NT											•		•												
Carex hostiana			EN								•	•	•				•											
Carex pulicaris			NT	EN																	•							
Carex umbrosa			NT									•																
Colchicum autumnale	▪																					•						
Chara spp.											•	•		•			•	•	•	•								
Cladium mariscus											•	•		•														
Dactylorhiza incarnata									•	•	•	•	•	•	•	•	•	•	•	•	•			•				
Dactylorhiza incarnata ssp. ochroleuca	▪		EN	EN								•				•												
Dactylorhiza majalis	▪		NT		•	•		•	•	•				•	•		•	•	•	•	•	•	•	•	•	•	•	•

Dianthus superbus													•			•	•								VU	▪	
Drepanocladus sendtnerii																	•										
Drosera anglica				•											•	•	•								EN	▪	
Drosera intermedia				•																					EN	▪	
Drosera rotundifolia					•			•	•				•		•		•	•							EN	▪	
Dryopteris cristata									•				•		•												
Eleocharis quinqueflora				•				•			•		•				•	•		•					VU		
Epipactis palustris		•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•		•	•	•		NT	▪	
Equisetum variegatum				•																							
Gentianella amarella																•									EN	▪	
Gymnadenia conopsea ssp. conopsea												•				•								•		NT	▪	
Hamatocaulis vernicosus				•					•	•				•						•							▪	
Helodium blandowii									•	•				•													▪	
Ligularia sibirica														•	•										EN	EN	▪	
Liparis loeselii				•				•	•	•	•	•	•	•	•		•	•	•						VU	VU	▪	
Listera ovata			•		•	•	•	•								•				•				•				▪
Malaxis monophyllos				•																					NT	VU	▪	
Nymphaea alba															•		•	•										▪
Ophioglossum vulgatum								•																		VU	▪	
Ostericum palustre																•	•								VU	NT	▪	
Pedicularis palustris											•		•												VU	VU		▪
Pedicularis sceptrum-carolinum																	•								EN	EN	▪	
Pinguicula vulgaris ssp. bicolor				•												•	•	•							CR	EN	▪	
Pinguicula vulgaris ssp. vulgaris					•	•						•					•									NT	▪	
Platanthera bifolia					•	•	•																					▪
Phyteuma orbiculare																	•	•										▪
Polemonium coeruleum																	•									VU	▪	

Pseudocalliergon lycopodioides												•					•	•								E	▪	
Pseudocalliergon trifarium				•											•												▪	
Ranunculus lingua								•																				▪
Salix lapponum																	•									CR	CR	▪	
Schoenus ferrugineus												•				•	•	•									EN	▪	
Schoenus nigricans																	•									VU	EN	▪	
Scorpidium scorpioides											•				•		•	•									E	▪	
Senecio macrophyllus																		•								VU	EN		
Sesleria uliginosa											•	•															VU		▪
Sparganium minimum																	•	•									NT		
Sphagnum fuscum													•		•														▪
Sphagnum teres									•	•			•		•														▪
Sphagnum warnstorfii									•				•																▪
Swertia perennis																	•									EN	EN	▪	
Tofieldia calyculata				•								•				•	•	•									NT	▪	
Tomentypnum nitens									•	•	•		•	•				•	•								V		▪
Trausteinera globosa					•																								
Trollius europaeus																	•										VU	▪	
Utricularia intermedia											•		•														VU	▪	
Utricularia minor									•		•	•	•		•		•	•									NT	▪	
Utricularia vulgaris													•		•		•	•									NT		
Viola epipsila																										CR	EN	▪	

• - species found during project LIFE13 NAT/PL/000024 implementation

• - species recorded in bibliography but not found during project LIFE13 NAT/PL/000024 implementation

Table 3. List of chosen, characteristic plant communities present on Natura 2000 sites within the LIFE13 NAT/PL/000024 project.

Syntaxa	Karkonosze	Beskid Śląski	Beskid Żywiecki	Lipienniki w Dąbrowie Górniczej	Ostoja Gorczańska	Małe Pieniny	Ostoja Popradzka	Torfowiska nad Prosną	Łąka w Bęczkowicach	Dolina Mierzawy	Ostoja Nidziańska	Ostoja Szaniecko - Solecka	Bagna Orońskie	Pakosław	Dolina Zwoleńki	Dolina Górnej Siniochy	Dolina Sieniochy	Łąki nad Szyszłą	Uroczyska Roztocza Wschodniego	Ostoja Magurska	Łysa Góra	Ostoja Jaśliska	Bieszczady	Moczary
Cl. *Potametea* R.Tx. et Prsg 1942 ex Oberd. 1957																								
O. *Potametalia* Koch 1926																								
All. *Potamion* Koch 1926 em. Oberd. 1957															X									
Cl. Utricularietea intermedio-minoris Den Hartog et Segal 1964 em. Pietsch 1965																								
Utricularietalia intermedio-minoris Pietsch 1965																								
Sphagno-Utricularion Müll. et Görs 1960																								
Scorpidio-Utricularietum minoris Müll. et Görs 1960															X									
Cl. *Phragmitetea australis* (Klika in Klika et Novak 1941) R.Tx. et Preising 1942										X	X						X		X					
O. *Phragmitetalia australis* W. Koch 1926				X																				
All. *Phragmition communis* Koch 1926																								
All. *Magnocaricion elatae* W. Koch 1926									X	X								X		X	X	X		X
Caricetum paniculatae								X	X								X							
Cladietum marisci Allorge 1922 ex Zobrist 1935																	X	X						
Caricetum rostratae Rübel 1912 ex Osvald 1923	X		X		X		X		X					X						X		X		X
Thelypteridi-Phragmitetum								X	X						X									

Cl. *Scheuchzerio-Caricetea fuscae* (Nordh. 1936) R.Tx. 1937									X					X		X			X					
Community on a verge of Molinio-Arrhenatheretea cl. and Scheuchzerio-Caricetea nigrae								X																
O. *Caricetalia fuscae* W.Koch 1926 em Nordh. 1936																								
sedge-moss fen alder													X		X									
All. *Caricion lasiocarpae* Vanden Bergen in Lebrun et al. 1949																								
Caricetum diandrae Jon. 1932 em. Oberd. 1957								X																
Menyantho-Sphagnetum teretis Waren 1926								X																X
sedge-moss fen with Phragmites australis				X																				
All: *Caricion davallianae* Klika 1934				X					X	X	X	X	X		X		X	X						
Valeriano-Caricetum flavae Pawłowski 1949 ex 1960	X	X	X		X	X	X													X	X	X	X	X
Caricetum davallianae Dutoit 1924	X		X		X	X	X	X			X													
Caricetum paniceo-lepidocarpae (Steffen 1931) W. Braun 1968 (Syn. i Pseud: *Parvocaricetum* Steffen 1931 *nom. illeg.; Parnassio-Caricetum fuscae* Oberd. 1957 *sensu auct. p.p. Campylio-Caricetum dioicae* Osvald 1923 *em.* Dierßen 1982 *sensu* Wołejko 2000 *p.p.)*								X	X	X	X		X		X									
Carcass comm. from O. *Caricion davallianae*				X				X	X															
All. *Sphagno warnstorfii-Tomentypnion nitentis*									X						X									
Cl. *Molinio-Arrhenatheretea* R.Tx. 1937																								
O. *Molinietalia caeruleae* W. Koch 1926									X		X	X		X		X	X	X	X					
All. *Molinion caeruleae* W. Koch 1926												X				X	X	X	X					

3. Practical experience in the actions taken to protect alkaline fens

3.1. Optimization of water conditions

Robert Stańko

As has been emphasized many times, the most important factor determining the formation and maintenance of alkaline fens is appropriate water conditions. This means that only undisturbed flow rate, appropriate level, and constant inflow of groundwater with specific physical and chemical parameters guarantee the development and proper conservation status of alkaline fens in the long term. Previous chapters, particularly the description of the sites included in the project, show that disturbed water conditions are the most frequent and the most important cause of degradation of habitat 7230. Currently in Poland, with the exception of some sites (probably just single instances), there are no fens located beyond the negative impact of hydrological conditions disturbed by human activity. The most frequent and easily noticeable element of these disturbances are the numerous drainage ditches (in Poland there are about 140 thousand km of them on all the fens!). In Poland, they are generally dug for drainage purposes only, without any means to inhibit excessive drainage or to block them during periods of drought. Due to the existing drainage systems, the drained fens are periodically or permanently dried out. Mineralizing peat radically changes the trophy of the habitat and restricts or completely eliminates the possibility of adapting its surface layer to naturally or anthropogenically changing hydrological conditions.

It is no coincidence that the activities consisting in inhibiting excessive outflow of water or raising the groundwater level occupy the majority of all the activities planned for the protection of fens. Over the last several years, when active protection of fens has become a very popular part of the activities of various organizations and institutions, many technical solutions for the improvement of the hydration of various types of wetlands, including fens, have appeared (Pawlaczyk et al. 2002, Pawlaczyk et al. 2005, Herbichowa et al. 2007, Makles et al. 2014). From the point of view of protection of all mires, including alkaline fens, the improvement of hydrological conditions – optimally, restoration of their original character – should be based on complete elimination of the ditches. The material used for this purpose should be the same as, or very similar to, the soil in which the ditch has been dug. In reality, unfortunately, such solutions do not exist on a larger scale. This is due to a number of factors (ownership and impact of such projects on the neighborhood, limited access to appropriate materials, e.g., poorly decomposed peat, technical capacity, etc.), the most important of which is the economic factor. For this reason, the vast majority of activities improving the water conditions boil down to individual blocking of water outflow from the drainage ditches. It is a compromise that is acceptable in terms of the effects achieved in relation to the required investment.

There is a wide range of technical solutions that effectively inhibit the outflow of water through drainage ditches and raise the groundwater level. Details of specific technical solutions are also described in the literature quoted in this chapter. When implementing the project of alkaline fens protection, as well as other projects aimed at wetlands conservation, we have always tried to pay particular attention to the appropriate selection of technical solutions in relation to local conditions. The most important of these are:

- the size of the drainage ditch and, consequently, the water flow rate,
- the terrain, especially the gradient of the bottom of the ditch, which determines the number of dams required to maintain the proper water content for specific fragments of the fen, and not only of those closest to the buildings,
- accessibility of the terrain and the distance to be covered when transporting the required materials (taking into account the possibility of using machines or the lack of such a possibility),
- the type of substrate on which the gate (or other structures) are to be built.

In our opinion, legal and formal-administrative conditions are also an important factor in the selection of technical solutions. It is worth bearing in mind that the simplest solutions (which obviously meet the requirement of effectiveness) requiring the shortest and least complicated legal procedures are the best ones since they save time and considerable financial resources.

On the basis of the experience gained during the project implementation, it seems that one of the most effective and relatively least expensive solutions for

improving the water conditions of the fens was the construction of various types of wooden gates. They are easy to build and install and they easily integrate into the landscape. Most often, these gates consist of one or two watertight walls made of oak boards (or other hard wood that can maintain its integrity in water for several decades) supported by a stone or earth-stone filling. They can be built even in the most inaccessible areas of the fens (all the necessary material and equipment can be moved without the use of transport vehicles!). Depending on the local conditions, the gates (wooden walls) were subject to various modifications (see photographs below) to prevent bed erosion in the case of dams higher than several dozen cm, or to enable the migration of water fauna. The advantage of simple wooden gates is that it is also possible to adjust the water level without any real additional cost.

When selecting technical solutions it is worth remembering to choose those which will not require special care and attention in the future or frequent repairs. Optimal solutions are those that will not require any maintenance for the assumed period of time, i.e., about 20 – 25 years. The technical solutions adopted in the project seem to meet this requirement and only errors made during their construction may cause a repair to be necessary. The most common cause of various defects is a misidentified elevation of overflows resulting in washing out the edges of the ditch at the ends of the gate. Unfortunately, even a perfectly made gate requires checking from time to time. The cause of its malfunction can be, e.g., beavers taking advantage of the opportunity to raise the water level even higher. During the period of "use" of the gate, taking care of its tightness, as opposed to taking care of the protected fen, is unnecessary. Problems can arise when beavers leave a dam the a formed on the gate, which in such situations is usually destroyed. The problems may also be caused by local residents looking for a non-existent connection between a flooded basement of their own house and a gate located 10 km away or simply random persons, for example, checking the strength of the structure. For this reason, simple and inexpensive solutions also seem to be advantageous in this situation as deliberate or unintentional damage caused can be easily and cheaply alleviated. Numerous examples of technical solutions are presented in the book entitled "The Guidebook on Good Practices in alkaline fens conservation" (Stańko et al. 2018). The improvement of the water conditions in fens is not always connected with raising the water level. Due to

Photo 115. One of the gates built as part of the project in a relatively wide and deep ditch. The use of a double wall with earth filling ensures full watertightness and excludes the possibility of any washing out of the structure (photo R. Stańko).

Photo 116. „Throttling" culvert built in a frame of LIFE13 NAT/PL/000024 project, which serves halting the water outflow from the fen. The excess of water is passed through the culvert pipes (photo D. Horabik).

the increasingly common activity of beavers, some of the fens are permanently flooded. In this situation, the solution used in the project was dedicated perforated PVC pipes, protected in such a way as to prevent their clogging by beavers, placed in a dam at a height ensuring optimum water level in the fen. Examples of such solutions are presented in Volume I of this Report in Chapter 2.

3.2. Inhibition of vegetation succession (mowing, trees removal)

Robert Stańko

Inhibiting the succession of forest vegetation in fens entails removing tree and bush wildings as well as mowing. Apart from inhibiting the succession, these activities contribute to the "defertilization" of the habitat most frequently characterized by increased trophy due to the mineralization of the surface layer of peat. Descriptions of these activities were also included in numerous publications on wetland protection (Pawlaczyk et al. 2002, Pawlaczyk et al. 2005, Herbichowa et al. 2007, Makles et al. 2014). It is worth mentioning here that not all alkaline fens (the best preserved ones) require the removal of trees and especially mowing! It should also be remembered that the frequency of these activities and their timing should be individually adjusted to each area; this usually depends on the degree of transformation of the fen and its vegetation. Observations indicate that the most intensive mowing is needed by the sites that are most deeply transformed. In these areas, early mowing (e.g., June or July) can also be much better than late mowing, especially if it is also intended to inhibit the growth of reed.

The equipment currently available on the market significantly improves the efficiency of these works, but still does not make them easy. An important factor determining the amount of work is the size of the fen. Large areas (several hundred hectares) make it possible to use specialist equipment that is a part of the extensive infrastructure allowing for the self-financing of the project. In these situations, the technical equipment used is worth making to custom order to meet all the requirements for use in difficult terrain (e.g., special continuous tracks designed to run on extremely muddy ground). However, areas of this size are rare even in Central Europe (e.g., the valley of Biebrza). Conducting the activities in the form of mowing alkaline fens is particularly difficult in the case of medium and small-sized sites. Depending on the possibility of access by vehicles or only on foot (mountains sites), objects with a small surface area (a few, a dozen ares) most often use ordinary gas-powered brushcutters. Where the surface area is larger (several, over a dozen hectares) and at the same time there is a relatively easy access by a vehicle, small single-axle tractors can be used (their weight is about

Photo 117. Single-axle tractor – a rubber track reel mower, perfect for coping with the most difficult conditions on a strongly hydrated fen, is a very good and effective technical solution. It enables mowing about 4 – 5 times as much area as a brushcutter in the same time, using about 2/3 less fuel while not damaging the vegetation (photo R. Stańko).

Photo 118. Preparing for the harvesting of the mown biomass with light horticultural tractors – even with wide or double wheels – is possible only for some of the fens, while manual harvesting remains the only option for the remainder (photo R. Stańko).

120 – 200 kg). Regardless of the water content, the best tractors for this purpose are those moving on rubber tracks with little contact pressure, which do not damage vegetation, especially the moss layer (see photo 117).

However, the biggest problem in the course of mowing operations is the removal of the mown biomass. Biomass is usually only partially dried and cannot be compressed and harvested mechanically. This part of work is sometimes the hardest (manual removal of biomass to the remote mineral edge of the fen) and the most expensive. Another issue worthy of attention is the problem with the use of the mown biomass, which is usually unsuitable for animal feed. Harvesting, preparation for transport (e.g., the need to compress biomass which is not sufficiently dried), the transport itself, in practice, in all conditions of small, distributed areas, incurs a cost that far exceeds any potential revenue.

3.3. Creation of nature reserves, land purchases

Magdalena Makowska, Dorota Horabik, Paweł Pawlaczyk

One of the important elements of the projects was the purchase of land and the creation of nature reserves (LIFE11 NAT/PL/423). Both these activities are perceived by the Naturalists' Club as tools permanently protecting areas of high natural value and additionally sanctioning the priority of nature conservation in a specific area, in contrast to Natura 2000 areas where human economic activity is treated mostly as equal to nature protection by definition.

In Poland, in the last 20 years, on private land (excluding land belonging to non-governmental organizations) practically no reserves were created, and the only two cases from the entire country seem to confirm this rule (Jermaczek 2016). The negative attitude of private owners towards creating reserves on their land results from the obvious loss of full control over the area and serious restrictions on the use of the area, with the absence of any system of compensation by the state. Therefore, one of the main tasks of the project LIFE11 NAT/PL/423 was to buy out the land which would allow the inclusion of a valuable part of the fen in reserve protection.

For various reasons (mainly the consequences of various conflicts and the growing hostility between NGOs and the government administration responsible for nature conservation), NGOs with a significant amount of land eligible as nature reserves are also often reluctant to include them in this form of protection.

Unfortunately, the situation is not significantly better in the areas belonging to the State Treasury. In recent years, on average, only a few reserves have been created in Poland each year. This is not due to a very well-developed network of nature reserves in the country or a lack of sites meeting the appropriate criteria, but rather results from common reluctance on the part of the state administration to accept this form of nature protection (although there are also exceptions in this respect). A great, unused potential in the scope of creating new reserves is presented by the land under the management of the State Forests National Forest Holding [Polish - Dyrekcja Generalna Lasów Państwowych] (managing the area occupying 30% of the total area of Poland!), or the National Centre for the Support of Agriculture [Polish – Krajowy Ośrodek Wsparcia Rolnictwa] (formerly the Agricultural Property Agency – Agencja Nieruchomości Rolnych). It is difficult to identify clear reasons for this state of affairs. One of the most important counter-arguments raised is that the location of the site within the boundaries of a Natura 2000 area is a sufficient method of its protection. The experience of the Naturalists' Club, gained both during the implementation of the projects and during its participation in the legislative consultation process, including plans of conservation tasks for Natura 2000 areas, does not confirm this opinion. However, it often and unequivocally indicates that the creation of reserves is the only effective tool for the protection of habitats and species for which a Natura 2000 area has already been established. In addition, they have broader and more far-reaching objectives. It is for this reason that they are distinguished in the Act on Nature Conservation as an independent form of nature protection. This also applies to reserves inside Natura 2000 areas. Due to the fact that the protection of Natura 2000 areas is limited to the resources of specific species and natural habitats, it does not ensure the protection of the entire nature and does not protect many other values that may also occur in sites within the Natura 2000 area. In such cases, they may require protection as a nature reserve inside a Natura 2000 area.

Reserve protection is therefore particularly necessary where not only species or natural habitats protected by the Natura 2000 network but also other values are worth securing and protecting. These values occurring in the areas proposed by us for establishing reserve protection include, among others:

- the entire natural and landscape complex, particularly dynamic and shaped by natural processes,

e.g., a complex of aquatic vegetation formed as a result of the succession of the overgrowing lake bay;

- landscape, particularly being the result and expression of natural processes (e.g., natural landscape of old river beds, landscape of well-preserved and extensive moss mires, flush mires and sedge patches);
- strong populations of endangered (at least regionally) species not listed in Annex II of the Habitats Directive and therefore not directly protected within a Natura 2000 area. A typical example would be some species of moss, i.e., *Paludella squarrosa, Helodium blandowii* or the extremely rare in Poland *Eriophorum gracile, Viola epipsila*, and *Herminium monorchis*, which are not protected under Annex II of the Habitats Directive although they are valuable and rare species. These species can be found in the area of our proposed/established reserves. The inclusion of these areas in reserve protection has strengthened the protection of these species independently of the protection of habitat 7230 where they occur;
- ecosystems/biogeocoenoses not directly protected within Natura 2000 areas, e.g., spring riparian forests, species-rich wet meadows, and sedge reeds. These ecosystems can be found in the areas of our proposed/established reserves. The protection of all the 7230 ecosystems surrounding the habitat which are functionally connected with the alkaline fen allows for a more permanent protection of the processes taking place in the surroundings of the fen, which are necessary for the proper functioning of the habitat protected within the framework of the Natura 2000 area;
- ecological or geomorphological processes – the protection within the Natura 2000 area does not always allow for the protection of natural, dynamic ecological processes. A reserve allows to include as a protection objective the preservation of those processes which naturally shape the ecosystems in the reserve area;
- natural values preserved in a natural state or with little change that should be excluded from the economy and shaped by natural processes, especially when such a process does not result directly from the requirements of the Natura 2000 area.

It should also not be overlooked that scientific and cultural values which are not taken into account in any way during the protection planning of a Natura 2000 area may be protected as part of the reserve protection. The social perception of the site as a protected area is also important.

It is not without reason that the art of nature protection widely recognizes, uses, and recommends the tool of internal zoning of the sites and methods of protection of larger protected areas, in particular the existence of „core zones" with increased protection requirements. The creation of nature reserves within a Natura 2000 area is the simplest way to achieve precisely this internal zoning of a Natura 2000 area, which will prove very useful for the protection of natural habitats and species in the area – in particular, for the preservation of the full biodiversity supported by natural habitats. At the same time, it is worth emphasizing that such protection often requires that certain patches of a natural habitat – more than the rest of the resources of that habitat in the same area – should be protected above the general standard (Pawlaczyk 2016).

It should also be emphasized that ensuring such protection within the Natura 2000 area itself would certainly require the development of a conservation plan, and not only a plan of protection tasks, because the plan of protection tasks does not allow for effective implementation of the prohibitions and restrictions that are often necessary for good protection of a Natura 2000 area. In practice, the planning tools of Natura 2000 areas are so imperfect that some important conservation measures (e.g., protection of entire ecosystems, processes or landscape values) cannot be implemented within them, or are very difficult to implement. The use of other forms of nature conservation within a Natura 2000 area is a good and simple way to implement some of the conservation measures that are highly desirable also from the point of view of a Natura 2000 area and cannot be included in the plans for that site.

It is important, especially in view of the Ministry of the Environment's interpretation, that no prohibitions or restrictions may be introduced in the plans of protection tasks. Meanwhile, appropriately formed prohibitions and restrictions on certain forms of human activity are very often necessary, also from the point of view of the protection of the Natura 2000 area. The creation of a nature reserve within a Natura 2000 area is the best way to introduce and shape such

regulations for human activities, as it automatically introduces the package of prohibitions from Article 15(1) of the Act on Nature Conservation, allowing for their appropriate, detailed adjustment, and reduction, as far as it is necessary, through the establishment of a conservation plan.

In particular, the following facts are worthy of emphasis:

- recognition as a nature reserve is, in the current legal system, the only effective method (excluding national parks) of permanently excluding the land from business activity and restoring it to natural processes (if it is part of the objectives of creating the reserve), and the existence of patches of natural habitats thus protected is often very necessary to achieve the objective of the Habitats Directive, which is to „protect biodiversity by protecting natural habitats". At the same time, it should be remembered that even if such exclusions were included in the plans for Natura 2000 areas or in the forest management plans, they would be in force only during the period covered by the plan. The reserve is the only form of area protection that has „perpetual" effects (together with limiting the possibility of liquidation to the case of the disappearance of the protected values), which can ensure the protection of natural processes in the timescale appropriate for their formation;
- recognizing a site as a nature reserve is the only effective way of permanently excluding it from hunting – and the existence of such sites, where hunting is prohibited, is important where there is a need to provide „rest areas" for animals or to promote the presence of animals due to its positive impact on ecological processes (e.g., the natural maintenance of non-forest ecosystems by eating the tree vegetation);
- similarly, the area covered by reserve protection allows for effective preservation of the existing good and stable water conditions in the area;
- recognition as a nature reserve is, in the current legislative system, the only effective tool for the organization, distribution and, potentially, limiting of tourist traffic. It introduces a prohibition on human presence (together with sanctions for infringement), while allowing exclusions by designating routes, accessible locations, etc. (Pawlaczyk 2016).

It should also be emphasized that the formula of the reserve is very useful in places where protection requires strong control. While in the Natura 2000 area „what is not harmful is allowed", which is easily and often abused, only the formula of the nature reserve clearly reflects this approach: „only what is explicitly approved by the nature protection authority is allowed" – either in the conservation measures or in the conservation plan, or finally in the relevant administrative decision (in the case when there are no relevant planning documents). The protection of the areas proposed by us – together with all their values – requires such an approach in order to fully and properly protect them. A good example of this is the problem of providing a calm sanctuary to the animals in moss patches, as their activity is a natural factor inhibiting forest succession. Based on the experience of the Naturalists' Club in the preparation and consultations concerning the conservation measures plan, it was not possible to include these aspects of the plan for Natura 2000 areas.

The establishment of a reserve is a clear message to the public that nature is protected and that the relevant authorities are concerned. Nature reserves are valuable because they identify a place with its specific natural and landscape values, both on the map and in the collective consciousness of the society. Reserves are commonly (and not without reason) seen as the *crème de la crème* of nature. For some communes and forest inspectorates, the local presence of a nature reserve(s) is a reason to be particularly proud and a confirmation of the outstanding, unique values of a given location and the efforts of these authorities to preserve it. Reserves are displayed in publications, on the Internet, on maps, etc., saturating them with natural content; their existence stimulates and concentrates scientific research, advanced natural education, obtaining necessary funds for protection, etc. The status of a nature reserve provides a unique brand to a given location, which no other formula can replace (Pawlaczyk 2016).

The long experience of the Naturalists' Club shows that the nature reserve form is more noticeable for the society, and more valued and respected than the Natura 2000 areas, which in our country are still young and unknown to a wider audience. As a result, the valuable area is better protected against negative factors related to human activities.

Table 4. Nature reserves planned during the LIFE11 NAT/PL/423 project:

Name	Location (region, municipality)	Conservation objectives	Area (ha)	Status
Established				
Mechowisko Kosobudki	Lubuskie, district Świebodzin, municipality Łagów	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	12,47 ha	Established (O.J. of Lubuskie 2017, no. 365)
Dolina Ilanki II	Lubuskie, district Sulęcin, municipality Torzym	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses (the reserve is supplementing already existing reserve Dolina Ilanki)	11,32 ha	Established (O.J. of Lubuskie 2017, no. 363)
Jezioro Ratno	Lubuskie, district Sulęcin, municipality Torzym	preservation of the aquatic-fen complex of eutrphic lake, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	48,72 ha	Established (O.J. of Lubuskie 2017, no. 364)
Mechowisko Radość	Pomorskie, district Bytów, municipality Lipnica	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	9,59 ha + buffer zone 69,36 ha	Established (O. J. of Pomorskie 2013, no. 2737)
Mechowiska Sulęczyńskie	Pomorskie, district Kartuzy, municipality Sulęczyno	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	22,58 ha + buffer zone 40,65 ha	Established (O. J. of Pomorskie 2014, no. 4108)
Mechowisko Krąg	Pomorskie, district Kościerzyna, municipality Stara Kiszewa	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	3,81 ha + buffer zone 17,07 ha	Established (O. J. of Pomorskie 2016, no. 1767)
Gogolewko	Pomorskie, district Słupsk, municipality Dębnica Kaszubska,	Preservation of soligenous fens and meadows together with characteristic biocenosis.	37,51 ha + buffer zone 75,10 ha	Established (O. J. of Pomorskie 2018, no. 1131)
Kruszynek	Pomorskie, district Chojnice, municipality Brusy	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	8,42 ha + buffer zone 11,03 ha	Established (O. J. of Pomorskie 2014, no. 1051)

Name	Location (region, municipality)	Conservation objectives	Area (ha)	Status
Mechowisko Manowo	Zachodniopomorskie, district Koszalin, municipality Manowo	preservation of soligenous alkaline fen in the complex with transition mires, riparian and bog forests together with the characteristic phytocenoses rich in flora and fauna	55,47 ha	Established (O. J. of Zachodniopomorskie 2018, no 3973)
Not established				
Torfowisko Pliszka	Lubuskie, district Krosno Odrzańskie, municipality Bytnica	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	19,45 ha	Lack of consent of Bytnica Municipality
Jezioro Wierzchołek	Wielkopolskie, district Złotów, municipality Zakrzewo	preservation for scientific, didactic and nature protection reasons of water and fen complex distinguished by the richness of flora and specific, rare phytocoenoses, as well as occurring processes of precipitation of calcium compounds (travertines) within the surface layer of moss vegetation	21,42 ha	RDEP in Poznań did not answer the Naturalists' Club application and left it without response
Jezioro Małe Długie	Pomorskie, district Kościerzyna, municipality Kościerzyna	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	7,4 ha	The whole area is private property - the owners did not allowed to set up a reserve or purchase land
Kwiecko	Zachodniopomorskie, district Koszalin, municipality Bobolice	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	4,91 ha + buffer zone 22,66 ha	RDEP in Szczecin recognized the creation of a reserve as unintended because it considered protection under the Natura 2000 network as sufficient
Dolina Płoni	Zachodniopomorskie, districy Myślibórz, municipality Barlinek	preservation of the alkaline fen ecosystem with a unique flora of mosses and vascular plants	23,28 ha	The majority of the area is private property - the owners did not allowed to set up a reserve or purchase land
Nowa Studnica	Zachodniopomorskie, district Wałcz, municipality Tuczno	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	30,59 ha	RDEP in Szczecin recognized the creation of a reserve as unintended because it considered protection under the Natura 2000 network as sufficient

Name	Location (region, municipality)	Conservation objectives	Area (ha)	Status
Kobyla Biel	Podlaskie, district Augustów, municipalities Nowinka and Augustów	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	22,33 ha	RDEP in Białystok recognized the creation of a reserve as unintended because it considered protection under the Natura 2000 network as sufficient
Borsuki	Podlaskie, district Augustów, municipality Płaska	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	6,8 ha	
Sawonia Mostek	Podlaskie, district Sejny, municipality Giby	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	2,3 ha	
Bagienna Dolina Rospudy	Podlaskie, district Augustów, municipalities Nowinka and Augustów	preservation of the fen complex, in particular soligenous, springs and forest and non-forest terrestrial and aquatic ecosystems together with their characteristic biocenoses	304,77 ha	

The resistance exhibited by various institutions, including some representatives of the State Forests NFH, is not primarily due to the possibility of losing potential benefits, including financial profit, but rather to the awareness of the loss of full control over the area, or the possibility for employees to pursue their hobbies in the form of hunting.

Also, not all employees of the authorities responsible for the establishment of nature reserves share the enthusiasm of naturalists for their establishment, as it is connected with the necessity of drawing up conservation plans, supervising the protective activities carried out, and most importantly – efforts to collect funds to implemnt them.

As a result of the project we state that for proper alkaline fens conservation there is a need of establishing as reserves those sites:

Torfowisko Pliszka

The planned reserve is located within a large forest complex included in the so-called Lubusz Forest. In the originally planned boundaries of the reserve covering the entire peatland complex along with adjacent forests, four ecological mire types were found: fluviogenic, soligenous, spring-fed and after lake terrestrialisation mires. They are connected in spatial complexes and can transform into one another as a result of succession, often induced by hydrological changes in the landscape scale. In the Pliszka Valley there is a visible belt zonation, related to the hydrological regime of the river and the impact of spring waters in the valley's hillside zone.

The largest area is covered fens. Peat layers with a thickness of approx. 3-4 m cover of lake sediments of a considerable depth, consisting of organic-calcareous gyttja. The fen is, therefore, at the same time

Fig. 89. Localisation of proposed reserve „Torfowisko Pliszka".

a remnant of lake terrestrialisation. In the course of field research in the area of the planned reserve and its closest neighborhood covering the entire fen complex, 185 plant species were found - 150 species of vascular plants, and 35 species of bryophytes. The flora of the planned reserve in opposition to neighboring areas isrelatively rich which results from the large diversity of the natural environment, especially the presence of such specific habitats as the spring mires, sedge-moss fens, bog and slope forests. Within the boundaries of the planned reserve 22 species of rare plants, endangered or protected by law (Stańko et al. 2014a) were found.

Jezioro Wierzchołek

The planned nature reserve occupies the initial fragment of a long glacial trough with numerous water reservoirs, partially water-bearing, as well as mires and bog forests. The designed reserve is mainly occupied by mires and a natural, eutrophic water reservoir. The vicinity of the planned reserve is covered mainly by pinewoods and broadleaved forests with a small share of acidic beechwood. The area of the designed reserve is characterized by a fairly varied topography. Its picturesque landscape is influenced by quite high and steep slopes of the postglacial channel sloping towards the lake and mire. The area of the planned reserve consists mainly of Lake (= Jezioro in Polish) Wierzchołek, surrounded on almost all sides by mineral soils, and a soligenous fen, filling former northern bay of the lake. Within the boundaries of the planned reserve, there were found 130 species of vascular plants, including *Epipactis palustris, Listera ovata* and *Carex diandra*, and 22 species of bryophytes including *Helodium blandowii, Homalothecium nitens*, *Drepanocladus intermedius*. All plant communities found in the area of the planned reserve can be recognised as natural phytocenoses (Stańko et al 2014a).

Fig. 90. Localisation of the planned „Jezioro Wierzchołek" reserve.

Fig. 91. Planned „Jezioro Małe Długie" reserve in aerial photo.

Jezioro Małe Długie

The planned reserve is a small (about 6 ha) fen in a narrow and deep former lake channel (postglacial) - the former bay of the Małe Długie Lake in the Bory Tucholskie forest complex. The area is built of sandstone formations, and the surface and underground basin is dominated by pine forests. Nevertheless, the waters infiltrating the basin of the fen and adjacent lakes have a high concentration of calcium and magnesium salts, which has a key impact on the development of alkaline fens within mesotrophic alkaline lakes accumulating lake sediments in the form of calcareous gyttja. In the past, the majority of the fen was used as a meadow. Nowadays, this part of the area is home to an interesting sedge-moss vegetation with a large population of *Epipactis palustris*. Sedge-moss vegetation takes up the edges of the terrain and fragments closest to the lake. Part of the former sedge-moss fens, located closest to the mineral edges, occupy floristically rich and naturally valuable meadow phytocoenoses from the *Calthion* association.

Fen, despite the small area, has unique advantages in the whole country - mainly due to the presence of yellow marsh saxifrage *Saxifraga hirculus* population found here in 2009 (Gdaniec 2010) the previously not recorded in literature position of *Liparis loeselii* (Stańko R., Kiaszewicz K. - oral information) was found.

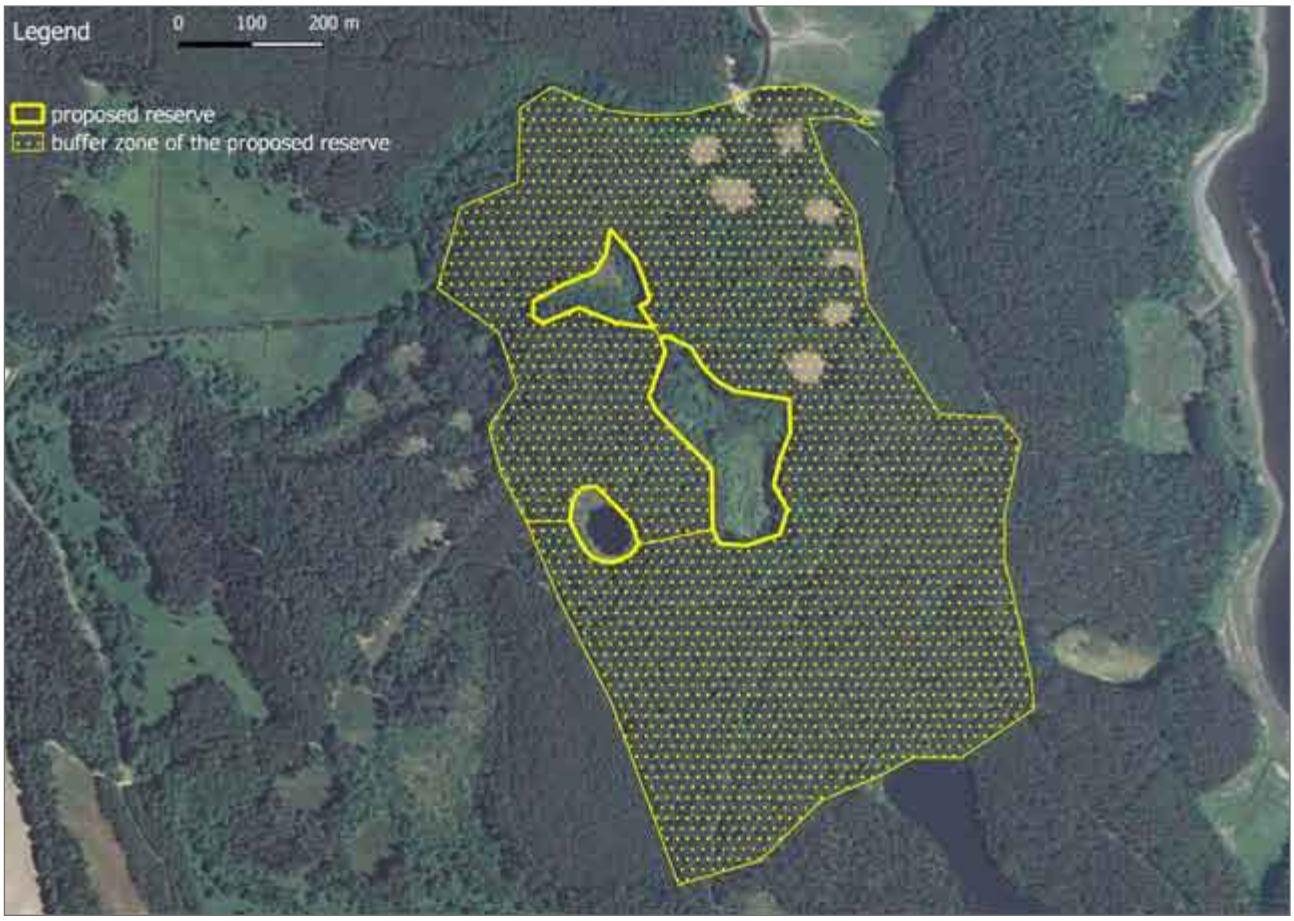


Fig. 92. Localisation of proposed „Kwiecko" reserve and its buffer zone.

Kwiecko

The planned reserve is located within a forest complex located near the Lake Kwiecko. They are mainly pine forests with an admixture or a small share of beech. There are a few depressions in the area with small lakes or swamps.

The area of the planned reserve and its buffer zone is a typical example of a young glacial landscape, shaped mainly during the last deglaciation. In the northern part, the area adheres to the trough of the Radew valley, which starts from the extensive melting basin of Lake Kwiecko. A small side valley, connecting with the Radew valley, is divided into small depressions currently filled with wetlands at various stages of development. One of them is a segde-moss fen with an area of about 3 ha, which is the most important site protected in the planned nature reserve.

Wetlands ecosystems of this area are interrelated developmentally, constituting successive links of ecological succession (functioning peat-forming process) or degenerative stages of these ecosystems (most often associated with attempts to drainage in the past). In such places we observe the development of marshy shrubs and forest communities on the peat. In the area of the designed „Kwiecko" reserve, there were found 90 species of plants, including 67 species of vascular plants - among them *Carex diandra, Epipactis palustris, Scheuchzeria palustris* and 23 species of bryophytes, including *Hamatocaulis vernicosus, Paludella squarrosa* or *Helodium blandowii* (Wołejko et al. 2014).

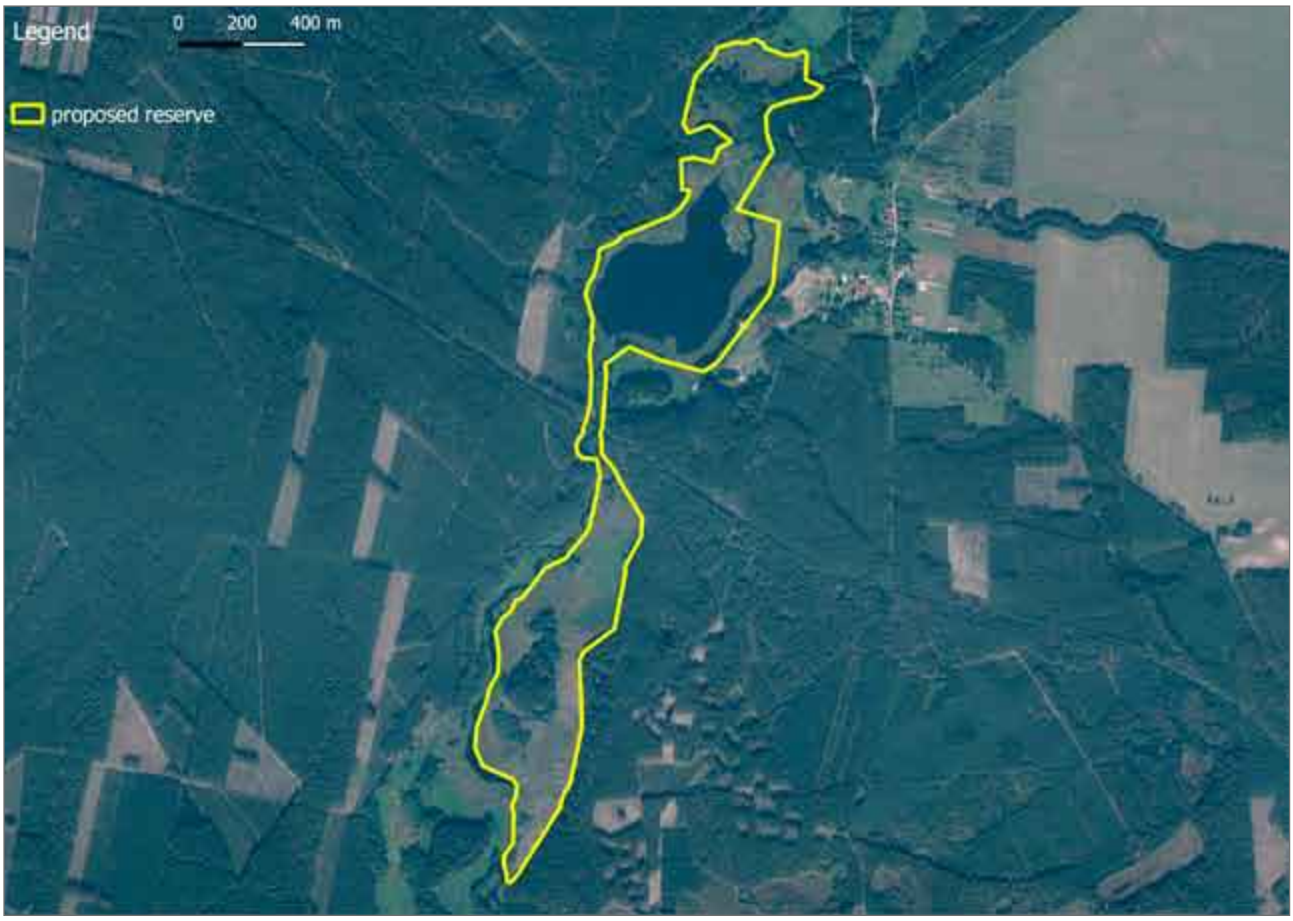


Fig. 93. Localisation of „Nowa Studnica" planned reserve.

Nowa Studnica

The planned nature reserve is located within the dense forest complex of the Puszcza Drawska forest, within the valley dissecting the sandur area. The edges of the valley are cut with shallow erosive gorge. The valley is largely filled with sediments of terrestrialased lakes. In its central part currently, the river Korytnica flows. The river is adjoined by well-hydrated and relatively extensive fragments of emmersive post-lake mires, ie actively reacting to changes in the water level in the river. Another element, more distant from the river, is a belt of percolating, soligenous fens, fed with groundwater out flowing from under the slopes of the sandbank surrounding the valley. Mineral islands located in the central part of the valley have a special role in feeding these mires. They play the role of hydrological windows through which underground waters emerge, feeding the best preserved fragments of sedge-moss vegetation. In the northern part of the planned reserve dominate the spring fens. They have the character of large cupolas "suspended" on the western slopes of the valley. They entered from the edge of the valley to the surface of the former lake reservoir, filled with limnic deposits and peat. The flora of registered vascular plants of the reserve has 159 species, among others *Dactylorhiza fuchsii, D. maculata* or *Epipactis palustris* and bryophytes flora of 22 species, including *Hamatocaulis vernicosus, Paludella squarrosa, Helodium blandowii* (Wołejko et al. 2015).

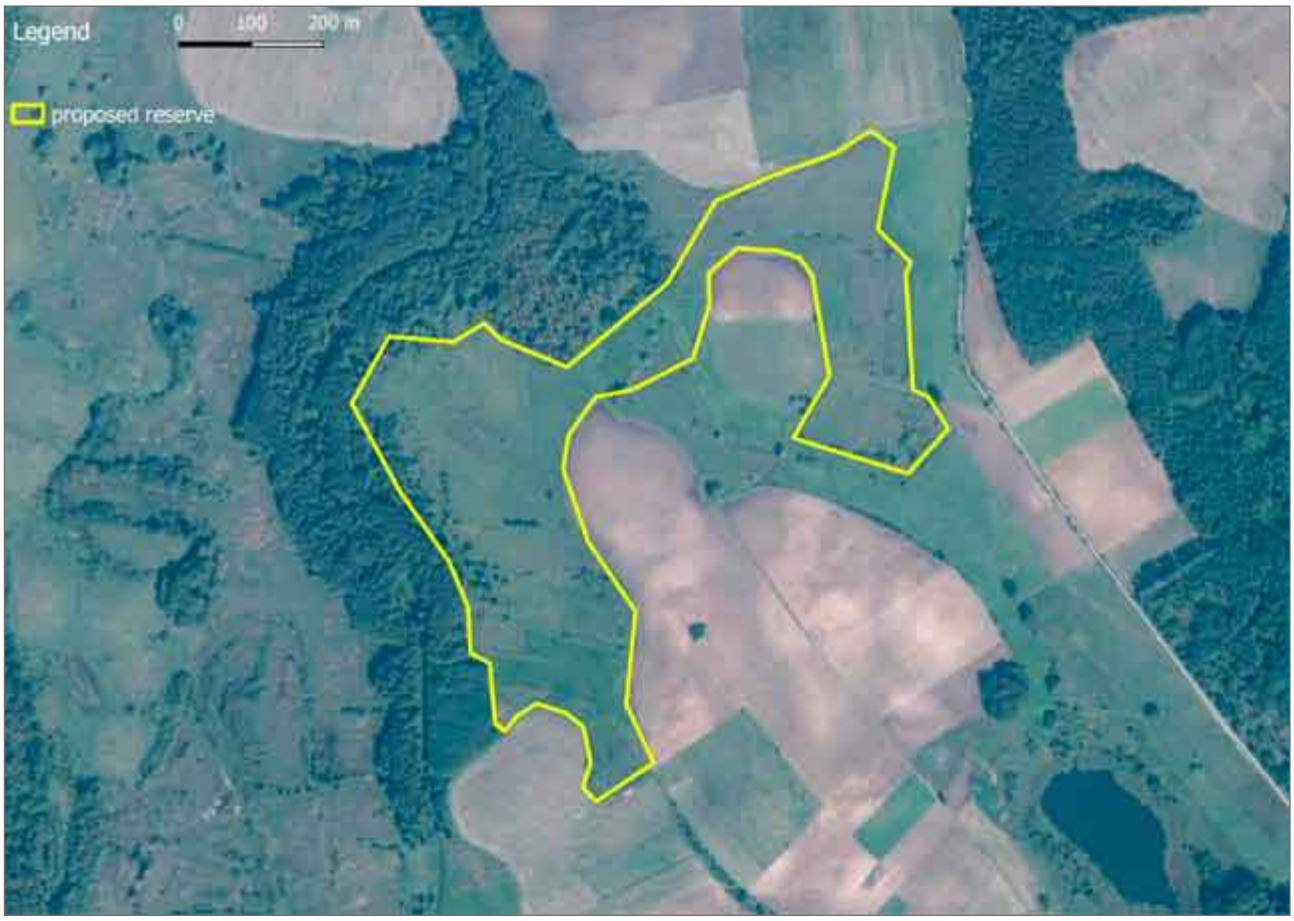


Fig. 94. Planned reserve „Dolina Płoni".

Dolina Płoni

The planned nature reserve includes a complex of soligenous fens with an area of approx. 25 ha located within the upper section of the Płonia river valley near Żydowo. It is a postglacial valley, crossing the highest moraine band of the Pomeranian phase of the last glaciation. The groundwater revealed here at various levels fed numerous springs, soligenous fens and water reservoirs. These waters are rich in calcium, which is evidenced by the active processes of petrification, as well as thick layers of subfossile carbonate deposits - travertines.

The fen near Żydowo fills local depressions between moraine hills located in the central part of the valley. The surface of the fen is inclined towards the Płonia river, which flows along this stretch over the former spring-fen sediments. Currently, water is discharged from the fen by a network of deep ditches. The Płonia Valley is one of the largest north-western refuges of plants associated with habitats rich in calcium. The alkaline fen near Żydowo is important for the preservation of the endangered species population - *Juncus sybnodulosus*. In addition, there are numerous populations of such species as: *Dactylorhiza incarnata, D. majalis, Trollius europaeus* and *Carex appropinquata* (Stańko ed. 2018).

Fig. 95. Localisation of proposed reserve „Kobyla Biel".

Kobyla Biel

The planned nature reserve occupies part of the terrestrialised lake mire together with forest communities that are part of the Augustów Primeval Forest. The system of plant communities in the former bay of the Augustów Lake, the western part of which is the planned reserve, reflects the various stages of plant succession on the overgrowing fen fed by soligenic water. The creation of a mire within the boundaries of the planned reserve is associated with the activity of the glacier of Baltic phase. Part of one of the larger post-glacial gutters occupies the Białe Augustowskie Lake and the fen is a fragment of the former, relatively extensive (about 60 ha) lake bay, located in its north-western part. As a result of the processes of shallowing and terrestrialisation, it was filled with peat sediments, with the process occurring under the conditions of accumulation of calcium compounds, which led to the formation of alkaline fens (Tyszkowski 1992). The layers of peat are, therefore, underlain by gyttia, forming in the lake bay. Currently, this area presents various stages of plant succession - from open segde-moss fen patches to mature bog forest. The current flora of the planned reserve includes 113 species of vascular plants, the most numerous being the *Cyperaceae* (24 species) and *Orchidaceae* (12 species) families (Gutowska et al. 2016).

Borsuki and Sawonia Mostek

Described sites distant from each other by about 5 km are soligenous fens with moss-sedge or moss vegetation. The coming into being of these fens is related to the terrain structure, which is the result of melting of the glacier ice. The Augustów Plain is a flat area of sandurs, built of sands and gravels embedded by the waters of a melting glacier. It is crossed by river valleys, there are also numerous lakes formed from the melting of dead ice lumps. Within the boundaries of the designed reserves,

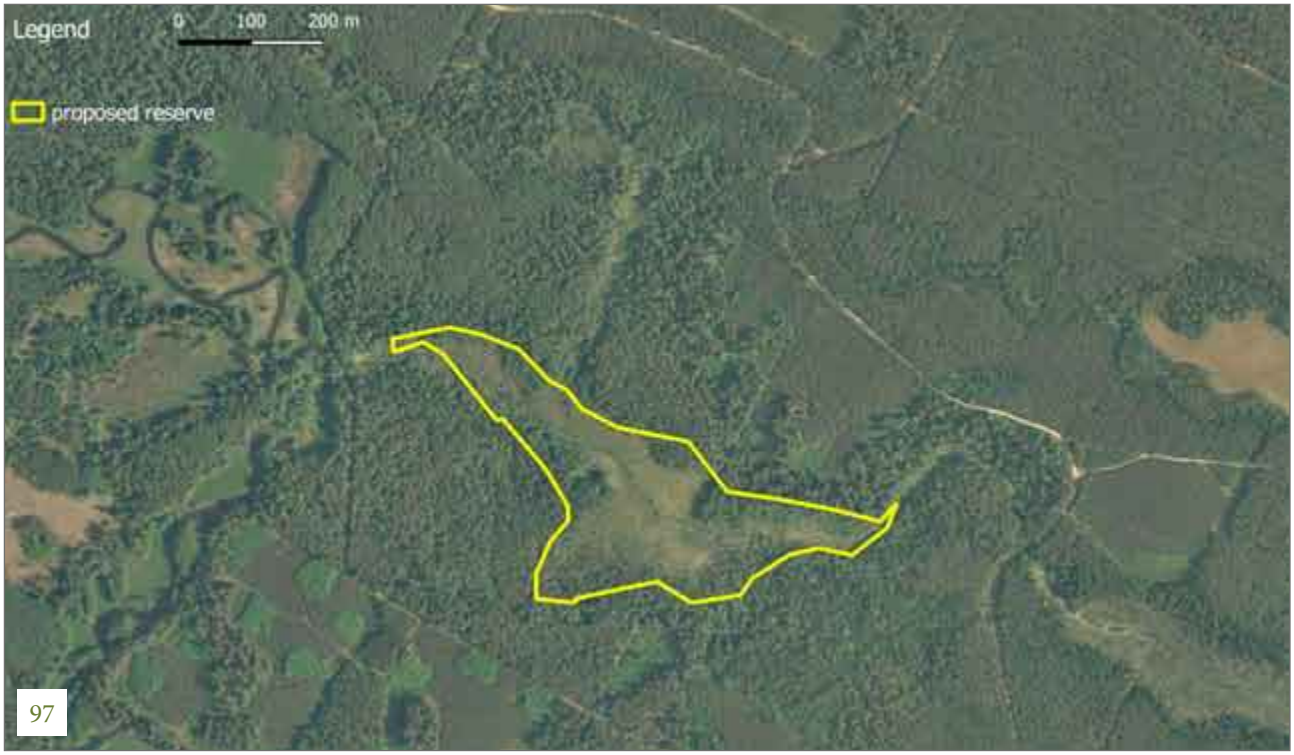


Fig. 96 – Borsuki and Fig. 97 – Sawonia Mostek. Localisation of two planned reserves on an aerial photo.

many rare and protected species were found. Among the vascular plants deserve attention: *Aldrovanda vesiculosa, Baeothryon alpinum, Betula humilis, Carex chordorrhiza, C. dioica, C. limosa, Cladium mariscus, Dactylorhiza baltica, D. fuchsii, D. incarnata, D. incarnata* ssp. *ochroleuca, D. ruthei, Drosera rotundifolia, D. anglica, Empetrum nigrum, Epipactis palustris, Eriophorum gracile, Listera ovata, Malaxis monophyllos, Pedicularis palustris, Salix lapponum, Utricularia intermedia* and *U. minor*. Particularly important in the area are also species protected under the Habitats Directive: *Liparis loeselii* (several hundred individuals), *Saxifraga hirculus* (several thousand individuals) and *Stellaria crassifolia* (locally medium abundance). There are also protected species of bryophytes, among others *Bryum neodamense, Campylium stellatum, Cinclidium stygium, Hamatocaulis vernicosus* (species protected under the Habitat Directive), *Helodium blandowii, Meesia triquetra, Paludella squarrosa, Pseudocalliergon trifarium, Scorpidium scorpioides, Sphagnum contortum, S. fuscum, S. teres, S. warnstorfii, Limprichtia cossonii* and *Tomentypnum nitens* (Gutowska et al. 2014).

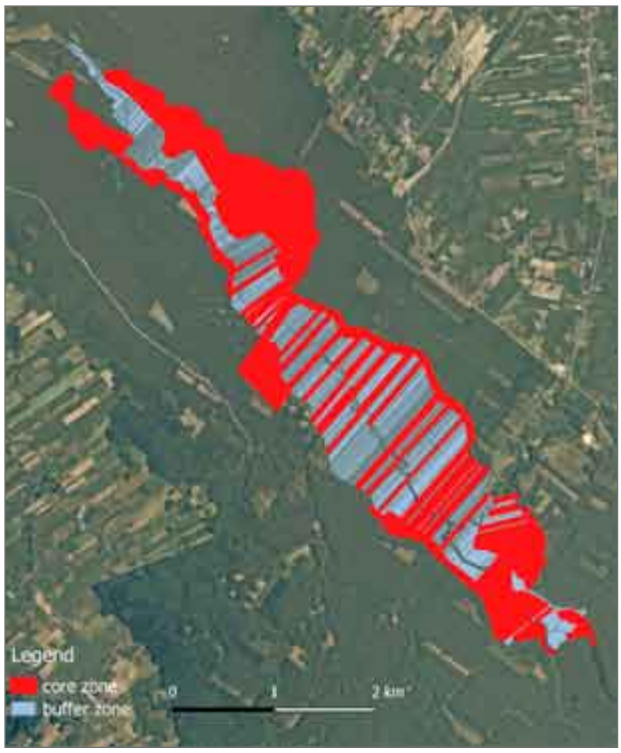


Fig. 98. Localisation of the proposed „Bagienna Dolina Rospudy" reserve.

Bagienna Dolina Rospudy (Wetlands of Rospuda Valley)

The planned nature reserve includes plots purchased thanks to the implementation of the LIFE11 NAT/PL/423 project currently owned by the Naturalists' Club, plots of State Treasury managed by SFH and the Augustów Municipality (plots once bought by General Directorate of Roads and Higways Administration for the construction of the Augustów beltway and then given to the community when the baypass was built elsewhere). Other remaining plots are private property and were included as a buffer zone of the reserve. Hence such unusual shape of the proposed reserve.

The planned reserve is located within a large forest complex that is part of the Augustów Primeval Forest. The area directly surrounding the wetlands of Rospuda valley was to a large extent a forest area, where management of varying intensity was conducted over the last centuries. The valley itself until the 1970s was extensively used for agriculture. Plots were mowed by hand, with a frequency depending on the availability of the area (no fixed dates of use), and hay was transported in winter when the surface of the fen was frozen. In the northern zone of the planned reserve (northern basin), the beginning of the alluvial river delta begins. On these soils interwoven layers of peat formed by forest and rush communities. Peat created by the sedge-moss vegetation in this place began to form relatively recently. In the central part of the planned reserve (southern basin), on the area of the former lake basin already out of the range of the alluvial delta, at a depth of about 3 m on the gytja, there is a small layer of peat formed by the communities of aquatic plants of terrestrialised lake, and on it there is a thick layer of sedge-moss peat (Jabłońska et al. 2010). The current flora consists of 274 species of vascular plants, including *Eriophorum gracile, Baeothryon alpinum, Betula humilis, Herminium monorchis, Saxifraga hirculus* (Gutowska et al. 2016a). The fen of the Rospuda Valley are not without reason considered to be one of the most valuable in Poland and Europe. The first attempts to cover them with reserve protection date back to the 1980s.

In addition to the aforementioned reserves designed as part of LIFE project, apart from the scope of these projects, but within the statutory activities of the Naturalists' Club, the conservation concept of several further valuable alkaline fens was additionally created:

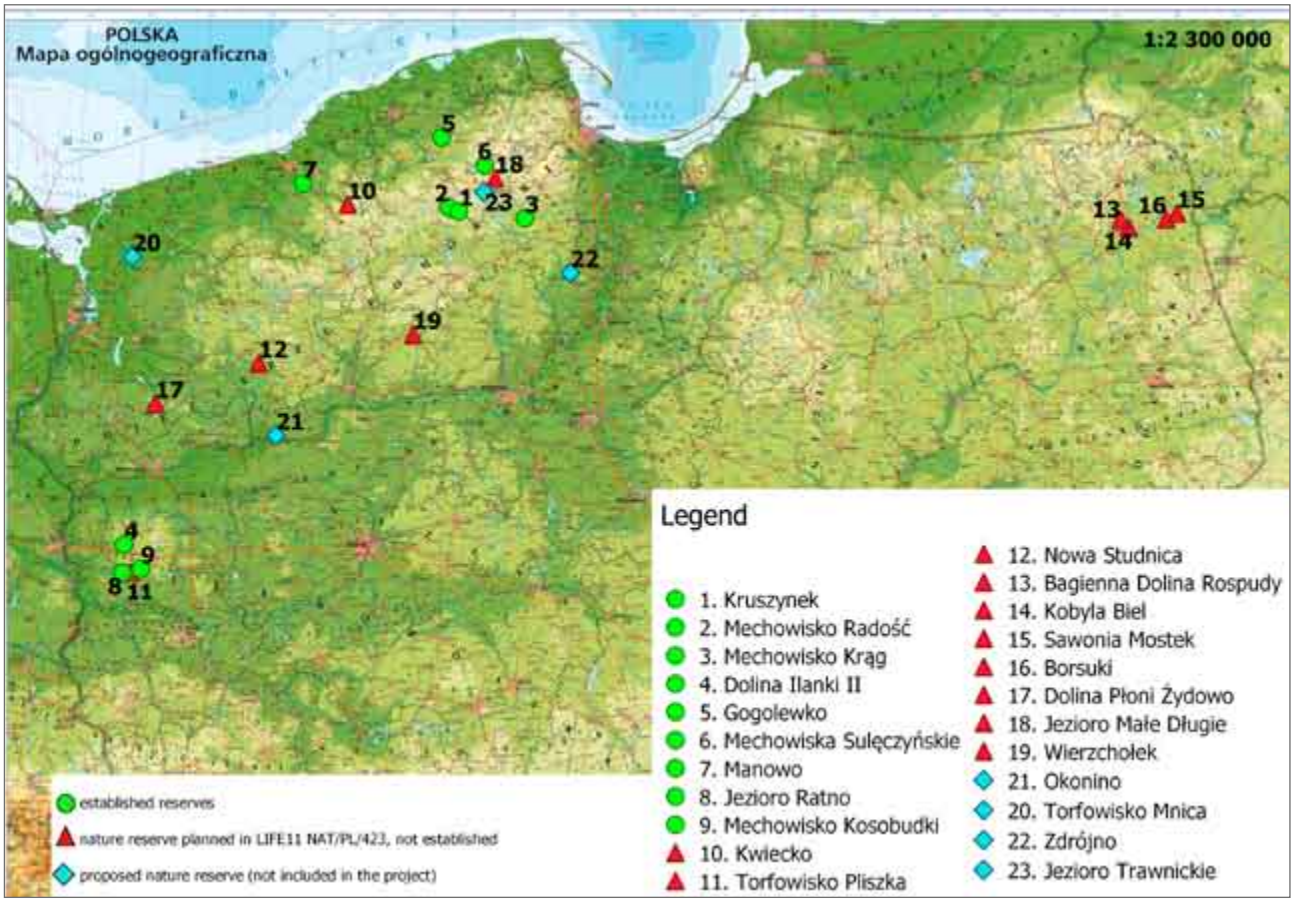


Fig. 99. Localisation on general country map all above and below mentioned reserves.

- **Torfowisko Mnica** (about 20 ha, 53,40101˚N, 15,70,840˚E), located on the Drawsko training ground, in the municipality of Drawsko Pomorskie in the Zachodniopomorskie province and in the Natura 2000 site "Jezioro Lubie i Dolina Drawy" PLH320023. In the site there is a patch with the *Cladium mariscus* and a well-developed sedge-moss fen on the percolating mire, among others with large patches of *Eleocharitetum quinqueflorae*. There is also a population of the *Liparis loeselii* and the *Drosera anglica* (Kujawa-Pawlaczyk unpubl.).

- **Jezioro Trawnickie** (ca. 32 ha, 54,06333˚N, 17,75056˚E), located in the municipality of Lipusz in the Pomeranian province, outside the Natura 2000 site. In addition to the lake with *Chara* sp. and three eutrophic lakes in the terrain gutter, there is 1.5 ha of well-shaped sedge-moss fen with a valuable, typical flora: *Liparis loeselii, Hamatocaulis vernicosus, Carex dioica, Cinclidium stygium* (extremely numerous!), *Scorpidium scorpioides, Paludella squarrosa* (Kozub unpubl.).

- **Zdrójno**. The existing nature reserve in the commune of Osiek, in the Pomeranian province, in the Natura 2000 site "Sandr Wdy" PLH040017, created originally in 1983 for the protection of beavers' stands around the lake Brzezianek, and in 2015 transformed into a biocenotic reserve for ecosystems of the lake and the river Brzezianek and the surrounding forests (169 ha). It should be enlarged by directly adjacent to its western border, but now located outside it, fen complex (about 15 ha, 53,74641˚N, 18.29406˚E). It is one of the largest and most beautiful alkaline fens in the Tuchola Forest. The areas are dominated by *Hamatocaulis vernicosus*, *Paludella squarrosa, Helodium blandowii* and *Tomentypnum nitens*, the classical moss-sedge communities with *Carex dioica*, *C. lepidocarpa* and *C. limosa*. There is *Liparis loeselii* and a huge population of *Epipactis palustris* (Kozub unpubl.). It is significant that, despite the elaborating and establishment (O. J. of Pomorskie 2014, item 1451, as amended) of the Conservation Measures Plan for the Natura 2000 site Sandr Wdy PLH040017, in which the

Photo 119. Torfowisko Mnica with patches of *Eleocharis acicularis* (photo J. Kujawa-Pawlaczyk).

Photo 120. Sedge-moss fen at Zdrójno reserve, which should be included in the reserve. Although it is one of the most valuable alkaline fens in the Tuchola Forest, it has not been noticed at all, neither in the design of the reserve nor in the established conservation measures plan for the Natura 2000 site in which it is located (photo Ł. Kozub).

fen is located, in this plan no prevalence of habitat 7230 in the area has been detected, without showing any of its patches, without identifying any specific hazards, or planning any protective measures, and only recording the need to supplement the state of knowledge. Also occurrence of Annex II of the Habitats Directive species was not recorded (*Hamatocaulis vernicosus, Liparis loeselii*) ...

- **Okonino** (ca. 52 ha, 52.79879˚N, 16.15448 ˚E), Fen located in the municipality of Wieleń in the Wielkopolskie province, near the town of Miały, found only in 2016 by S. Rozsadziński, previously not described. A terrestrialised lake basin dominated by alkaline, limnogenic sedge-moss fens. The largest populations in Wielkopolska: *Paludella squarrosa* and *Helodium blandowii*; in addition: *Cladium mariscus Carex paniculata, Sphagnum teres, S. warnstorfii, S. contortum, Campylium stellatum, Tomentypnum nitens* (S. Rozsadziński unpubl).

During the implementation of those and the previous projects, we were also met with an extremely favorable disposition of the owners/managers of the area (both private persons and forest inspectorates or employees of the nature protection administration), who considered the natural values of their areas to be the greatest and most important asset. Cooperation with an environmental non-governmental organization was perceived in positive light. We have also often met with actively seeking support from the Naturalists' Club in the implementation of nature protection (e.g., in the form of establishing a reserve) by the Forest Inspectorate or the communes. However, frequent meetings and discussions have almost always been the basis for this cooperation. This was particularly the case for the land purchase efforts. Finding the owners involved, firstly, obtaining their personal data (name, address etc.), which is not a simple matter at present, and undertaking discussions and negotiations on the possible sale of land. These conversations are usually not easy due to emotions connected with for example family history, memories, as well as different attitudes towards nature protection and environmental non-governmental organizations (NGOs) (which are also private entities often perceived as a threat to the region's traditionally understood economic development). Conducting negotiations requires considerable skills, sensitivity, knowledge of regional conditions and, above all, time – usually several months.

In the projects, the purchases were planned as one of the types of measures aimed at protecting the most valuable patches (i.e., the best preserved) of the habitat in the places where it occurs in Poland. Only areas remaining privately owned were purchased – i.e., under Polish law they were to a limited extent protected from the negative impact of human activity, especially in the context of low environmental awareness and the perception of bog areas as being useless.

As part of the LIFE13 NAT/PL/000024 project, due to the characteristic plots fragmentation in southern Poland, a large number of owners (sometimes difficult or impossible to determine) and unsettled ownership issues, causing redemption of the land in the short term of the Project impossible, it was decided to buy off land only in the Gorce National Park, where Park employees have been talking to private owners already for several years in this matter.

Land purchases focused on habitat 7230 should also be seen from the perspective of other natural considerations, such as:

- the abundance of geomorphological formations, such as the river valleys in which they were formed (e.g., the Rospuda Valley);
- the occurrence of phenomena connected with water and slope erosion of the valley and natural successions caused by these dynamic processes;
- the occurrence of many rare communities presenting stages of plant succession – from open moss patches to mature bog forest stands;
- the occurrence of specific habitats, their abundance and diversity, and the often characteristic density and striped layout, and thus the presence of distinct ecotone zones under unique conditions;
- the existence of a specific topoclimate that provides conditions different in relation to the surrounding areas;
- the abundance of the flora, presence of rare and vanishing plant communities, complexes and species of thermophilic, spring and fen plants, unique outside the valleys, including species from the Polish Red Book of Plants (Kaźmierczakowa et al. 2014), only some of which are covered by Annex II of the Habitats Directive;
- the particular abundance of fauna – especially birds associated with wetland and forest biotopes, as well as animals from other groups such as mammals living in valleys or visiting them regularly, molluscs, amphibians, and reptiles, insects and arachnids – many rare and endangered species not covered by the Council Directive have

Table 5. List of the land purchased as part of the project. The characteristics of the individual objects are presented in Chapter 2 of Volume I and Chapter 5 of Volume II.

Project	Project site name	Natura 2000 site name	Area [ha]	Number of registered plots
LIFE11 NAT/ PL/423	Kosobudki	Dolina Pliszki	12,4743	1
	Rospuda	Puszcza Augustowska	36,22	69
	Rudawki	Poszeszupie	3,5344	6
	Sulęczyno	Sulęczyno	6,7014	8
	Wierzchołek	Uroczyska Kujańskie	2,6481	3
LIFE13 NAT/ PL/000024	Hala Nowa	Ostoja Gorczańska	0,7829	1
	Jonkówki		1,3534	2
	Przysłopy		0,4172	2
	Skole Jędrasowe		0,3700	2
	TOTAL:		64,5018 ha	

Fig. 100. Location of the purchased land and the established nature reserve Mechowisko Kosobudki.

been observed, as in the case of flora. One example can be the odonata, where 5 rare species have been identified among the 20 species listed for the planned reserve Bagienna Dolina Rospudy, only one of which is included in Annex II.

These conditions became the main reason for the planning and purchase of nearly 65 ha of land in 6 Natura 2000 areas as part of the project (see Table 25)

Fig. 101. Location of purchased plots (on the right) on the background of the proposed Bagienna Dolina Rospudy reserve. In the upper right corner, the fragmentation of plots is depicted.

Photo 121. Fens of Rospuda valley – one of the most precious alkaline fens of Central Europe – now are partialy owned by Naturalists' Club (photo R. Stańko).

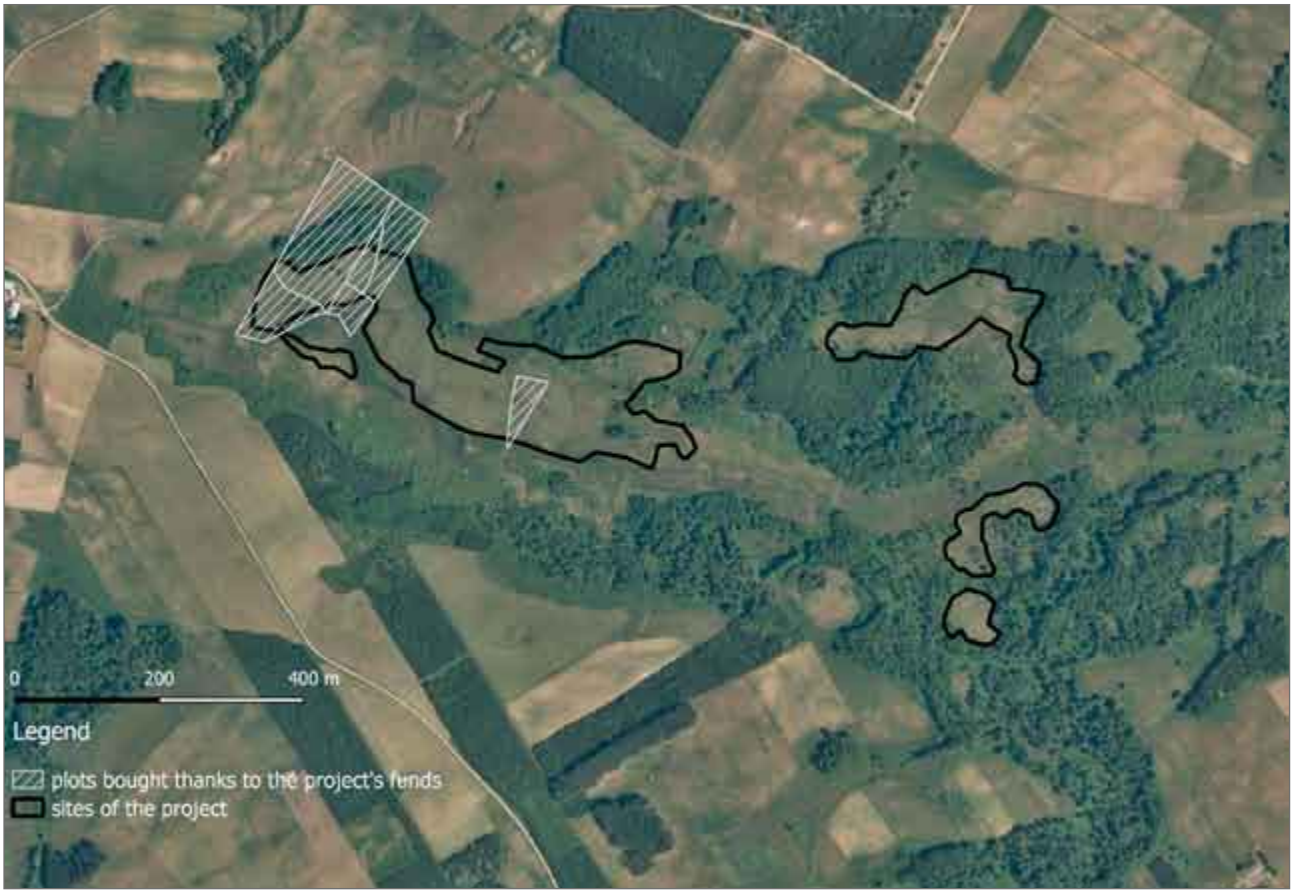


Fig. 102. Location of purchased plots within the Rudawki site.

Fig. 103. Location of purchased plots against the background of Mechowiska Sulęczyńskie reserve established as part of the project.

Fig. 104. Location of purchased plots against the background of the proposed Jezioro Wierzchołek nature reserve.

Fig. 105 Location of purchased land in the Gorce National Park, site: Jonkówka, Skole Jędrasowe, Nowa Hala

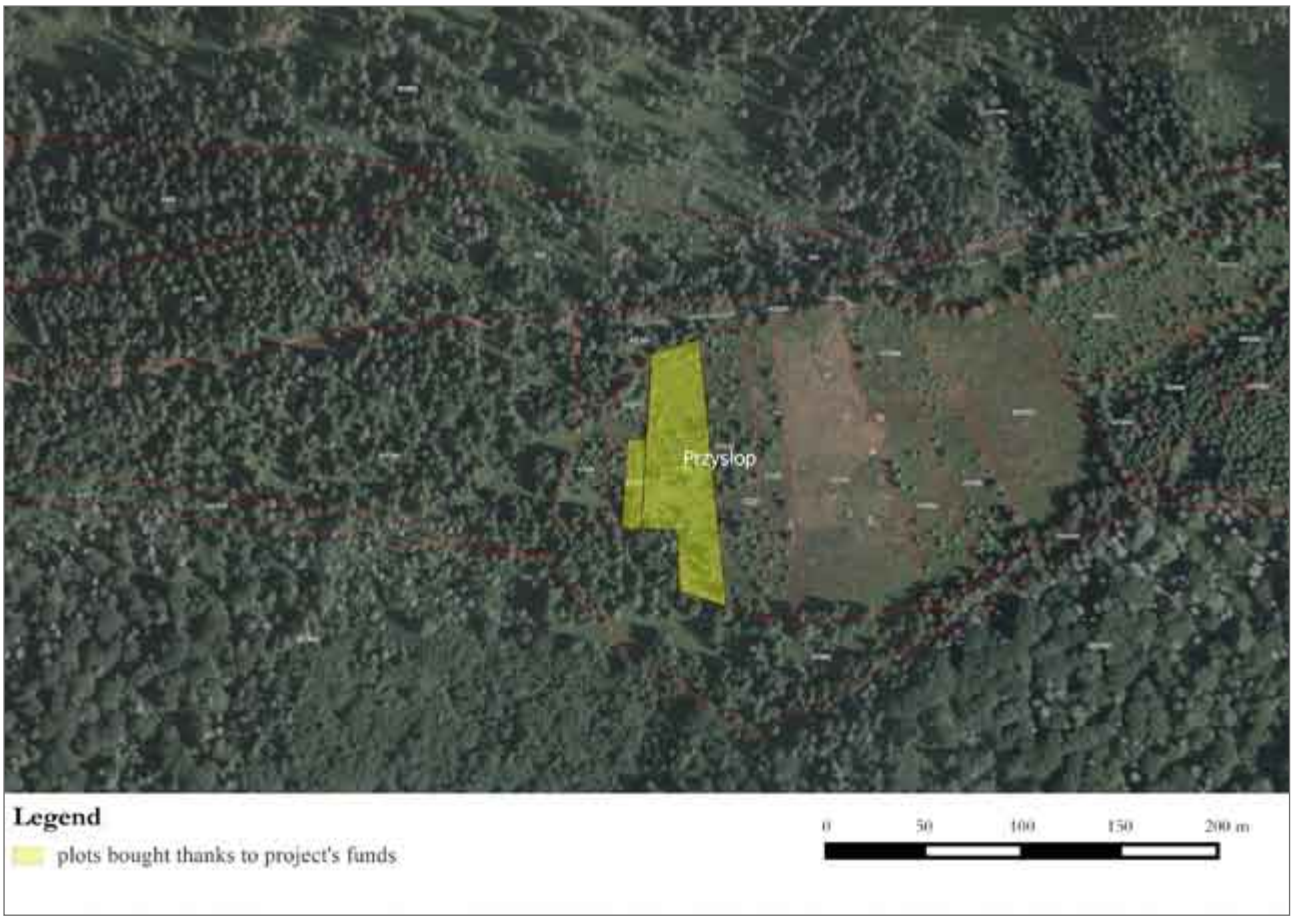


Fig. 106. Location of purchased land in the Gorczański National Park: Przysłop

3.4. Monitoring of procedures for preparation of conservation measures plans and conservation plans for reserves and Natura 2000 areas

Magdalena Makowska, Dorota Horabik

Like most long-term projects, the conservation of fens requires good planning based on extensive knowledge. Reality indicates that this is not an easy task – not necessarily because of the lack of knowledge of the planners, but often because of the unpredictability of nature. An additional difficulty in planning is the difficulty of reconciling the often contradictory interests of nature conservation and various aspects of human activity. The lack of appropriate measures included in the plans does not have to be the result of substantive conclusions drawn during the preparation of a given planning document. This is often the result of strong pressure at the planning stage to minimize the scope and scale of planned activities, especially those that are more costly or carried out on private land, to which no one is likely to officially admit. It is also a result of the fears of the administration responsible for the implementation of the tasks scheduled in the plan that it will encounter a problem with obtaining funds for their implementation in the future. Although, for example, the plan of protection tasks for a Natura 2000 area is an act of local law, the existing legal loopholes make it impossible to enforce the implementation of protection measures. That is why it is so important to cooperate with the owners/managers of the land on which the natural habitats or species being the subject of protection are located. As a rule, only a few-year project aimed at the protection of a given habitat or area makes it possible to establish a broader and long-term cooperation between the owner and the entity interested in nature conservation.

In order to learn the scope of activities performed within the framework of the LIFE Project, please refer to the Table no. 3 in chapter 1.5.2 (Volume I) and Table no. 2 in chapter 1.2 (Volume II) of the Report. Below, the focus is on the conditions of implementation, rather than its results.

Nature reserve conservation plans

According to the Act on Nature Conservation, the conservation plan is prepared for national parks, landscape parks, and nature reserves within 5 years from the date of establishment of a given protected area. A conservation plan may also be prepared for a Natura 2000 area or a part thereof, but in practice it is prepared only if the Natura 2000 area overlaps to a significant extent with the area of a national park, landscape park, or nature reserve. Conservation plans are drawn up on the basis of complete knowledge of the area, gained by detailed field inventories conducted usually for a period of at least two years. The provisions of the conservation plan drawn up for a period of 20 years allow for the establishment of stable rules of protection for the area, taking into account the conditions of conducting the potential business activity in a given area in such a way that it does not adversely affect its values.

The protection plan itself must, among other things, take into account the characteristics and assessment of the natural environment, social and economic conditions, spatial development, and identification of the internal and external risks. A detailed field survey is a key and most labor-intensive element of properly planned protection measures, often requiring the involvement of a large group of experts over a long period of time. Unfortunately, in Polish conditions we often encounter situations in which this key element is performed unreliably – sometimes as a result of work performed by unprepared contractors, sometimes erroneous financial planning by the administration body that commissioned the preparation of the plan (too short deadlines for providing the documentation due to the need to settle funds with external donors, too low fees for contractors resulting in poor quality of the documentation itself), or a reduction of the scope and scale of the protection activities due to the interests of local communities (further discussed below).

The draft plan – and in particular the measures described in it which are mainly aimed at the protection of the habitats and species in the area concerned – shall be subject to a public consultation process, and the draft plan itself shall be subject to an opinion by the relevant commune councils. Unfortunately, in practice, the most necessary provisions in the scope of active protection measures (which in many cases are also the most expensive measures) are often not approved by the group of stakeholders/manager or owner of the land. During these public consultations, they are significantly modified (to the detriment of the protection needs of the reserve), as a result of which their implementation does not bring the desired effect. In Polish conditions, in situations where the area of the planned reserve is owned by natural persons, the best solution, unfortunately, usually only possible in the case of granted funds from EU projects, is to buy out the most valuable natural areas with the intention of establishing a nature reserve. As mentioned earlier, the creation of the reserve is the first (although crucial) stage in the process of ensuring the long-term protection of the area. In the project, on the basis of research conducted by the Naturalists' Club before and during the implementation of the LIFE project, many projects and protection plans were prepared and submitted to the relevant regional director of environmental protection (some of the reserves in the project were created only by the effort of our Project LIFE11 NAT/PL/423 Partner – the Regional Directorate of Environmental Protection in Gdańsk, which then prepared the conservation plans for these reserves by itself). However, in situations where the purchased private area is involved, the transfer of a reliable draft plan significantly speeds up the approval process as it is no longer necessary to guarantee funds for the performance of research by the Contractors selected in the usually costly tender procedure. The experience of the Naturalists' Club from LIFE11 NAT/PL/423 and other projects shows that conservation plans for well researched and relatively small areas are approved more quickly, and their provisions are successively implemented. Unfortunately, conservation plans for large areas, such as national parks or Natura 2000 areas, are often not successful because the long-term process of their preparation does not keep pace with the changing legal basis and practice of nature protection, and above all with nature itself, which is not waiting for the plan to be approved.

Conservation Measures Plans for Natura 2000 areas

Conservation Measures Plan (CMP) for Natura 2000 areas are prepared for a period of 10 years, within 6 years from the date of approval of the area by the European Commission as a site of Community importance. Contrary to conservation plans, they are often drawn up on the basis of existing, sometimes incomplete or outdated knowledge and basic identification of the conservation status of the protected sites. Unfortunately, in many cases such an approach – where at the stage of drawing up the conservation

measures plans no detailed inventory of the existing habitats and species was provided – makes it impossible to carry out effective protection. Failure to perform reliable field research, identify risks, or make a forecast regarding the effectiveness of the planned activities obviously affects the quality and effectiveness of the provisions of the plan.

The aim of the CMP is to develop a list of the most crucial actions from the point of view of preservation of the sites. This plan of protection tasks indicates whether it is necessary to prepare a conservation plan for the area in question. However, regardless of the type of planning document that is ultimately drawn up, it is necessary to ensure the participation of interested individuals and entities carrying out business activities within the scope of the occurrence of natural habitats and species in the entire process. Due to the often short period for the preparation of the CMP (i.e., lack of time for field research), gathering knowledge among the residents and local naturalists regarding the traditional use of a given area and activities previously performed within the natural habitats is an extremely important element of the process of plan preparation. In addition, it is crucial to win the support of the local community for the planned measures, especially in the case of areas where the natural habitats are private property, and to allow the effective implementation of particular provisions of the document.

It should also be noted that despite the 10-year perspective of developing conservation measures plans, the provisions often change during their term of validity. Both before and during the project, the Naturalists' Club was constantly monitoring the process of developing new and revision of the approved CMPs for Natura 2000 areas. The aim of this activity was to ensure that plans for those areas where habitat 7230 is protected ultimately included appropriate provisions for its conservation. Often, we prepared the entire documentation of the plan ourselves as a contractor (eg as part of the LIFE13 NAT/PL/000024 project, on the basis of an agreement with the Regional Directorate for Environmental Protection in Łódź, Club prepared a draft conservation measures plan for the Natura 2000 site Torfowiska nad Prosną PLH100037, which was subsequently approved, all activities included in the Plan for this site were implemented as part of the Project), and if this failed, we took part in the public consultation and actively sought to introduce appropriate content to protect the habitat. At the end of projects implementation, two-thirds of the conservation measures plans for Natura 2000 areas had appropriate provisions in the part concerning the recommended measures. The remaining one-third are Natura 2000 areas of relatively small size for which no CMP had been developed by the time the project was completed.

The process of monitoring works in the scope of preparing planning documents for Natura 2000 areas, but also for other forms of area protection – including reserves and landscape parks – is one of the long-term but crucial activities that should be carried out in order to effectively protect the species and habitats.

3.5. Raising of environmental awareness

Magdalena Makowska, Dorota Horabik

The main objective of the projects was to stop the rapid pace of degradation of the country's alkaline fens through a series of planned active protection measures. In the original assumptions of the projects, forming the environmental awareness of the society was a complementary element, implemented „in addition" to the main goals. Subsequent stages of the projects gradually made the people involved in its implementation aware of the importance of this issue in relation to other tasks. This process did not result from an erroneous belief in the low importance of the problem, but from an underestimation of the necessary time for its implementation and an underestimation of the number of stakeholders with an impact on the achievement of the assumed projects' objectives. The number of persons (employees of various stages of administration, authorities issuing various types of decisions, permits, etc., land managers and owners) with whom it was necessary to conduct a series of direct discussions providing detailed information on the projects and theirs objectives in the context of the Natura 2000 network, was finally estimated at well over 1,000. These contacts were of a various nature and took place within the framework of the previously planned activities listed below.

3.5.1. Preparation of natural and planning documentation

Within the projects, four different types of natural documentation were created – plans of protection tasks of Natura 2000 areas, reserve conservation plans, plans of habitat management, and agri-environmental (and agro-environmental-climatic) documentation. Each of them contains a different scope of content and performs different functions.

Conservation Measures Plans for a Natura 2000 area (CMP) – valid for 10 years. It is a document containing information on the conservation status, threats, and necessary protective measures for natural habitats and species being the subject of protection in a given area. The procedure for its preparation usually includes 2 – 3 meetings within the so-called local cooperation team, i.e., all those interested due to being an owner, civil servant, local environmental activist, etc. The draft CMP is subject to public consultation. The purpose of these meetings is not to discuss the idea of the Natura 2000 network or the appropriateness of establishing a Natura 2000 area on a given land. In practice, however, these topics are still frequently addressed and invoke a great deal of emotion, especially if the area is entirely privately owned. A new explanation of the principles of management within Natura 2000 areas generally dispels the doubts and myths accumulated over the years about Natura 2000 areas. At the same time, it is conducive to building positive attitudes towards this form of nature protection.

Conservation plan of the reserve – is a comprehensive expert document referring to all known aspects of the conservation of the reserve area. It is drafted by a team of specialists from various fields for a period of 20 years. Apart from the entities executing the plan, representatives of various levels of nature protection administration, water management, State Forests, local governments, advisory bodies of nature protection administration and land managers, as well as other interested parties take part in the process of establishing the plan during public consultations.

The public participation is much lower during the development of the reserve conservation plans. As mentioned in chapter 3.3, reserves are not generally established on private land; therefore, they are created on the land owned by the State Treasury (they remain in the hands of the national or local government administration).

Habitat management plan – equivalent to a conservation plan, but on a much smaller scale – refers only to the patches of habitat 7230 within a given site. Its function is to include knowledge about the habitat in a single document, enabling its use in many areas and circumstances (local spatial development plans, environmental impact reports, forest management plans, agri-environmental documentation, as well as future CMPs, reserve conservation plans, etc.). The document is handed over to the land managers or owners.

Agro-environmental documentation (currently agro-environmental-climatic) – created as a result of expressing the will of the owner/manager of the land to join the agro-environmental-climatic program and to use the habitat in accordance with its requirements.

The common element connecting the above-mentioned documents is providing knowledge about the habitat and its protection methods to a relatively wide group of persons of key importance for the protection of a given natural habitat or species. The advantage of the procedures described above is the opportunity to meet in a wider group and discuss various problems and to learn more about the local historical conditions which are important for the protection of specific habitats or species. Different types of meetings in a wider group allow for the owners of valuable natural areas to feel appreciated, and to some extent also induce a sense of special responsibility for the protection of areas and a form of pride of ownership. Unfortunately, high turnout and wider interest among local communities is a rather rare occurrence.

3.5.2. Press articles, publications, conferences and workshops

As part of the project, a total of 25 popular-scientific articles were published in the national press and in the publications of the Naturalists' Club; 13 posters presented at international conferences in Poland and abroad (including the XXVII International Congress of Conservation Biology in Montpellier, France); many presentations were also given at meetings organized by the Naturalists' Club or other institutions. A total of 16 meetings of various scales were organized, ranging from small meetings for several people to international study tours and conferences. The representatives of the project took part in nearly 30

Photo 122. Poster session at the XXVII International Congress of Conservation Biology in Montpellier, France. A block of the Naturalists' Club about alkaline fens (photo R. Dobrowolski).

meetings organized outside the scope of the project by other entities or by the Club itself (e.g., traditional April sessions, annual Meetings of Members of the Naturalists' Club, training sessions for forest inspectorates, schools, etc.). In all these manifestations of educational activity, the objectives and assumptions of the project were repeatedly presented, and the numbers presented above did not include meetings within the framework of the preparation of the CMP or conservation plans referred to in chapter 3.4, nor the direct meetings referred to below.

This type of activity, which provides key knowledge on the functioning and effectiveness of the applied conservation methods, seems (according to the experience of the Naturalists' Club – gathered both during and outside the projects implementation) to be the least measurable, but – although underestimated – extremely important for the protection of habitats in the future.

An important and interesting aspect of the implementation of any LIFE projects is the exchange of experience with other project participants. In practice, it is very rare for project representatives to respond to invitations to present the results of the project after it has been completed, but they are happy to welcome visitors to their area. This means that if one wants to gain knowledge about other LIFE projects on the same subject, one must actively and independently seek contact. It is also still relatively rare for project materials to be translated into English, which significantly limits access to these texts.

3.5.3. Direct meetings

The number of individual meetings conducted with private owners, forest officials, village heads, employees of forest inspectorates, parks, communes and regional directorates cannot be counted precisely. There were hundreds or more of them. During each of such meetings, a very wide range of topics was discussed with a small group of 2 – 3 persons, and often even with one person – from the awareness of the presence of a habitat (sometimes a Natura 2000 area) within a given site and education on its protection, through negotiations on the conditions for the implementation of conservation measures, to the binding legal conditions.

In the case of private persons, individual meetings are more difficult and time-consuming. Starting from the very fact of finding the owner, sparking interest in the problem of nature conservation, through gaining a minimum level of trust, and ending with convincing the owner about the protection of a valuable natural habitat on their land. The entire process – in the case of an amenable owner – may consist of one meeting. Sometimes, however, it is necessary to hold several meetings with the owner as well as with other persons (other family members, the village head, local mayor, local activists), to whom the owner looks for assistance in the decision. Because alkaline fens are often wastelands (from an agricultural point of view), where farming had been abandoned for a long time, it is unusual

(and sometimes suspicious) for the owner that this land is a valuable area to be protected. In such cases, the arrangements last a little longer, but often have beneficial effects from the point of view of building responsibility for the natural values of the area they own. The surprise of having valuable habitats in their care and the growing pride in ownership are frequent observations during the presentation of the natural values of specific sites.

In practice, such meetings brought about the most visible effect, and thus – despite the fact that they were long and labor-intensive – they seemed to be the most effective form of education for a wide range of people in the field of values, risks, and the needs of protection of alkaline fens. The detailed experience of the meetings with private owners and managers was described in The Guidebook on Good Practices in alkaline fens conservation (Stańko et al. 2018).

Robert Stańko, Lesław Wołejko, Filip Jarzombkowski

4.1. Hydrological monitoring, methodology and conclusions

The presented conclusions resulting from the conducted groundwater monitoring pertain to the observations carried out in selected areas of alkaline fens, both in the period of the implementation of the projects and before their commencement. The period of monitoring varies greatly due to limited access to appropriate technical devices (automatic recorders), occasional permanent damage resulting in the loss of some data, and theft.

Among the areas covered by the project, monitoring was carried out in:

- 9 fens of north-western Poland (Dolina Kulawy, Płonia-Żydowo, Bagno Stawek, Ilanka V, Ilanka VI, Kosobudki, Kosobudki II, Kijewo, and Bukowskie Bagno);
- 14 fens of north-eastern Poland (Kopaniarze, Trępel, Głógno, Żytkiejmska Struga, Morgi, Rudawki, Zocie, Łosiniany, Stare Biele, Sawonia-Mostek, Żyliny, Sarnetki, Kobyla Biel and Rospuda);
- 11 fens of southern Poland (Torfy Orońskie, Mierzączka, Bełk, Sędowice, Plebanka, Śniatycze - Swaryczów, Bęczkowice, Ostoja Magurska, Torfowiska nad Prosną, and Hala Długa (Ostoja Gorczańska).

Groundwater levels were measured with the use of automatic recorders of Diver and Baro-Diver type, placed in so-called piezometers (wells made of perforated pipes with filters) installed in the fen. The recorders were placed at a depth of 1 or 2 m. The measurements were made with a frequency of 4 records per day. In addition to the water column pressure, the devices also measured water temperature. In order to compensate for atmospheric pressure, atmospheric pressure recorders were located in the vicinity of the Diver devices placed in the piezometers. The measurements were finally compensated with the use of Diver-Office software.

Photo 123. Hydrometeorological station in Kosobudki (photo R. Stańko).

As a complementary element of hydrological monitoring, 2 fens (Kosobudki in western Poland and Sarnetki in north-eastern Poland) were provided with hydrometeorological stations measuring rainfall, temperature, evapotranspiration, wind speed, sunshine, and water flow rate in the ground.

As part of a project carried out in southern Poland, a hydrometeorological station was installed in one of the fens of the Gorce National Park.

The results of the measurements in the form of graphs of water level and temperature changes in piezometers are presented in chapter 2, Volumes I and II, in the part devoted to the descriptions of particular sites and the results of the project.

Photo 124. Hydrometeorological station in Sarnetki (photo E. Gutowska).

Photo 125. Hydrometeorological station in the Gorce National Park (photo D. Horabik).

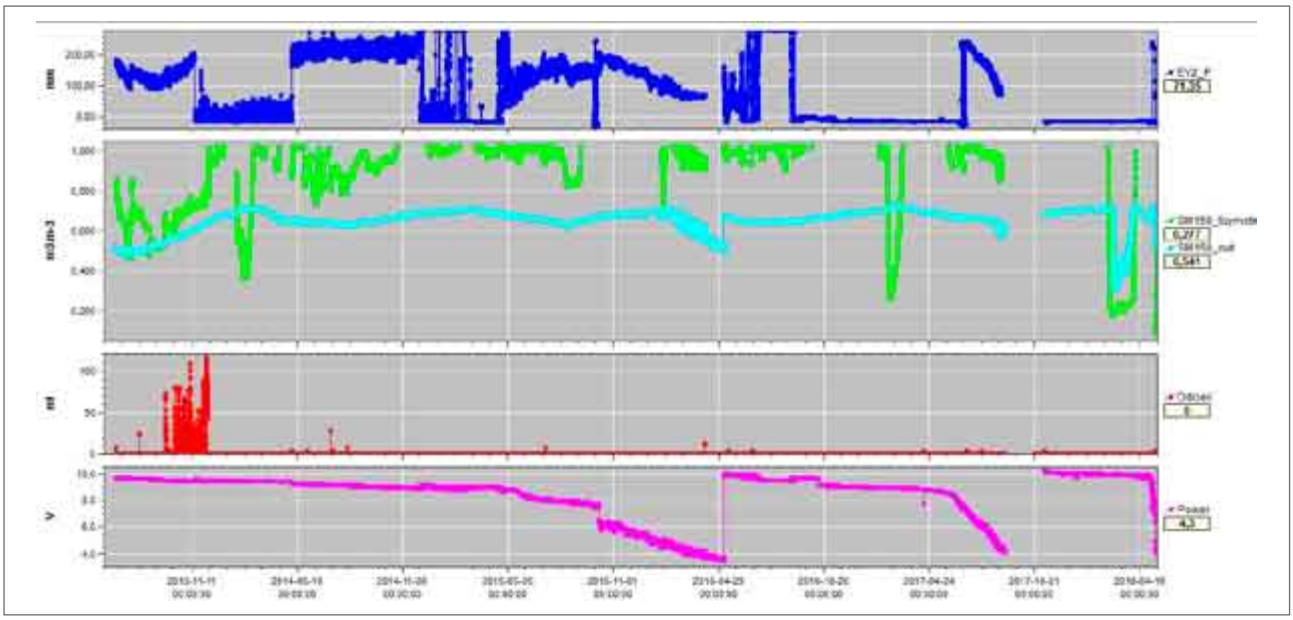


Fig. 107. Changes in the values of selected measurement elements in the hydrometeorological station in Kosobudki during the implementation of the LIFE11 NAT/PL/423 project.

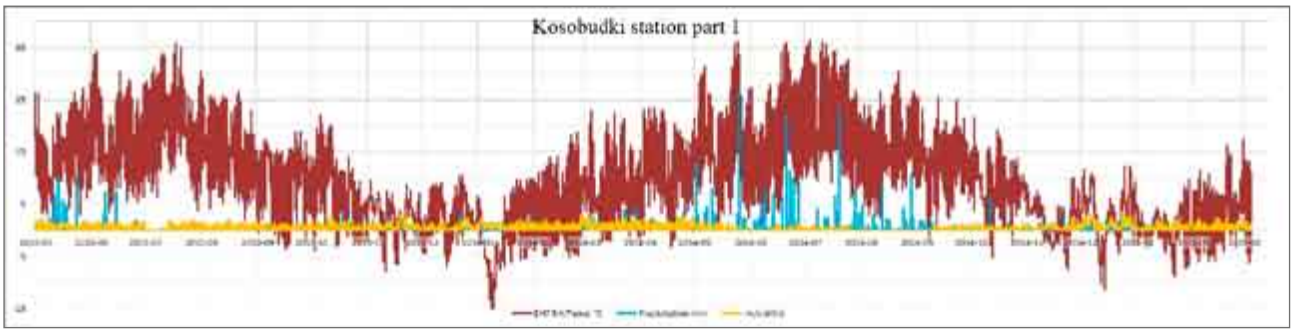


Fig. 108. Example of change in the values of selected measurement elements (wind force, temperature and rainfall) at the Kosobudki station.

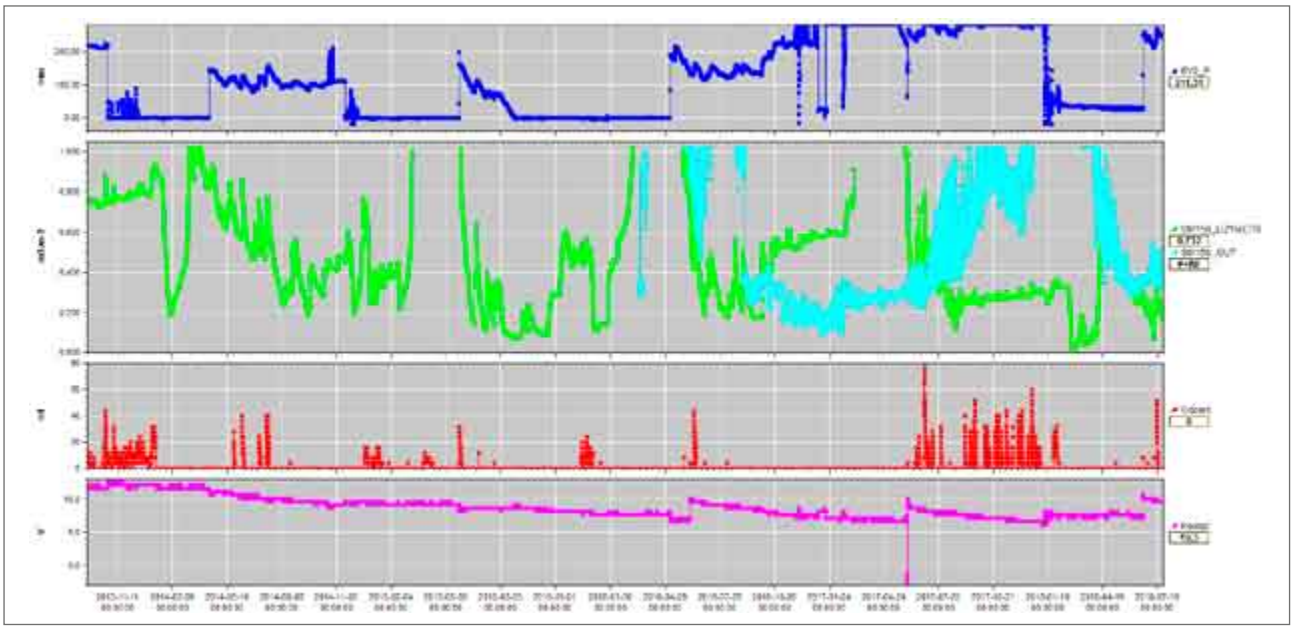


Fig. 109. Changes in values of selected measurement elements at the hydrometeorological station in Sarnetki during the implementation of the LIFE11 NAT/PL/423 project.

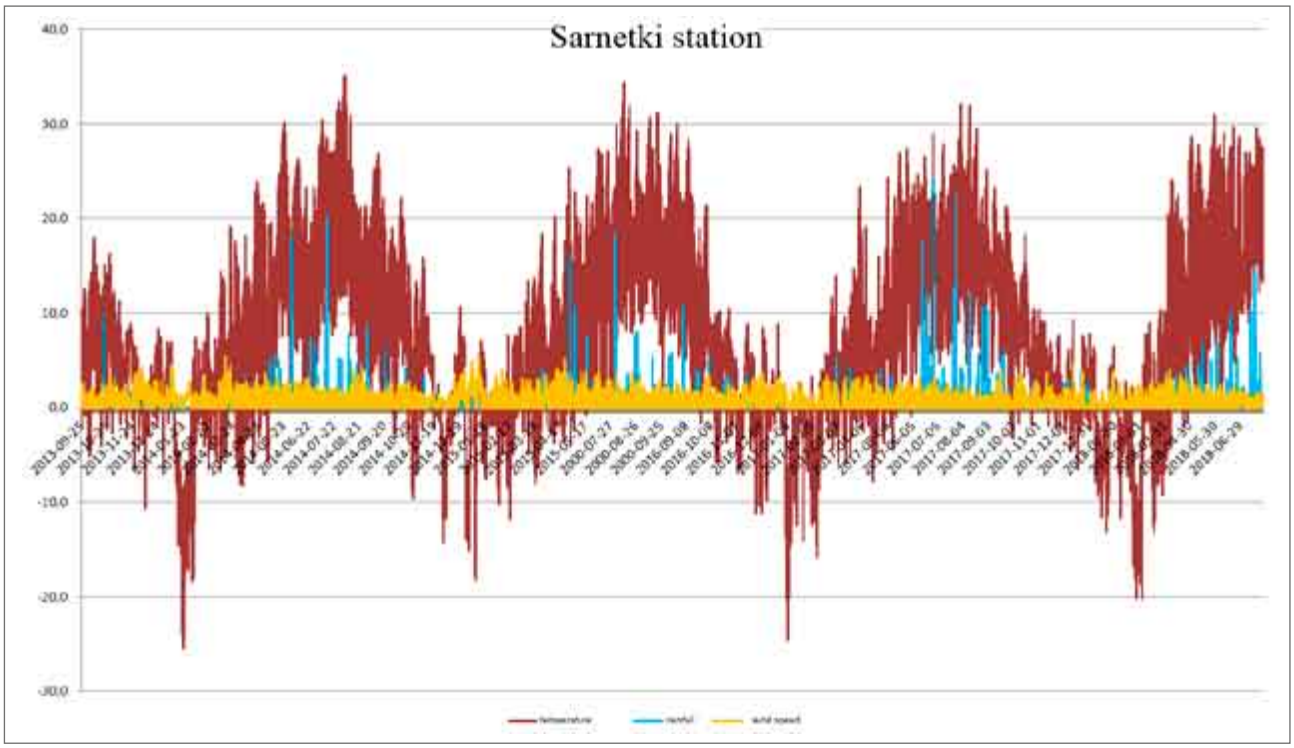


Fig. 110. Example of change in the values of selected measurement elements (temperature, rainfall, wind force) at the Sarnetki station in 2013 – 2018.

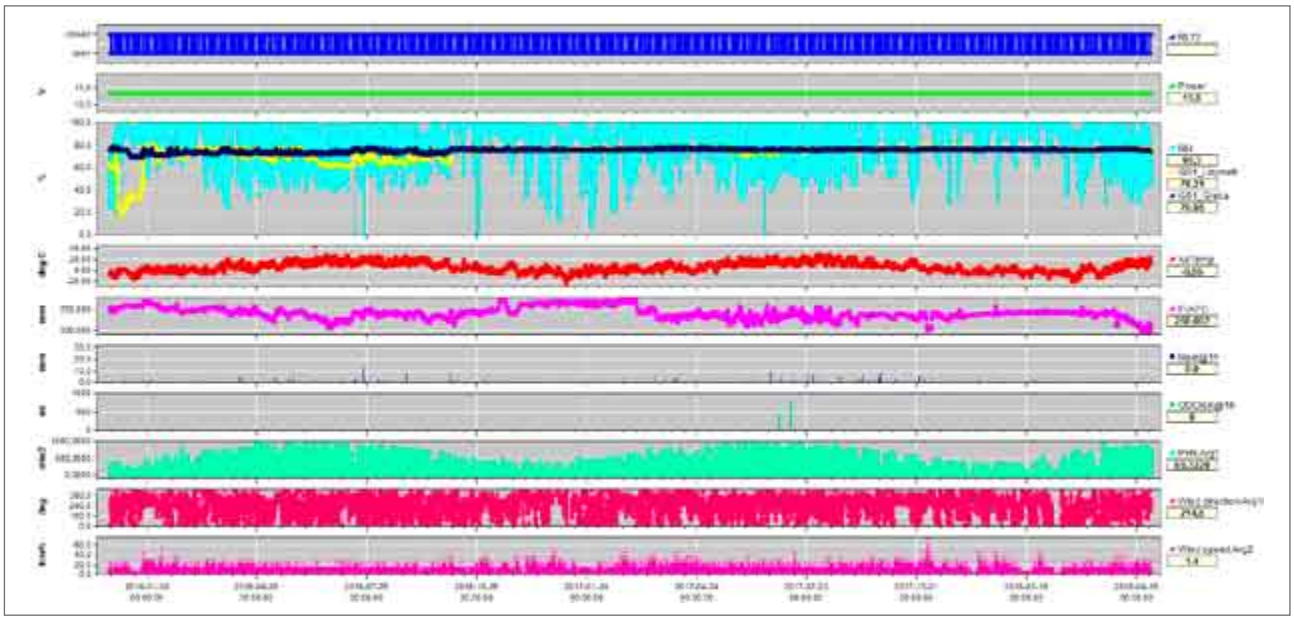


Fig. 111. Changes in the values of selected measurement elements in the hydrometeorological station in the Gorce National Park during the implementation of the LIFE13 NAT/PL/000024 project.

Fen ecosystems, despite numerous studies, are poorly described in terms of their ecology. This is particularly true for near natural and natural systems, which are relatively rare. From the point of view of their protection, it is crucial to identify water-related issues, as this factor is one of the most important and affects both the shape, type, and the very existence of fens. Unfortunately, similarly to all meteorological observations, this research takes time, for example, to eliminate only temporary weather changes. The four-year cycle (in the case of the stations in Sarnetki and Kosobudki) and the two-year cycle (in the case of the stations in Gorce) of observations under the project – particularly taking into account the fact that these were the so-called "dry years" – is therefore insufficient to determine the water balance of the surveyed fens, but allows for characterizing individual elements

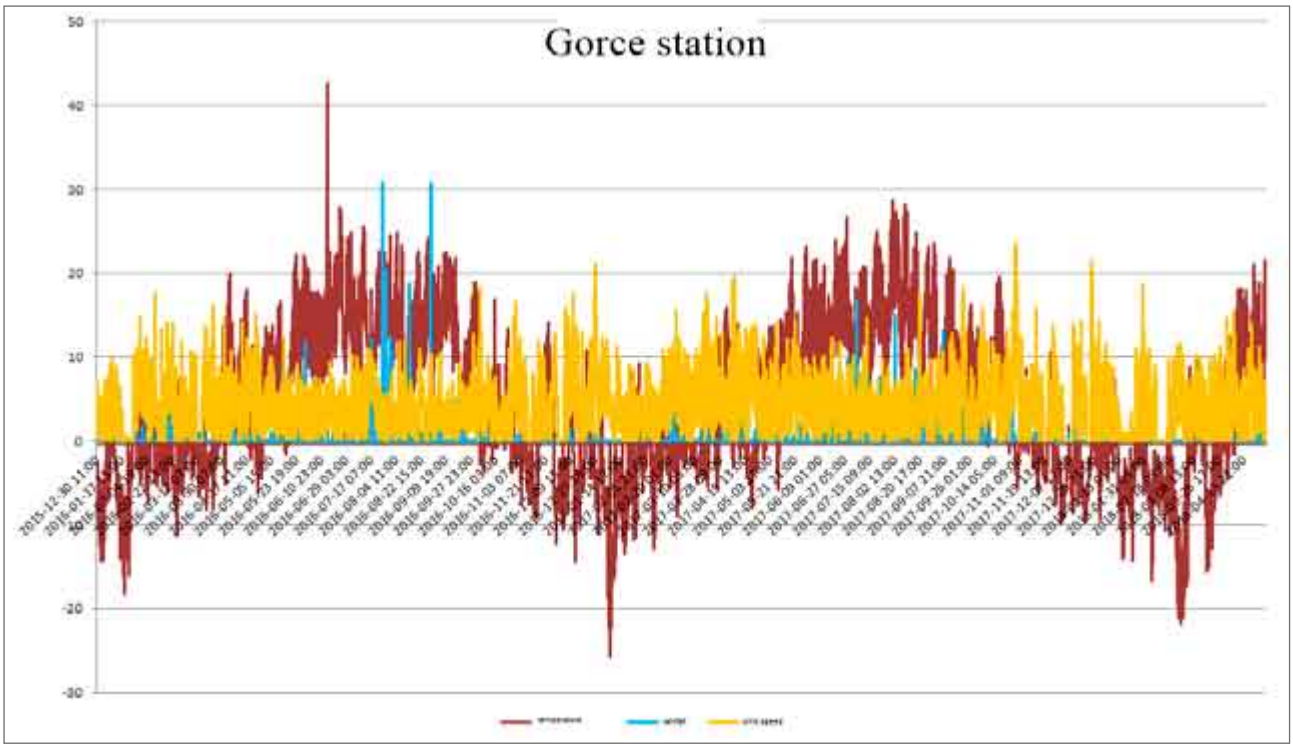


Fig. 112. Example of change in the values of selected measurement elements (temperature, rainfall, wind force) for the station in the Gorce National Park in 2015 – 2018.

related to fen hydrology within a short period of time.

Rainfall is one of the most important elements shaping the water balance of fens. The observations show that total rainfall volume in the hydrological year did not change significantly over the years, however its structure changed. An increase in torrential rainfall was observed, preceded by relatively long periods of drought, as well as reduced winter retention due to the lack of cold winters. At the same time, precipitation at the hydrometeorological research stations was slightly higher than at the state-operated measurement stations, which may be related to their location in forest complexes where precipitation is slightly more frequent. It should be noted that the observation period was the so-called „dry years", when the rainfall is lower than in the other periods. This is a natural phenomenon, however it does not allow for forming generalized conclusions.

Observations of water content in soil indicate relatively constant and high water content in well-preserved moss fens and significant fluctuations in this parameter in transformed ecosystems where the top layer of peat has been mineralized. Moreover, it was found that the water content in the case of an unaltered fen was almost four times higher than on a transformed one. In addition, regional differences were observed – in eastern Poland water content drops due to low temperatures in the winter months were observed, while in the west there were no significant differences related to this.

The surface temperature of the fen is clearly related to the air temperature, the former being characterized by lower annual amplitudes. The biggest differences between the air temperature and the peat temperature are observed in winter and spring, when the differences reach up to 20 °C. In winter, the air temperature is lower than the soil temperature, and in April and May – significantly higher. Daily fluctuations are also significant – in the summer months the difference may reach 20 °C, while peat maintains a relatively stable temperature. Such large temperature amplitudes, especially daily, are conducive to maintaining specific conditions at the surface of the fen, ensuring high dampness in the vegetation development zone, even in the absence of precipitation.

Another important factor for the vegetation of fens is sunlight, which determines the power of solar radiation. In the Sarnetki and Gorce fens, insolation reaches 400 W/m^2 in March and falls below this value at the beginning of October. This is sufficient for the development of moss vegetation with predominantly low, narrow-leaved sedges and a range of rare, often phototropic, plant species. On the Kosobudki fen, in turn, insolation exceeds this value only at the end of March, and falls already at the beginning of September. This translates into a shorter time of delivering higher energy resources to plants on this fen

by about 1.5 months per year on average, which may have an impact on the possibility of development of specific phototropic vegetation.

The data obtained from these relatively short observations make it possible to get to know the ecology of the fens better and, as a result, to protect them more effectively. It is not only the constant and high hydration of the fen that turns out to be important, but also the constant water content in the ground zone, changes in surface temperatures of the fen, or insolation. Therefore, in order to preserve the moss vegetation, actions conducive to disturbances of these factors should not be indicated such as, among others, mowing in summer, leaving biomass on the fen, or excessive accumulation of water. It is not easy or quick to obtain detailed results, and further observations are needed to reach clear conclusions regarding this issue. Nevertheless, the knowledge gained, by helping to understand the principles of the functioning of the moss fens translates into sensible and scientific methods of nature protection.

For the purpose of a deeper analysis of the correlation between rainfall and changes in groundwater levels, water levels in the Pliszka River caused by beaver dams, as well as changes caused by the construction of gates on ditches, the measurements from 3 recorders installed in the fen complex between Kosobudki and Kijewo (recorders located within a radius of approx. 600 m) and measurements from the hydrometeorological station installed as part of the project in the Mechowisko Kosobudki Reserve, were used (measurements in 2013 – 2017, Fig. 115). The highlighted fragment of the graph with the information „no data" means a break in the data recording due to the failure of the recorder, as well as rainfall data collected by the IMGW at the nearest measurement points in Boczów and Cybinka (2008 – 2017, Fig. 114).

The data obtained from the groundwater level recorders are incomplete due to their failures and necessity of replacement (the implementation of the project enabled the continuation of observations thanks to equipment purchases). However, due to the long period of data collection, this information is sufficient to reach some important, although preliminary, conclusions.

Fig. 113. Location of the gates and hydrometeorological station with automatic water level recorders in the Kosobudki II.

Conclusions

Records of groundwater level changes show that:

- alkaline fens in lowland Poland are characterized by a moderate amplitude of fluctuations from 15 cm (e.g., the Bagno Stawek Reserve) to about 50 cm per year (the Kijewo site in the Pliszka valley in 2010);
- the largest decreases observed in groundwater levels during the growing season due to capillary rising still provide water available to plants (including species typical of alkaline fens);
- the amplitude of water level fluctuation in individual sites, both where active protection activities were carried out, consisting in inhibiting excessive outflow, and where such activities were not carried out, gradually decreased;
- within the selected alkaline fens, the hydrological conditions have been relatively stable over the decade.

A more detailed analysis of data from the Pliszka Valley shows that within the fen complexes, where there was no interference with water conditions (the Kijewo site and Kosobudki II – located outside the Mechowisko Kosobudki Reserve, Figs. 117 and 118), the level of groundwater has changed over the last 10 years, with a slightly noticeable downward trend (probably due to beavers leaving the site and the destruction of their dams). Due to the dynamically changing hydrological situation of surface waters resulting from frequent changes in the level of the Pliszka River (dams being alternately built and destroyed), it is very difficult to correlate changes in the level of groundwater with the amount of rainfall in any given year, although this relationship seems doubtful by assumption. Neither the markedly low rainfall recorded in the period 2011 – 2016 nor the high rainfall of 2010 and 2017 (Fig. 114) are actually reflected in the groundwater level measurements carried out in these years. Perhaps a more in-depth analysis of the distribution of rainfall on a monthly or weekly basis would make it possible to establish the existing relationships; however, the correlation between precipitation and groundwater level fluctuations in the studied fens is likely to reveal itself in a much longer, several-year long period, partially dependent on the filtration capacity of the geological formations adjacent to the studied fens. The fact that the groundwater level is not dependent on rainfall is proof of the proper functioning of these ecosystems, where rainwater plays a much smaller role than groundwater. It is possible that the greatest influence on the level of hydration in the fens is the water level in the Pliszka River and in drainage ditches – during the period of low rainfall, these watercourses drain the water from the fen, and during flooding they supply additional water. It should be noted that research on the hydrological processes requires long-term observations, and continuation of the hydrological monitoring carried out so far on the basis of the installed measuring equipment for the next few years should allow for gaining a better insight into the functioning of this ecosystem.

Interesting correlations were found in the Mechowisko Kosobudki Reserve, where numerous dams were built under the LIFE11 NAT/PL/423 project. In the last 5 years (Fig. 116) a gradual increase in groundwater levels has been observed, despite the exceptionally low rainfall. Undoubtedly this was due to the high water level in the Pliszka River which was maintained until spring 2015 thanks to the beaver dam, whose backwater was approaching the measurement site to a distance of only 30 – 40 m, with an almost flat surface of the fen. In 2015, after the construction of the gates on drainage ditches, a further slight increase in the water level was recorded that lasted until May 2018. It should be noted at this point that as a result of the destruction of the damming in 2016, the water level in the river significantly decreased, which in turn did not significantly affect the change of the groundwater level in the fen. High groundwater level in the moss fen was maintained partly due to high precipitation in 2017, but mainly due to the dams built on the drainage ditches.

The observations carried out during the project implementation within the hydrological monitoring regime therefore indicate that the water conditions of the studied alkaline fens, despite unfavorable climate changes – mainly changes in rainfall structure, i.e., the occurrence of heavy rains in the growing season and lack of snow cover in winter – do not deteriorate and, with protective measures, they improve.

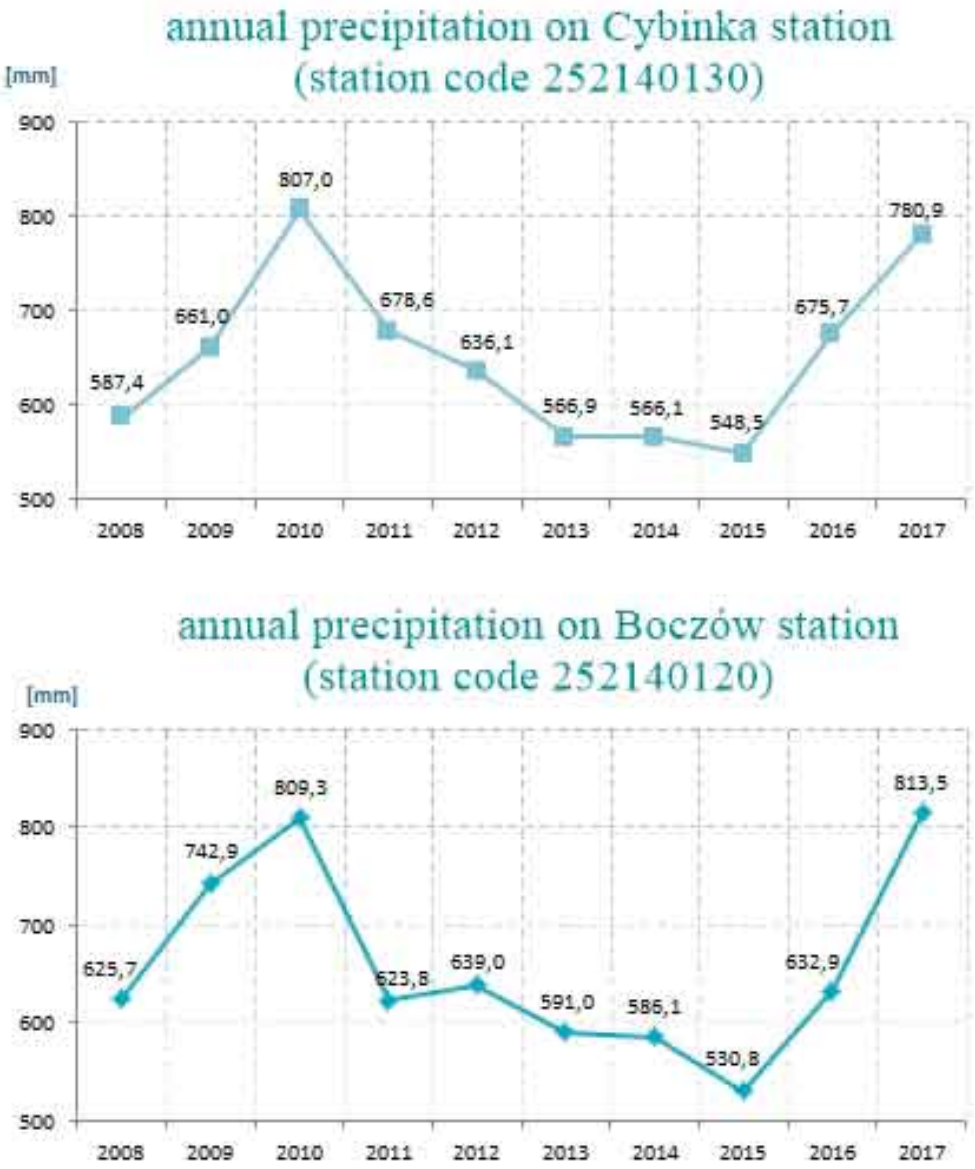


Fig. 114. Total annual rainfall for the Boczów and Cybinka measurement points in 2008 – 2017 (source: IMGW).

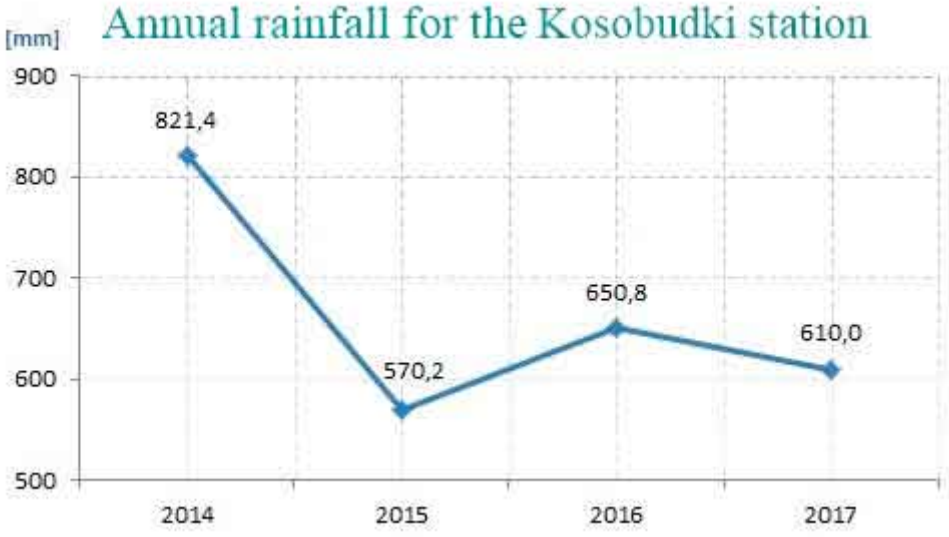


Fig. 115. Total annual rainfall recorded at the hydrometeorological station in the Mechowisko Kosobudki Reserve (note: the rainfall in 2014 is likely to be affected by an error due to unknown technical reasons).

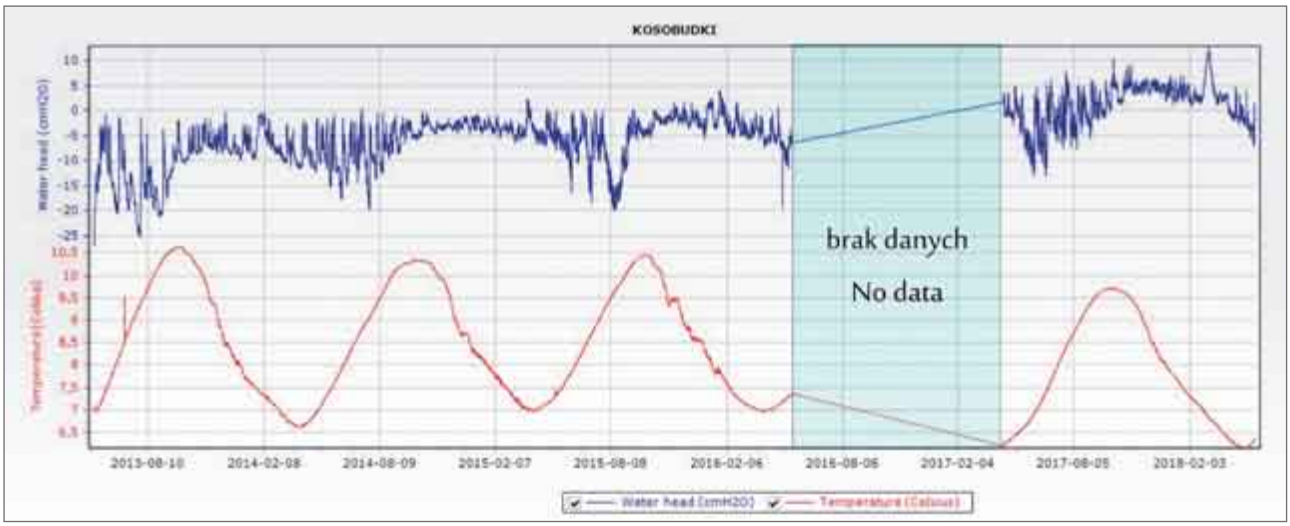


Fig. 116. Changes in the groundwater level in the vicinity of the hydrometeorological station in the Mechowisko Kosobudki Reserve (Natura 2000 area Dolina Pliszki).

Fig. 117. Changes in the groundwater level in the Kosobudki II site (Natura 2000 area Dolina Pliszki), fen on the other side of the river, outside the Mechowisko Kosobudki Reserve.

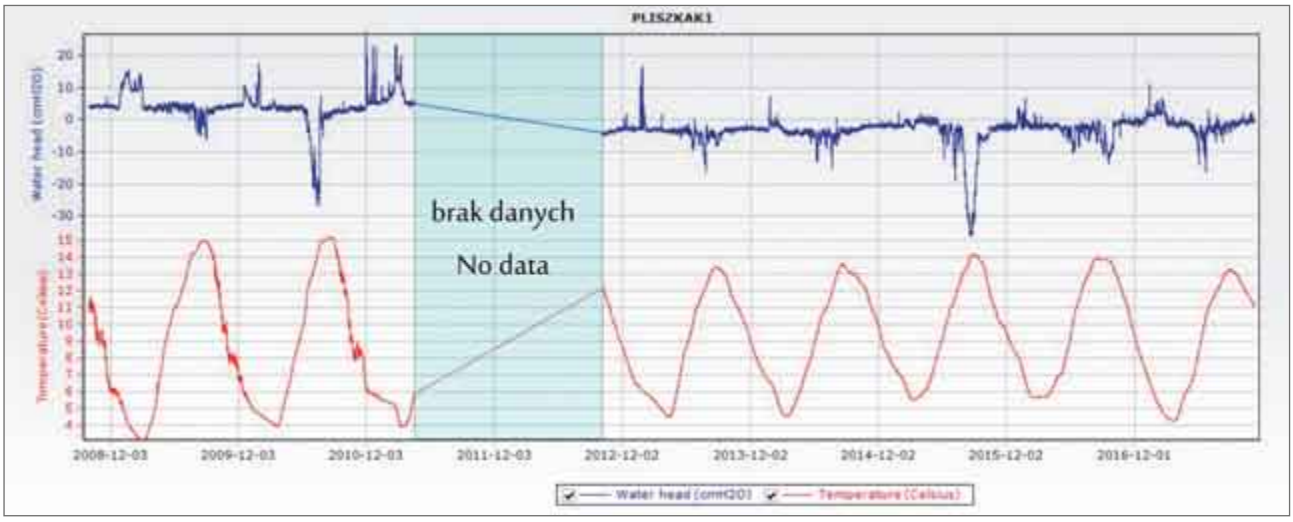


Fig. 118. Changes in groundwater level at the Kijewo site (Natura 2000 area Dolina Pliszki).

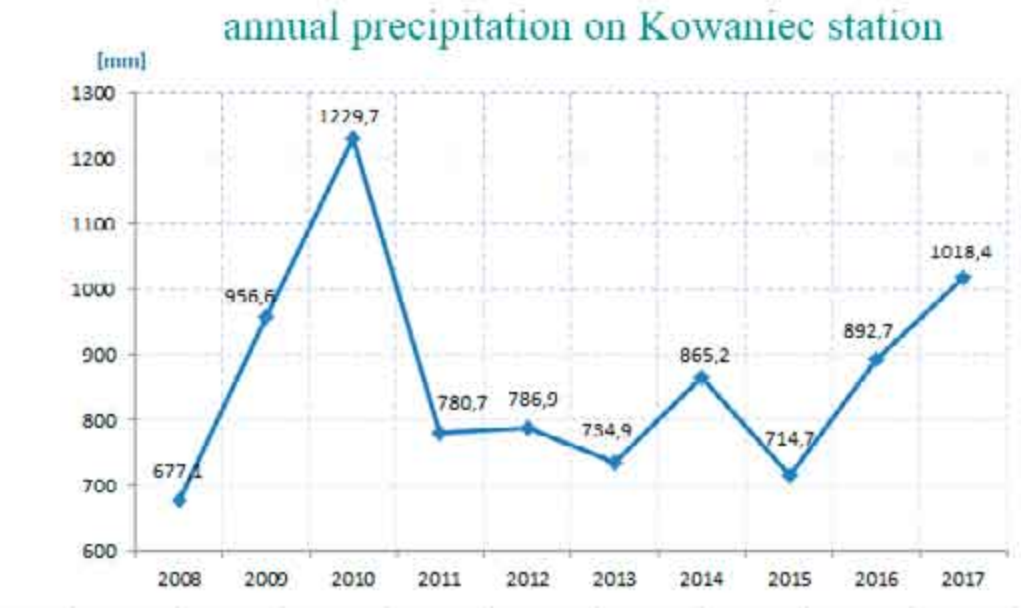


Fig. 119. Total annual rainfall for the Kowaniec station in the years 2008 – 2017 (source: IMGW).

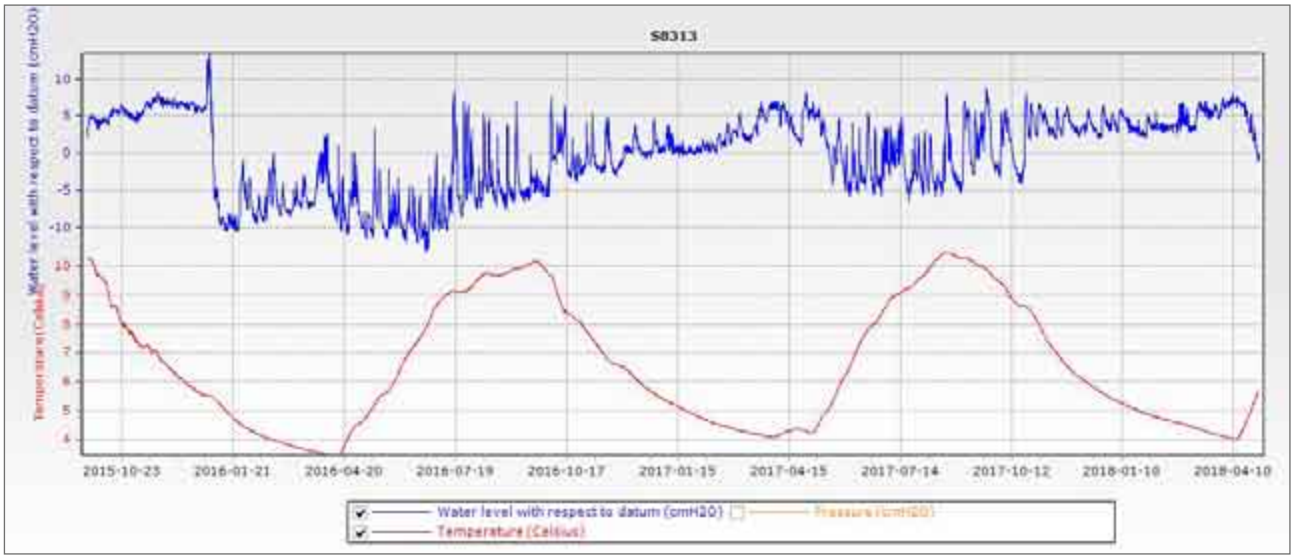


Fig. 120. Changes in the groundwater level in the Hala Długa area.

4.2. Phytosociological monitoring, methodologies and conclusions

As already indicated in the previous chapters, the areas covered by the projects were of interest to the Naturalists' Club several, and sometimes over a dozen years before the start of the project (especially sites located in north-western Poland). Part of the data, including data on vegetation, was collected systematically in accordance with the previously planned methodology and was used for the purposes of the project preparation. At the same time, they are excellent comparative material for many sites, allowing conclusions to be drawn regarding the effectiveness of the adopted methods of protection of alkaline fens, which are impossible to formulate in the short term of the project implementation. A short period (1 – 2 years), which usually elapses between the completion of the treatments and the end of the projects, does not give the possibility to observe and fully analyze the changes in vegetation, except for obvious elements such as the lack of removed trees and shrubs.

Phytosociological monitoring within the individual sites included mainly studies of vegetation on designated, representative research transects. Stratigraphic analyses were carried out on the transects

in order to reconstruct the history of the fens development and to assess the conservation status of the peat deposit. In order to characterize the vegetation and to record the initial state, i.e., before taking the protective measures, relevées were taken at the central points of the outstanding plant patches using the standard Braun-Blanquet method. Phytosociological studies were repeated at various intervals, from several to 20 years. Additionally, for a part of the existing and planned reserves, within which protection plans were drawn up under the LIFE11 NAT/PL/423 project on the basis of current and historical maps of actual vegetation, an analysis of changes in vegetation was carried out, taking into account, among others, the impact of the undertaken conservation measures. During the monitoring studies, in each of the sites the type and scope of protective measures were recorded in order to assess their intensity. Detailed information on the results of the conducted phytosociological research is included in the nature documentation and protection plans. The results of the conducted vegetation monitoring studies are presented in detail in chapter 2 of Volume I together with the descriptions of individual sites. Their generalized graphic form for selected areas was presented in several figures – stratigraphic cross-sections together with the distribution of identified phytosociological units.

Detailed phytosociological observations were carried out mainly in the hydrological monitoring places (cf. chapter 4.1.); however, in the absence of automatic groundwater level recorders in the past it has not been possible to collect complete data on vegetation and hydrology at the same time. The earliest phytosociological data used in the report were collected in 1995 (Dolina Ilanki), and hydrological data from automatic measurement instruments were obtained only in 2008. Earlier, hydrological information was obtained from piezometers, however these were manual measurements of irregular frequency. The observations carried out in Eastern Poland covered only the project duration, as no relevant data from previous years were available. The most important conclusion observed on the majority of the studied fens is that their lighting conditions have significantly improved due to the removal of trees and shrubs, as well as reeds. This was particularly evident in the area of Sarnetki where the reed dominated almost the entire alkaline fen, and after preparatory and secondary mowing, already carried out as part of the agri-environmental program, the species has decreased its cover and height.

Mowing the sward together with removal of basal offshoots is particularly important when the weather conditions favor increased penetration by trees and shrubs (long dry periods alternating with heavy rainfall). Given that the climate is currently unfavorable to the conservation of these ecosystems, it is therefore extremely important not to allow an increase in tree cover density and the development of forest communities, even though there is no clear change in flora composition in favor of moss fen species. Often, therefore, the beneficial effect of the project – despite the vegetation being transformed already before the commencement of protective measures – is the lack of significant changes in the flora and species composition of the plant communities.

Nevertheless, in many cases, the observations of vegetation showed an improvement in the habitat condition – on the Torfy Orońskie fen it was observed that extensive hay production favors the development of species of the *Scheuchzerio-Caricetea nigrae* class, i.e., those associated with fens (see Figure below); in addition, the share of meadow spe-

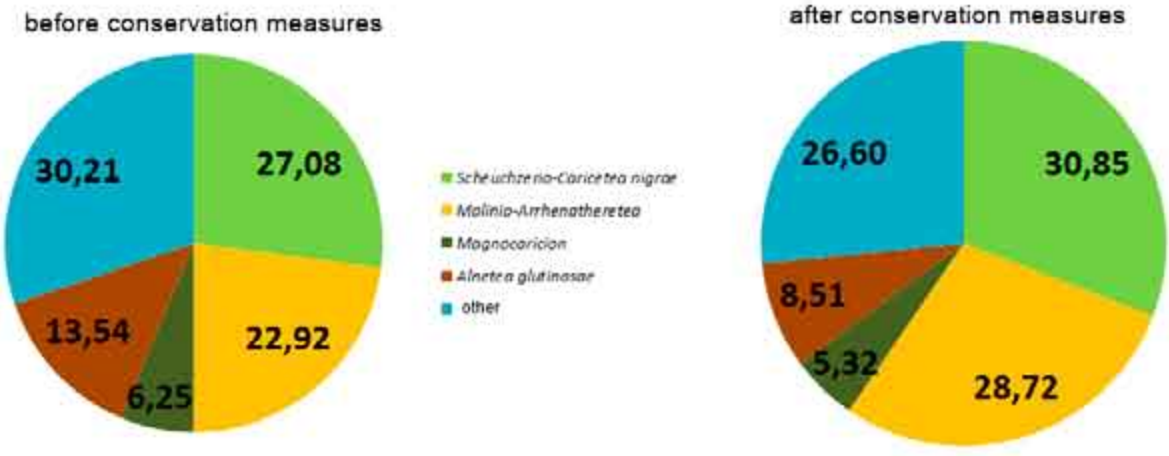


Fig. 121.Percentage shares of species of individual phytosociological units before mowing (in 2009) and after four mowings (in 2017) on Torfy Orońskie site.

cies of the *Molinio-Arrhenatheretea* class increased. Other species, including reed and alder species, have decreased their share, which is beneficial for the conservation of habitat 7230 in a favorable condition.

Conclusions

1. A dozen or so years of observations of alkaline fens in northern Poland indicate different dynamics of vegetation changes. Among tens of alkaline fens, the following can be considered as the best preserved and representative vegetation maintaining its unaltered character (in the absence of protection measures or their occasional use) over the last dozen or so years: Bagno Stawek Reserve, Mechowisko Radość, Mechowisko Manowo, Rospuda Valley, Torfowisko Morgi, Torfowisko Zocie, and Kobyla Biel**.** In southern Poland it will surely be fens and flush fens of Gorce and Magura National Parks. The process of slow changes of vegetation within these fens should be linked to the preservation of natural or only slightly modified hydrological conditions within their surface and underground catchment areas.
2. The different dynamics of changes in vegetation of alkaline fens apply not only in relation to entire sites, but also within fragments of fen complexes. Examples include the fens of the Ilanka and Pliszka River Valleys.
3. Protective measures consisting in regulation of groundwater level, removal of forest and rush vegetation, as well as mowing may result in various effects.
4. Protective measures, limited only to raising the water level within alkaline fens with altered hydrological conditions, contribute little to inhibiting the expansion of forest vegetation.
5. Raising the water level in sites where the top layer of peat is mineralized contributes to the expansion of rush vegetation.
6. Maintaining or restoring vegetation characteristic for alkaline fens in strongly transformed sites is possible by raising the water level combined with simultaneous intensive removal of biomass, but sometimes for unknown reasons the implementation of this measure – even for many years – does not bring the desired effects.

Photo 126. The Bagno Stawek Reserve is one of the best preserved alkaline fens of western Poland, characterized by relatively low dynamics of fen vegetation (photo R. Stańko).

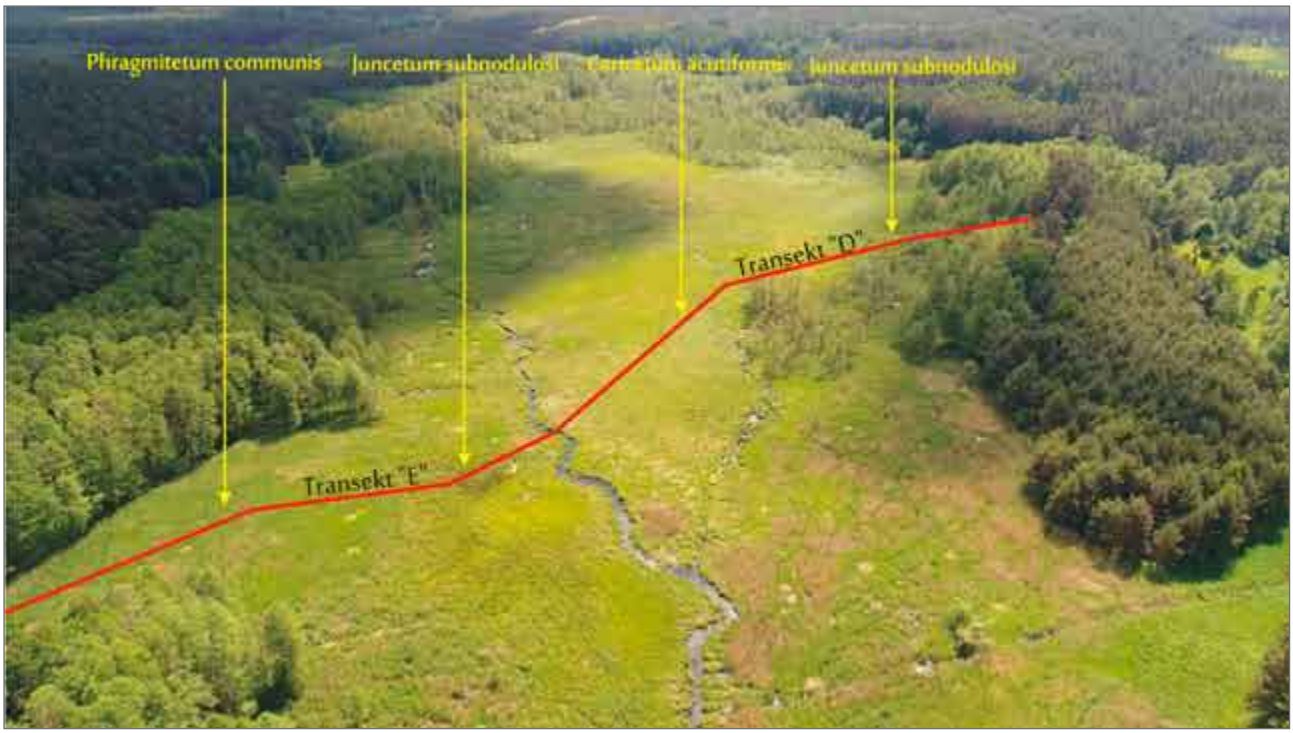


Fig. 122. Ilanka River Valley – transects "D" and "E", in the photo from 2018 as an example of a fragment of a fen complex where over the last 20 years the vegetation has not changed significantly with almost no active protection.

Photo 127. Torfowisko Pliszka – one of the few fen complexes where the dynamics of the fen vegetation is relatively slow, which can be associated with natural or only slightly altered hydrological conditions. The degree of naturalness of the complex somehow reflects the natural system of surface watercourses, i.e., an unregulated meandering river and the lack of traces of drainage ditches (photo R. Stańko).

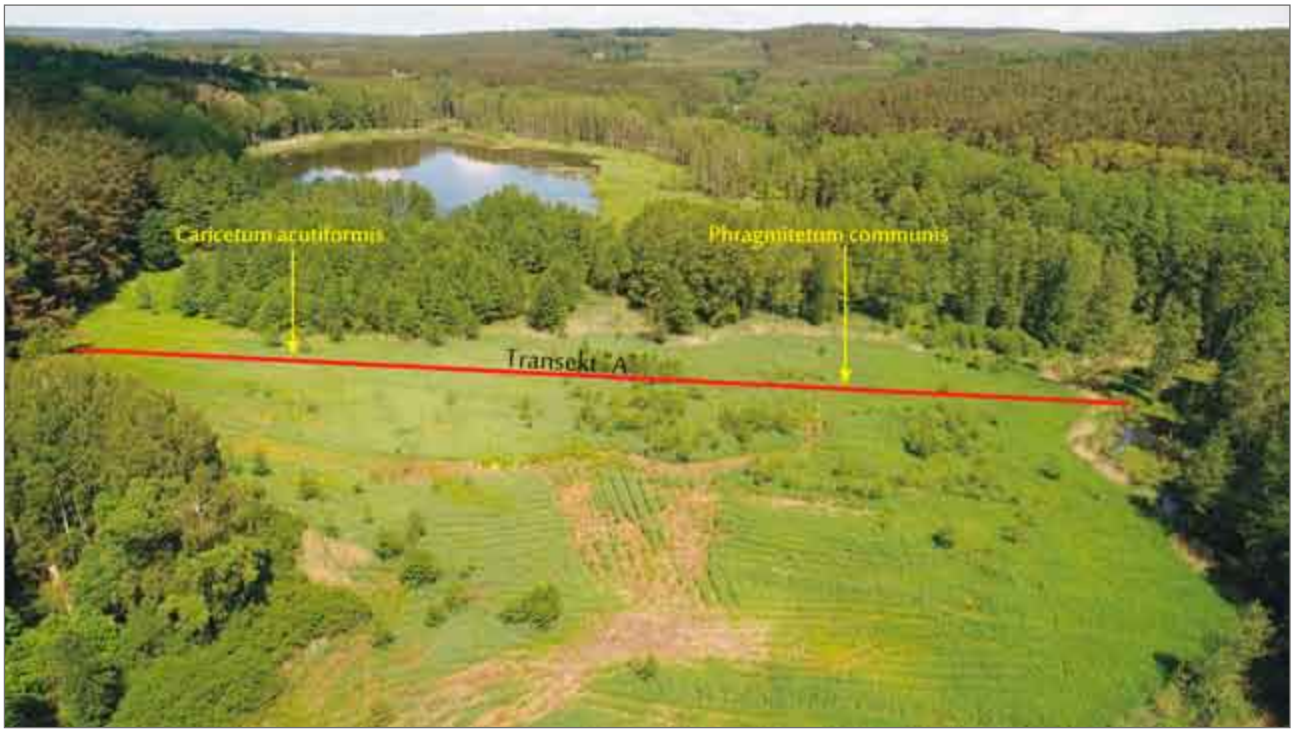


Fig. 123. Ilanka River Valley – transect "A" (located only 0.5 km from transects "D" and "E") as one of the few examples where, despite the improvement of water conditions and intensive conservation efforts, the vegetation characteristic for alkaline fens is disappearing.

7. Occasional (every 3 – 5 years) removal of tree wildings ensures that the characteristic vegetation of the least transformed alkaline fens is maintained.
8. A significant influence on the changes in vegetation of alkaline fens, especially the altered ones, is the level of habitat hydration – in the case of the so-called „wet years", the vegetation may transform towards rush communities, while during the „dry years" – towards meadows.
9. The use of moss fens with heavy mechanical equipment, such as groomers, has a negative impact on the ecosystem by homogenizing the structure of the fen and affecting its biodiversity.
10. In the case of removal of bushes from alkaline fens, it is necessary to remove the root offshoots for several consecutive years.
11. Alkaline fens are distinguished by many specific features, depending on the local hydro-ecological conditions, and require highly individual treatment in the selection of protection methods.

5. Prospects for the protection of alkaline fens

Robert Stańko, Lesław Wołejko, Paweł Pawlaczyk

Alkaline fens are a habitat distinguished mainly by the abundance of rare and endangered plant species and protected species, including several from Annex I of the Habitats Directive. For this reason, they should be of particular concern not only to the national authorities responsible for nature conservation but also to the European Community. Even a cursory comparative analysis of the area of alkaline fens under protection, such as reserve protection, indicates that they are much less represented than transition mires or raised bogs. Unlike other types of fens, alkaline fen reserves are still rare. Thanks to the project, the number of reserves with alkaline fens as the main conservation objective increased by at least a few percent nationwide. Without the creation of the Biebrza National Park, which protects the largest area of alkaline fens in Poland, habitat 7230 would occupy a marginal place in the national system of protected areas.

Despite its high natural values, the surface area of alkaline fens, as has been shown earlier, decreased dramatically over the last several decades as a result of drainage works. The state of preservation of the sites which have survived to this day is also a cause for concern. It is estimated that fens in good condition cover less than 10% of their total area.

Due to the unique water conditions that determine the development of alkaline fens, these areas are particularly sensitive to any modification of the natural hydrological systems, which are extremely difficult to identify and remedy.

As habitats under past agricultural pressure, alkaline fens require in most cases continuation or restoration of extensive use for their further development.

Nevertheless, the preservation of Polish resources of alkaline fens in their present state, and even their improvement, although very difficult, seems possible. Postulates of actions and solutions that in implementation such a goal could help:

- **Recognition of funding for habitat 7230 protection activities as priority under the Priority Action Framework for Natura 2000. Granting for the fastest dying habitats in the European Union (to which habitat 7230 belongs), the same rank and privileged funding rules that are currently available to habitats, for which the EU has a special responsibility for biogeographic reasons (so-called 'priority habitats').**
- **Set as priority financing from national funds the protection of habitat 7230. Restore applicant's friendly (all types of them - not only to State Tresury entities), terms and conditions.**
- **Covering with protection under nature reserves further alkaline fens in Natura 2000 sites, and especially beyond them. Practice indicates that the very existence of the Natura 2000 site, and even landscape park or protected landscape sites, is not always enough for correct diagnosis of occurrence, not to mention the effective protection of alkaline fens.**
- **A broad and ambitious nationwide buy-out program of the most valuable alkaline fens from private owners, together with the provision of financing.**
- **More ambitious support for operations, including experimental ones, on the field of restoration of peatlands, in particular, restoring natural hydrological conditions in areas of concentration of alkaline fens.**
- **Ensure that all - even minor – water management investments, including above all modernisation and maintenance of ditches and small ones watercourses, as well as the construction of any water-based facilities, planned and implemented in areas with the possible occurrence of alkaline fens – have always been subjected to meticulous impact assessment procedures and approval by the nature protection authority. Sufficient for that are currently functioning legal provisions (including Article 118 of the Nature Protection Act), but it would have to be significantly improved in practice of using them.**
- **Reforming and improving the quality of environmental impact assessment procedures together with impact assessment on Natura 2000 sites, so as to exclude any activities that could potentially disrupt local and regional hydrological conditions, especially regarding**

groundwater flow in areas where alkaline fens occur. Full application in these procedures the precautionary principle; taking into account also the pressure distant in space and the effects of distant in time causes.

- Execution of the requirement of good recognition of natural values of the area, including inventory, classification and diagnosis of peatlands, before drawing up plans or studies of spatial development and before publishing decisions on land development conditions. Properly taking into account the needs of peatlands in strategic impact assessment on peatlands.
- Providing all drainage systems on peatlands with functional equipment enabling closing of the water flow and working out such water management patterns, which, among others, guarantee proper water conditions for peatlands.
- Make, existing and future agri-environmental schemes or their equivalents, more flexible. Program requirements should assume the possibility of an individual mode of use for each patch of habitat, allowing both intensification as well as extensification of conservation measures matched to a specific fen. An effective system of sanctions in payments is also necessary in the event of a breach of requirements - both general and individualy set by the expert for a specific fen. In parallel, an intense education of habitat experts and agro-environmental advisers in the specific needs of alkaline fens is necessary, so that they knew correctly and for the benefit of the fen how to adjust the detailed usage requirements.
- Ultimately, changing support from agro-environmental-climate programs recompensation of lost benefits, to the payment system which amount depends on the achieved effects (preserved occurring on the farmer's plot natural values) and not methods of use.
- Promotion, through the use of agricultural policy mechanisms, maintenance of grassland in the neighborhood of alkaline fens. Preventing transformation of grassland and wasteland for arable land, ponds, etc.
- Extension and methodical improvement of the conducted monitoring of the natural habitat 7230 on a national scale, in particular a supplement for a component of good hydrological monitoring. Establishment of good local monitoring systems of specially protected peatlands, especially in reserves, national parks and Natura 2000 sites. This requires investment but usually obtained in this way knowledge of exact, often specific conditions of protection, is worth spending.
- Seriously treating by the State Forest Holding its statutory obligation of „conservation of natural wetlands and peatlands in forests", understood as an obligation to act on behalf of or restoration of the favourable conservation status of peatlands located in forest managed by SFH - implemented by SFH alone or as eased to a large degree the protection of peatlands on State Forests' land to others interested entities.
- In the forest management, adaptation of breeding methods to stabilize water conditions within the basin of individual peatland, in particular non-use of total cuts in the vicinity of peatlands and springs.

Acknowledgements

The implementation of projects covering almost 54 Natura 2000 sites and almost 190 different alkaline fens located in the area of almost the whole country required the involvement of at least several hundred people and dozens of different institutions, which can not be calculated. We have contacted many of them before the start of the project, but with the majority, due to our limited organizational and financial capacity as a non-governmental organization, only during its implementation. We have taken a risky attempt to protect the alkaline fens, often not knowing their owner, let alone his views on nature conservation. Hoping that the protection of nature, and especially the protection of its most valuable and the fastest disappearing elements, will prevail over all real and apparent problems. In the vast majority of cases, we have not made a mistake! Especially surprising for us was the fact of successful cooperation with the majority of private owners, in contrast to many disappointments accompanying us from institutions or state entities, often responsible for nature conservation. But these cases were also rare. We would like to thank all those who actively and passively supported us. This is particularly true for representatives of the state administration responsible for nature conservation and land managers - mainly forest inspectorates, for real concern for nature, courage in making decisions, including cooperation with the non-governmental organization, which is not always favorably perceived in the environment. We would like to name them all, because without them protection of alkaline fens would not be possible. However, knowing the conditions that have been in place for years, we are forced to do so only individually.

First of all, we would like to thank our partners:

- in Project LIFE11 NAT/PL/423: Regional Directorate of Environmental Protection in Gdańsk and Olsztyn. We have invited the majority of regional directorates to the partnership in which we implemented the project, but only two of them finally took this joint risk.
- in Project LIFE13 NAT/PL/00024: Gorce National Park, especially Director Janusz Tomasiewicz and Marek Ruciński, as well as all employees of the Park.

We are also grateful to the Regional Directorate for Environmental Protection in Gorzów Wielkopolski and Szczecin (Project LIFE11 NAT/PL/423), Regional Directorate for Environmental Protection in Łódź, Kraków, Lublin, Warsaw, Katowice, Kielce and Wrocław (Project LIFE13 NAT/PL/000024). Special thanks are due to the Regional Directorate of Environmental Protection in Rzeszów, who expressed a desire to co-finance the project (actions undertaken in the Podkarpackie Voivodeship).

We would like to extend our special thanks to the Pomeranian Landscape Parks Team, which throughout the whole period of the project's implementation was its third, informal partner and the Magura National Park and the Bieszczady National Park

Implementation of the projects would not have been possible without the consent and often active assistance from the following Forest Inspectorates in: Bobolice, Bytnica, Bytów, Cisna, Cybinka, Człopa, Dukla, Drawno, Ełk, Gołdap, Jastrowie, Kalisz Pomorski, Krosno Odrzanskie, Krościenko, Kościerzyna, Krynki, Lidzbark, Lipusz, Manowo, Osusznica, Olsztynek, Piwniczna, Płaska, Polanów, Płytnica, Przymuszewo, Rymanów, Torzym, Ujsoły, Wejherowo, Wisła, Złotów - thank you all.

We would also like to thank the private individuals mentioned below for understanding and, above all, for the trust they have placed in us: Barbara Adamska, Mieczysław Adamus, Magdalena Alma, Hanna Andruszkiewicz, Marcin Andruszkiewicz, Wiesław Aniołowski, Marek Armata, Barbara Auguścik, Marianna Babert, Józef Babiarz, Jerzy Balicki, Grzegorz Baran, Jerzy Barański, Józef Barański, Bogumiła Barczuk, Aleksandra Barszcz, Bernadetta Bartyzel, Tadeusz Bijak, Jarosław Biłbak, Krystyna Biniek, Arkadiusz Bogucki, Mariusz Bogucki, Elżbieta Boguszewska, Antoni Bołoz, Maksymilian Bołoz, Monika Bołoz, Paweł Bołoz, Dariusz Borczyk, Stanisław Borkowski, Kamil Brezgieł, Genowefa Bufor, Agnieszka Bułajewska, Henryk Butkiewicz, Witold Cejest, Stanisław Chmielewski, Zdzisław Chmielewski, Leszek Chmieliński, Stanisława Chrzanowska, Renata Chudyba Wiesław Chwedeczko, Beata Cieciora, Monika Cieciora, Grzegorz Ciesielski, Radosław Cygan, Jan Cyran, Małgorzata Czerwińska, Barbara Czerwonka, Piotr Czupinka, Wiesława Danilak, Krystyna i Adam Dąbrowscy Wojciech Dębski, Zbigniew Dębski, Małgorzata i Andrzej Dłoniak, Barbara Dobiech, Halina Dolot, Sylwester Drab, Wiesław Drygaś, Stanisław Dubielewski, Wiesław Dubielewski, Piotr Duraziński, Łukasz Duziak, Iwona Dziura, Marek Famulski, Stanisław Ficek, Tadeusz Fiedorowicz, Krzysztof

Filipczak, Krystyna i Krzysztof Frysiak, Olgierd Furman, Robert Gadomski, Krystyna i Andrzej Gardas, Józef Gibowicz, Karol Grabowski, Marek Grabowski, Stefania Granek, Jolanta i Marek Grądz, Tadeusz Grądz, Franciszek Grądz, Mieczysława Grądz Wojciech Gromada, Tadeusz Grosz, Tadeusz Grosz, Adam Gruźlewski, Barbara Gut, Radosław Guźdź, Ewa i Marek Haponik, Lucyna Hęś, Wiesław Hryc, Barbara Iłczewa, rodzinie Jadwigi Iwanek, Eugeniusz Iwaszko, Paweł Jabłoński, Tomasz Jabłoński (Polany Kolonia), Tomasz Jabłoński (Pakosław), Włodzimierz Jabłoński, Zygmunt Jabłoński, Krystyna Jach, Andrzej Jadeszko, Jan Jakubczak, Krzysztof Jakubiak, Krzysztof Jakubik, Teresa Janicka, Magdalena Jankowska, Mariusz Jankowski, Rozalia Janota, Józef Jarocki, Anna i Michał Jarzębak Antoni i Bronisława Jarzębak, Barbara Jarzebak, Ignacy Jarzebak, Jan Jarzębak, Kazimierz Jarzebak, , Sławomir Jarzębak, Stefania Jarzębak, Wioletta i Jacek Jarzębak, Maria Jasionowska, Jan Jaśkiewicz, Marianna Jaśkiewicz, Barbara Jeger, Jarosław Jeż, Dariusz Justa, Dorota Justa, Tomasz Juś, Jarosław Kalinowski, Małgorzata Kalisz, Krzysztof Kapusta, Józef Kapusta, Lucjan Kapusta, Jan Karpiński, Grzegorz Karpowicz, Wiesław Karpowicz, Marcela Karwan, Marzena Kasprzyk, Dorota Kiełbasa, Andrzej Kiljanek, Mieczysław Klementowski, Krzysztof Kliszcz, Ryszard Kliszcz, Sławomir Kliszcz, Grażyna i Kazimierz Knapek, Anna i Marcin Kniaź, Monika Knieć, Jolanta Knieć, Stanisława Kobyłka, Antoni Kocoń, Elżbieta Kocoń, Irena Kołodziejczyk, Stanisław Konwerski, Edmund Konarski, Józef Kopczacki, Danuta Koral, Marcin Korenkiewicz, Jan Korenkiewicz, Jerzy Korenkiewicz, Robert Korenkiewicz, Grzegorz Korękiewicz, Elżbieta Korpusik, Jacek Kostecki, Maria i Józef Kotarba, Urszula Kowalczyk, Kazimierz Kowalewski, Andrzej Kowalik, Ireneusz Kozłowski, Ryszard Kozłowski, Bogdan Krasoń, Anna i Wojciech Krawczyk, Stanisław Krawczyk, Alicja Krupa, Teresa Krupa, Dorota Kryścio, Jan Krzeszowiak, Stanisław Kruczek, Paulina Kuc, Zygmunt Kuc, Wiesław Kuceł, Halina Leśniewska, Mateusz Leżański, Piotr Leżański, Piotr Litwińczuk, Tadeusz Łosiewicz, Karol Lutyński, Mariusz Łagowski, Katarzyna Mach, Andrzej Maciejewski, Jan Magdziak, Jacek Majcher, Ireneusz Małysa, Andrzej Majerski, Ewa Maślanka, Grzegorz Maślanka, Andrzej Milewski, Dariusz Milewski, Jan Milewski, Janusz i Andrzej Milewscy, Józef Milewski, Krzysztof Milewski, Marcin i Jan Milewscy, Mieczysław Milewski, Stanisław Milewski, Wiesław Milewski, Zofia i Grzegorz Mirotowie, Wiesław Misiun, Waldemar Misztal, Henryk Mitręga, Młodzieżowy Dom Kultury „Dom Harcerza" (Aleksandra Grodecka, Grzegorz Szewczyk), Krzysztof Młyńczak, Marcin Mokrzecki, Marian Mrozik, Ewa i Marcin Musiałek, Piotr Nabywaniec, Marcin Napiórkowski, Franciszek Nazarczuk, Bolesław Niśkiewicz, Danuta Nobis, Anna Nowak, Halina Nowak, Krystyna Nowakowska, Izabela Nurkowska, Michał Ogorzałek, Kazimierz Ogrodnik, Krystyna i Grzegorz Okoń, Jan Olszewski, Zdzisław Olszewski, Ewa Omiljańczyk, Tadeusz Orszulak, Grzegorz Osiński, Michał Ostafiński, Dorota Pacek, Alfred Paczwa, Maria Padula, Elżbieta Papiernik, Zbigniew Pawelec, Zdzisław Pawlak, Paweł Pędziwiatr, Elżbieta Pfeifer, Jan Pfeifer, Dariusz Piekarczuk, Mieczysław Pietruszewski, Halina Piróg, Dariusz Piskórz, Teresa Płobucka, Henryka Płoskonka, Karol Pojawa, Tomasz Pojawa, Michał Przeor, Danuta Przybyłek, Jadwiga Puchała, Aleksander Pytalski, Edward Racis, Karol i Marek Radeccy, Beata Radek, Aleksandra Radomska, Marek Rajczewski, Zygmunt Rajtar, Milena Rak, Stanisław Rekowski, Andrzej Rogala, Jerzy Rogala, Krzysztof Roganowicz, Roman Rogoziński, Krzysztof Romańczuk, Bernadetta Róg, Karol Różalski, Andrzej Różański, Danuta Rybnik, Halina Rypel, Grzegorz Rytwiński, Zenona Sadowska, Edyta Samulewska, Renata Sękacz, Sebastian Sidoruk, Marek Sieczkowski, Józef Siejwa, Waldemar Sielwanowski, Jolanta Sieraczyńska, Agnieszka Skalik, Stanisława Skrzydelska, Rafał Skrzypczak, Zofia Smyda, Maria i Ryszard Sobczak, Aleksandra Sobczyk, Stanisław Socik, Barbara Socha, Rozalia Sobolew, Ryszard Sobolewski, Renata Solecka, Agnieszka Sosińska, Bronisław Sporek, Franciszek Sporek, Józef Sporek, Szczepan Sporek, Dariusz Stępień, Family Garden Plots Assosiation in Augustów (Janusz Harasim, Dariusz Ostapowicz), Jadwiga Suława, Ewa Szastak, Ewa Szawaryn, Kazmierz Szczygielski, Andrzej Szeremeta, Jacek Szmit, Dariusz Szot, Aneta i Piotr Szpindowie, Daniel Sztabiński, Małgorzata Szudy – Mroczka, Dariusz Szykuła, Marzena Szymczyk, Zdzisław Szyszko, Adrian Środa, Ireneusz Świąder, Jacek Tama, Jadwiga Tarapacz, Jan Toczek, Marek Toczek, Maria i Stanisław Toczek, Halina Topczewska, Anna Tomaniak, Wiesław Topolski, Małgorzata Trocka, Henryk Truchan, Jadwiga i Jan Truty, Beata Tusińska, Szczepan Tusiński, Wojciech Tusiński, Antoni Tutaj, Lech Tytulski, Marcin Urban, Jacek Urban, Tomasz Urbanek, Marek Urbanowicz, Edyta Utkowska, Tadeusz Waligórski Ireneusz Wawrzyn, Krzysztof Wawrzyn, Tadeusz Wawrzyn, Józef Wiatrak, Danuta Wielgoszyńska, Joanna Więcaszek, Grzegorz Wilczewski, Alicja i Wiesław Wiśniewscy, Marian Wiśniewski, Krystyna Witkowska, Tomaszom Witkowskim, Zdzisław Witkowski, Bronisław Włochyński, Jan Włodarczyk, Janina Włodarczyk Maria i Jan Wnęk, Elżbieta Wrona, Andrzej Wron-

ka, Ewa i Edward Wróblewscy, Land Community of Śniatyczne Village (Jerzy Marucha), Forest and Land Community Hala Łyśniowska and Hala Uszczawne (Jan Kupczak), Forest and Land Community in Szczawnica (Marian Dziedzina - Wiwer, Jan Malinowski, Kazimierz Salomon), Pasture Community of Łosiniany Village, Osiek Village Community (Kazimierz Markiewicz), Józef Wolny, Sylwester Wójcik, Maria Wydrzycka, Grzegorz Zaborski, Urszula Zabrocka, Marianna Zakrzewska, Przemysław Zawada, Witold Zawada, Zofia Żerebiec, Monika Żyła, Anna Żywczak.

We thank for help in carrying out the project the representatives of the City of Iłża, Jarczów Municipality (Tadeusz Mucha, Mariusz Szopa, Zdzisław Wojnar), Komarów – Osada Municipality (Wiesława Sieńkowska, Agnieszka Wszoła), Piwniczna Town and Municipality, Suwalki Landscape Park (Magdalena Marzec, Teresa Świerubska), Wigry National Park, Polsih Water Holding Wody Polskie, the Biała Podlaska Catchment Board, Regional Water Management Boars in Lublin, and Wiaczesław Michalczuk and Krzysztof Monastyrski.

We would also like to thank the representatives of the Life + Fund and the National Fund for Environmental Protection and Water Management in Warsaw for their understanding and help in overcoming so many problems that accompany the implementation of the project.

Special thanks for the invaluable help and understanding during the monitoring of the project we would like to express to Mrs. Marta Kaczyńska.

We would also like to thank all the employees of the Naturalists' Club who have been involved in various ways in the Project, directly supporting us in specific activities or just doing other jobs for us.

Finally, we would like to thank all those whom we have not mentioned and who have helped us in any way. Which, by inattention or memory problems, we have overlooked or even for which help we had no idea.

Thank you for help at the same time, we hope that you will forgive us and forget all our *faux pas* and even mistakes that we have certainly committed and in the future we will be able to continue cooperation to protect our (common) alkaline fens!

In the name of whole project team
– Robert Stańko

References

Andrzejewski H., Kurowski J. K., Witosławski P. 2002. Nowe stanowisko lipiennika Loesela w środkowej Polsce. Chrońmy Przyr. Ojcz. 58, 6: 70-72.

Chmielecki B., Halladin-Dąbrowska A., Nedźwiedzki P., Ratajczyk N. 2009. Perspektywy ochrony cennych gatunków i siedlisk na obszarze Natura 2000 „Łąka w Bęczkowicach". Przegl. Przyr. 20, 3-4: 79-86.

Ćwikliński E., Głowacki Z. 1984. Rezerwat florystyczny „Oronne". Opracowanie dokumentacji naukowo-badawczej. Wojewódzki Konserwator Przyrody, Wydział Ochrony Środowiska, Gospodarki Wodnej i Geologii, Urząd Wojewódzki w Siedlcach.

Denisiuk Z., Korzeniak J. 1999. Zbiorowiska leśne krainy Dolin Bieszczadzkiego Parku Narodowego. Monogr. Bieszczadzkie. T.5. Ośrodek Nauk.-Dyd. BPN. Ustrzyki Dolne.

Dobrowolski R., Bałaga K., Buczek A., Alexandrowicz W. P., Mazurek M., Hałas A., Piotrowska N. 2016. Multi-proxy evidence of Holocene climate variability in Volhynia Upland (SE Poland) recorded in spring-fed fen deposits from the Komarów site. Holocene 26, 9: 1406-1425.

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, pp. 7).

Falkowski M., Górski P., Kajzer K., Bistuła-Prószyński G, Woźniak A. 2005. Projekt planu ochrony rezerwatu przyrody „Torfy Orońskie". Narodowa Fundacja Ochrony Środowiska, Warszawa.

Falkowski M., Krechowski J., Piórek K. 2009. Szata roślinna rezerwatu „Torfy Orońskie". Chrońmy Przyr. Ojcz. 65, 1: 53-60.

Gdaniec M. 2010. Nowe stanowisko skalnicy torfowiskowej *Saxifraga hirculus* L. na torfowisku nad jeziorem Małe Długie na Pomorzu Gdańskim. Acta Bot. Cass. 7-9: 251-254.

Gramsz R. 1984. Wstępna ocena walorów torfowiska Pakosław oraz prognozowanie zmian w środowisku spowodowanych zmianą stosunków wodnych. Publishing House of Radom Scientific Assosiation.

Grzyb M. 1990. Plan zagospodarowania rezerwatu „Torfy Orońskie". Voievodship Office in Siedlce.

Grzyb M. 1993. Torfy Orońskie. Las Polski 9: 16-17.

Gutowska E., Jarzombkowski F., Kotowska K. 2014. Dokumentacja przyrodnicza wybranych obiektów – torfowisk alkalicznych Puszczy Augustowskiej. Świebodzin, ms.

Gutowska E., Jarzombkowski F., Kotowska K., Gawroński A., Gawrońska A. 2016a. Dokumenatcja przyrodnicza projektowanego rezerwatu przyrody „Kobyla Biel". Świebodzin, ms.

Gutowska E., Jarzombkowski F., Kotowska K., Gawroński A., Gawrońska A. 2016b. Dokumentacja przyrodnicza projektowanego rezerwatu przyrody „Bagienna Dolina Rospudy". Świebodzin, ms.

Hájek M., Haberowa I. 2001. *Scheuchzerio-Caricetea fuscae*. In: Valachowić M. Rastlinne spoločenstvá Slovenska. 3: Vegetacia mokradli. Veda. Vyd. Slov. Akad. Vied. Bratislava.

Halladin-Dąbrowska A., Chmielecki B., Niedźwiedzki P. 2009. Obszar Natura 2000 „Łąka w Bęczkowicach" jako ostoja cennych gatunków roślin naczyniowych – problemy i perspektywy ochrony. Parki Nar. Rez. Przyr. 28, 2: 107-124.

Herbichowa M., Pawlaczyk P., Stańko R. 2007. Ochrona wysokich torfowisk bałtyckich na Pomorzu. Doświadczenia i rezultaty projektu LIFE04/NAT/PL/000208 PLBALTBOGS. Świebodzin.

Jabłońska E., Chormański J., Falkowski T., Jarzombkowski F., Kłosowski S., Okruszko T., Pawlikowski P. 2010. Hydrologiczno-hydrochemiczne uwarunkowania zróżnicowania przestrzennego roślinności i przebiegu procesów sukcesyjnych w ekosystemach torfowiskowych na przykładzie doliny Rospudy. Uniwersytet Warszawski, ms., p. 110.

Jarzombkowski F., Gutowska E., Kotowska K. 2017. Uzupełnienie stanu wiedzy o przedmiotach ochrony: 7140 Torfowiska przejściowe i trzęsawiska (przeważnie z roślinnością z *Scheuchzerio-Caricetea nigrae*), 7230 Górskie i nizinne torfowiska zasadowe o charakterze młak, turzycowisk i mechowisk, 1903 lipiennik Loesela *Liparis loeselii*. Monitoring stanu wyżej wymienionych przedmiotów ochrony oraz monitoring realizacji celów działań ochronnych na terenie obszaru Natura 2000 Łąka w Bęczkowicach PLH100004. Klub Przyrodników, ms.

Jarzombkowski F., Kozub Ł. 2011. Stan, zagrożenia i ochrona mechowisk w krajobrazie rolniczym Mazowsza. In: Dembek W., Gutkowska A., Piórkowski H. (ed.). Współczesne narzędzia identyfikacji oraz ochrony mokradeł i muraw w krajobrazie rolniczym. Publishing House ITP. Falenty: 85-105.

Jarzombkowski F., Pawlikowski P. 2012. Krajowy program ochrony lipiennika Loesela *Liparis loeselii*. Publishing House Klub Przyrodników, Świebodzin.

Jermaczek A., Wołejko L., Misztal K. 2009. Poradnik ochrony mokradeł w górach. Publishing House Klub Przyrodników, Świebodzin.

Jermaczek A., Wołejko L., Chapiński P. 2012. Mokradła Sudetów Środkowych i ich ochrona. Publishing House Klub Przyrodników. Świebodzin.

Jermaczek A. 2016. Ochrona rezerwatowa w Polsce - czy dokądś zmierzamy? Przegl. Przyr. 27, 4: 3-17.

Jermaczek A., Wołejko L., Misztak K. 2009. Poradnik ochrony mokradeł w górach. Publishing House Klub Pzryrodników, Świebodzin.

Jermaczek A., Wołejko L., Chapiński P. 2012. Mokradła Sudetów Środkowych i ich ochrona. Publishing House Klub Przyrodników. Świebodzin.

Kaźmierczakowa R., Zarzycki K., Mirek Z. (ed.). 2014. Polska czerwona księga roślin. PAN Instytut Ochrony Przyrody, Kraków.

Kaźmierczakowa R., Bloch-Orłowska J., Celka Z., Cwener A., Dajdok Z., Michalska-Hejduk D., Pawlikowski P., Szczęśniak E., Ziarnek K. 2016. Polska czerwona lista paprotników i roślin kwiatowych. Instytut Ochrony Przyrody PAN, Kraków.

Kil E. 2010. Waloryzacja przyrodnicza torfowiska Bęczkowice. Katedra Ochrony Przyrody UŁ, Pr. mgr.

Kondracki J. 2011. Geografia regionalna Polski. Publ. House PWN, Warszawa.

Kornaś J., Medwecka-Kornaś A. 1967. Zespoły roślinne Gorców. Naturalne i na w pół naturalne zespoły nieleśne. Fragm. Flor. Geobot. 13, 2: 173-316.

Krasicka-Korczyńska E. 2008. Effect of the cutting date on blooming and fruitbearing of *Ostericum palustre* Besser. Acta Agrobot. 61, 1: 129-136.

Kucharski L. 1989. Ekologiczne podstawy ochrony i zagospodarowania terenów chronionych i zabytków przyrody województwa piotrkowskiego. Wartości przyrodnicze obszarów łąkowo-torfowiskowych w dolinie Luciąży k. Bęczkowic. Wojewódzki Konserwator Przyrody z Piotrkowie Trybunalskim, mscr.

Kucharski L. 1996. Nowe stanowisko turzycy Davalla *Carex davalliana* w Polsce Środkowej. Chrońmy Przyr. Ojcz. 52, 4: 92-93.

Kucharski L., Pisarek W. 2001. Roślinność terenów podmokłych w Polsce Środkowej i jej ochrona. Chrońmy Przyr. Ojcz. 57, 5: 33-54.

Makles M., Pawlaczyk P., Stańko R. 2014. Podręcznik najlepszych praktyk ochrony mokradeł. Publ. House Centrum Koordynacji Projektów Środowiskowych, Warszawa.

Michalczuk W. 2003. Nowe stanowisko storczyka krwistego żółtawego *Dactylorchiza incarnata* ssp. *ochroleuca* na Zamojszczyźnie. Chrońmy Przyr. Ojcz. 59, 5: 126-128.

Michalczuk W. 2004 Potwierdzenie występowania niebielistki trwałej *Swertia perennis* ssp. *perennis* na Zamojszczyźnie. Chrońmy Przyr. Ojcz. 60, 6: 122-126.

Michalczuk W. 2005. Nowe stanowiska starca wielkolistnego *Senecio macrophyllus* na Zamojszczyznie. Chrońmy Przyr. Ojcz. 61, 1: 98-101.

Michalczuk W., Stachyra P. 2003. Nowe stanowiska lipiennika Loesela *Liparis loeselii* na Zamojszczyźnie. Chrońmy Przyr. Ojcz. 59, 5: 122-126.

Michalska-Hejduk D., Kopeć D. 2010. Ecological and sociological spectrum of *Ostericum palustre* at new localities in Central Poland. Biodiversity: Research and Conservation 17: 63-71.

Nobis M., Piwowarczyk R. 2008. The distribution, habitat preferences and size of population of *Ostericum palustre* Besser on the south-western limit of its occurrence in Poland. Nature Conservation 65: 43-49.

Olaczek R., Kurzac M. 1997. Inwentaryzacja florystyczna torfowiska Pakosław koło Iłży, mscr.

Olaczek R., Kurzac M. 1998. Torfowiska w Pakosławiu. Studium geobotaniczne do projektu ochrony, ms.

Pawlaczyk P., Herbichowa M., Stańko R. 2005. Ochrona torfowisk bałtyckich. Wyd. Klubu Przyrodników, Świebodzin.

Pawlaczyk P. 2016. Czy potrzebne są rezerwaty wewnątrz innych, wielkoobszarowych form ochrony przyrody? Przegl. Przyr. 27, 4: 18-26.

Pawlaczyk P., Wołejko L., Jermaczek A., Stańko R. 2002. Poradnik ochrony mokradeł. Wyd. Lubuskiego Klubu Przyrodników, Świebodzin.

Pawlak S., Wilżak T. 2012. Walory przyrodnicze torfowisk „Pastwa" w dolinie środkowej Prosny. Przegl. Przyr. 23, 1: 3-20.

Pępkowska-Król, Bobrek R., Wilk T. (ed.). 2013. Przyroda polskich Karpat. Publ. House OTOP.

Przemyski A., Wołejko L. 2011. Calcareous fens of the Nida basin. In: GROOTJANS A. P. (Ed.). International Wetland Conservation Group Newsletter 4: 44-48. On 16.07.2018. [http://www.imcg.net/media/newsletter/nl1104.pdf].

(Regulation of the Minister of the Environment of October 16 2014 on species protection plants). (O.J. 16/10/2014, no 1409).

Stańko R., Wołejko L., Horabik D., Makles M. 2014b Dokumentacja przyrodnicza i plan ochrony projektowanego rezerwatu „Torfowisko Pliszka". Świebodzin, ms.

Stańko R., Wołejko L., Gawroński A., Horabik D., Kiaszewicz K. 2014a. Dokumentacja przyrodnicza projektowanego rezerwatu przyrody „Jezioro Wierzchołek". Świebodzin, ms.

Stańko R., Horabik D. 2015a. Raport z oceny stanu siedlisk: 7230 górskie i nizinne torfowiska zasadowe o charakterze młak, turzycowisk i mechowisk i gatunku: 1903 *Liparis loeselii*. Świebodzin, ms.

Stańko R., Horabik D. 2015b. Siedliska podmokłe. In: Czarnota P., Stefanik M. Gorczański Park Narodowy. Przyroda i krajobraz pod ochroną. Publishing House of Gorce National Park.

Stańko R., Wołejko L., Pawlaczyk P. (ed). 2018. Podręcznik dobrych praktyk w ochronie torfowisk alkalicznych (7230). Publ. House Klub Przyrodników, Świebodzin.

Stańko R., Wołejko L. (ed.). 2018. Conservation of alkaline fens (7230) in Poland. Report from realization of the projects: Conservation of alkaline fens in young-glacial landscape of northern Poland (LIFE11 NAT/PL/423) and Conservation of alkaline fens in southern Poland (LIFE13 NAT/PL/000024). Vol. I. Publishing House of Klub Przyrodników, Świebodzin.

Tyszkowski M. 1992. Godne ochrony torfowisko nad Jeziorem Białym koło Augustowa. Chrońmy Przyr. Ojcz. 6.48: 68-72.

The Act of April 16, 2004 on Nature Conservation (O.J 2018 no 1614).

Wilczek Z. 2006. Fitosocjologiczne uwarunkowania ochrony przyrody Beskidu Śląskiego (Karpaty Zachodnie). Publishing House of Silesian University Katowice.

Wołejko L. Stańko R., Pawlikowski P., Jarzombkowski F., Kiaszewicz K., Chapiński P., Bregin M., Kozub Ł., Krajewski Ł., Szczepański M. 2012. Krajowy program ochrony torfowisk alkalicznych (7230). Publishing House Klub Przyrodników, Świebodzin.

Wołejko L., Stańko R., Gawroński A., Horabik D., Makles M. 2014 Dokumentacja przyrodnicza projektowanego rezerwatu przyrody „Kwiecko". Szczecin-Świebodzin, ms.

Wołejko L., Stańko R., Gawroński A., Horabik D., Makles M. 2015. Dokumentacja przyrodnicza projektowanego rezerwatu przyrody „Nowa Studnica". Świebodzin, ms.

Zając I., Kucharski L. 2011. Problemy ochrony torfowisk w Polsce Środkowej na przykładzie SOO Natura 2000 „Łąka w Bęczkowicach". Torfowiska w krajobrazie przekształconym – funkcjonowanie i ochrona. 1–3 czerwca 2011 r., Wawrzkowizna k/Bełchatowa, after conference materials.

(Ordinance of the Minister for Environmental Protection and Natural Resources of August 12, 1987 in on recognition as nature reserves). (O.J 1987 no 28 item 222).

Żarnowiec J., Stebel A., Ochyra R. 2004. Threatened moss species in the Polish Carpathians in the light of a new redlist of mosses in Poland. In: Stebel A., Ochyra R. (ed.). Bryological Studies in the Western carpathians. Sorus, Poznań: 9-28.