INTERNATIONAL MIRE CONSERVATION GROUP

NEWSLETTER

issue 2011/4, December 2011

The International Mire Conservation Group (IMCG) is an international network of specialists having a particular interest in mire and peatland conservation. The network encompasses a wide spectrum of expertise and interests, from research scientists to consultants, government agency specialists to peatland site managers. It operates largely through e-mail and newsletters, and holds regular workshops and symposia. For more information: consult the IMCG Website: http://www.imcg.net

IMCG has a Main Board of currently 15 people from various parts of the world that has to take decisions between congresses. Of these 15 an elected 5 constitute the IMCG Executive Committee that handles day-to-day affairs. The Executive Committee consists of a Chairman (Piet-Louis Grundling), a Secretary General (Hans Joosten), a Treasurer (Francis Müller), and 2 additional members (Ab Grootjans, Rodolfo Iturraspe).

Fred Ellery, Seppo Eurola, Lebrecht Jeschke, Richard Lindsay, Viktor Masing (†), Rauno Ruuhijärvi, Hugo Sjörs (†), Michael Steiner, Michael Succow and Tatiana Yurkovskaya have been awarded honorary membership of IMCG.

Editorial

This Newsletter is entirely dedicated to the 16th international IMCG Field Symposium, which took place in Slovakia and Poland 4-18 July, 2010. This special issue of the IMCG newsletter is also the pre-publication of a free electronic book that will be published soon. The title of the e-book is "Groundwater fed mires in Slovakia and Poland: a guide to the IMCG 2010 field symposium." It was edited by Ab Grootjans and Ema Gojdičová. The design and layout was done by Viktória Ihringová, (State Nature Conservancy of the Slovak Republic). 15 authors contributed to the book, presenting text and illustrations on numerous fens and bogs in Slovakia and Poland. About 50 people participated in the IMCG Field Symposium. They were from 19 countries and 5 continents, and were accompanied and supported by representatives of the State Nature Conservancy and by Slovakian and Polish scientists. We travelled across Slovakia and Poland, studying the diversity and functionality of peatlands and the issues facing them. It is clear, however, that several existing National Nature Reserves, National Parks and Natura 2000 areas in Slovakia and Poland are not yet sufficiently protected. In Slovakia we have observed that several legally protected spring mires and fen meadows, such as Abrod and Belianske lúky, lack adequate hydrological buffer zones to protect the sensitive ecosystems against damage brought on from the outside. In Poland we have also observed damage to protected nature areas due to inflow of nutrients from neighbouring agricultural fields or by abstraction of groundwater from aquifers that feed the mires. An example of the latter is the unique calcareous mire Torfowisko Sobowice near the city of Chełm, which is threatened by industrial water extraction. Such negative influences are insufficiently controlled by current management. In the book presented here more information is available to underpin the resolutions on Slovakia and Poland published in the IMCG Newsletter of December 2010.

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Field symposium is supported and presenting results of following projects:

PIN/Matra project 2001/033; Ecohydrological Research as a base for restoration of calcareous fens in the Slovak Republic.
The UNDP/GEF project Conservation, Restoration and Wise Use of Rich Fens in the Slovak Republic.
PIN/Matra project 2003/011: Multifunctional use of Polish peatlands; a chance for preservation of Biodiversity.

SLOVAKIA

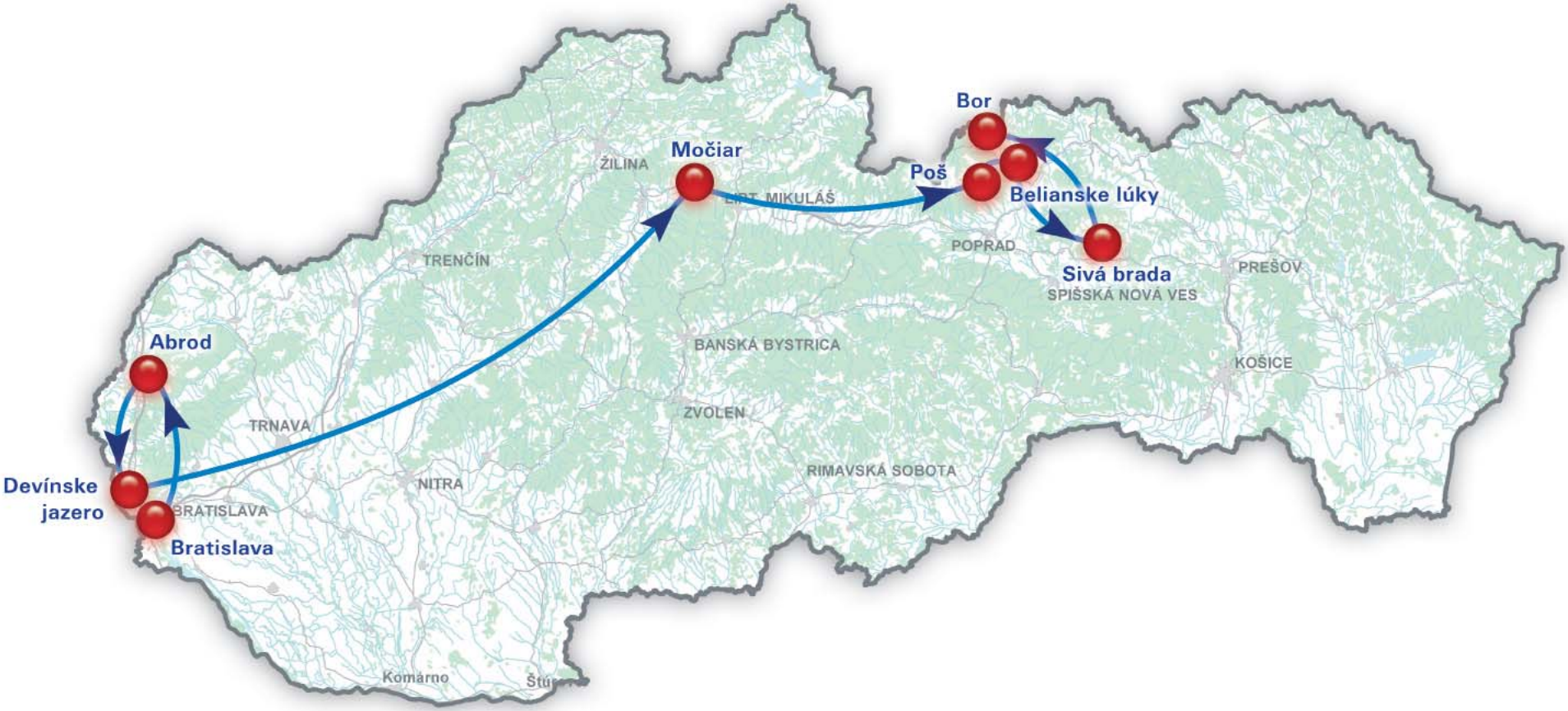
5 – 9 July 2010

1) National Nature Reserve Abrod; fen meadows
2) Morava floodplain: grasslands
3) Nature Reserve Močiar; calcareous fens
4) National Nature Reserve Poš
5) National Nature Reserve Belianske lúky; calcareous fens
6) National Nature Reserve Sivá Brada; travertine hill
7) National Nature Reserve Bor

POLAND

9 – 17 July 2010

8) Orawa Nowy Targ: bogs
9) Nida valley: chalk mires
10) Sobowice mire: calcareous fens
11) Chelm: calcareous fens
12) Lake Moszne: poor fens
13) Krowie Bagno: drained calcareous fens
14) Całowanie peatland: fens and fen meadows
15) Biebrza mires: fens and fen meadows
16) Sidra: travertine hill
17) Rospuda: fens
18) Lempis Nature Reserve: fens and bogs
19) Suchary Nature Reserve: floating fens and bogs
20) Struga Nature Reserve: spring fens
21) Mechacz Wielki Nature Reserve: bog


Bor
Močiar
ŽILINA
Poš
Belianske lúky
LIPT. MIKULÁŠ
POPRAD
Sivá brada
SPIŠSKÁ NOVÁ VES
PREŠOV
TRENČÍN
Abrod
BANSKÁ BYSTRICA
KOŠICE
TRNAVA
ZVOLEN
RIMAVSKÁ SOBOTA
Devínske jazero
NITRA
BRATISLAVA
Bratislava
Komárno

1. Orawa-Nowy Targ Basin
2. Torfowisko Sędowice
3. Torfowisko Bełk
4. Torfowisko Zwierzyniec
5. Torfowisko Słopiec
6. Torfowisko Sobowice
7. Chełm calareous fens
8. Moszne Lake
9. Krowie Bagno
10. Całowanie peatland
11. Lower Biebrza Basin
12. Red Bog
13. Rospuda valley
14. Upper Biebrza Basin
15. Sidra spring fen
16. Lempis nature reserve
17. Suchary nature reserve
18. Żytkiejmska Struga nature reserve
19. Mechacz Wielki nature reserve
20. Goniadz - conference

FEN GRASSLANDS OF ABROD

Compiled by: Viera Šefferová Stanová, Mikuláš Madaras, Ab Grootjans

The Nature Reserve Abrod was designated in 1964 and has with an area of 92 hectares. It is located in the Borská lowland in western Slovakia, at an elevation of around 150 m. The main purpose for the creation of this reserve was the protection of calcareous fens (*Caricion davallianae*) and purple moorgrass meadows (*Molinion caeruleae*). The site itself and some surrounding remnants of wetlands were later included in the Natura 2000 network as Special Area of Conservation. After it was extended the total area of the reserve is now 200 hectares (Fig. 1).

The mire is relatively young and started to develop in the Early and Late Subatlantic period some 2500 years ago. The maximal depth of the peat layer used to be 120 cm (Krippel 1965). In 2000 a pollen study was carried out by Kamil Rybníček and Michal Hájek, using a peat profile of one metre. After a preliminary analysis in the laboratory, they found that the peat was so highly mineralised, that almost no pollen grains were left.

GEOLOGICAL LANDSCAPE SETTING

The Borská lowland is a part of the Vienna Neogene's sedimentary basin. Close to Abrod lagoon neogene sediments prevail, represented by varicoloured clays, sands and lignites. Their thickness here is about 700 m. The largest Quaternary facies in the Zahorie lowland are eolic deposits, consisting of fine-grained non-calcareous sands, which are formed by the fluvial deposits of the Morava River. The area of Abrod belongs to a low lying zone west of the Jánsky fault (Fig. 2). Therefore, the whole area was influenced by the Morava River sedimentation. At present, the small river Porec flows through the Abrod reserve. This has resulted in partly removal of Morava River deposits. The Porec created its own floodplain consisting of fine-grained sand, which was transported from upstream area. The Porec floodplain is the youngest sedimentary cover belonging to the Holocene period. The mires in the Porec floodplain have developed during the Holocene period, after sediments from the Morava River had blocked most of the river systems in that area (Polesňák 2003).

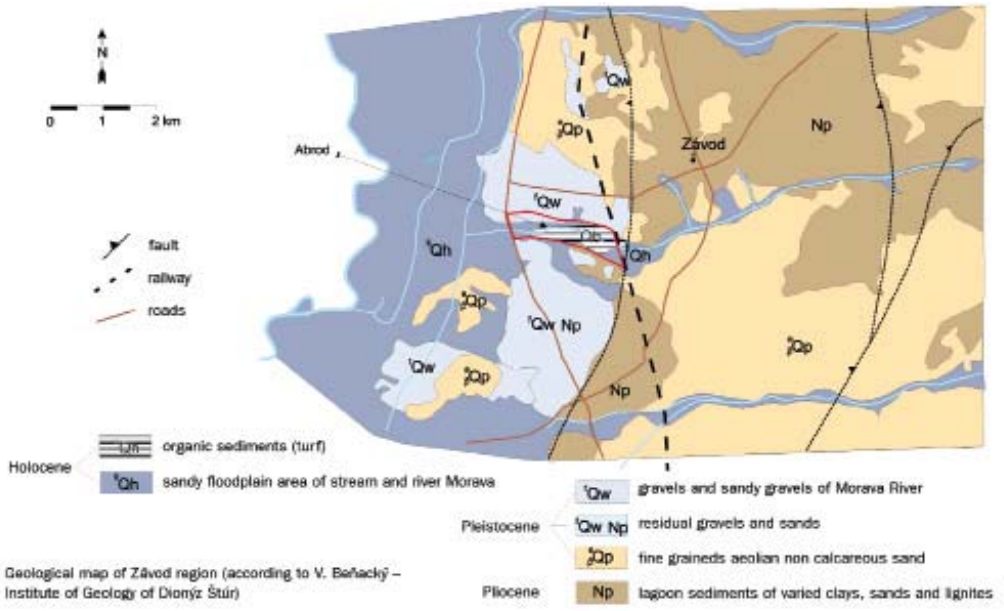


Figure 2. Geological map of part of the Borská lowland, showing the position of the reserve Abrod (red lining) within the deposits of the Morava River (from: Stanová & Viceníková 2003).

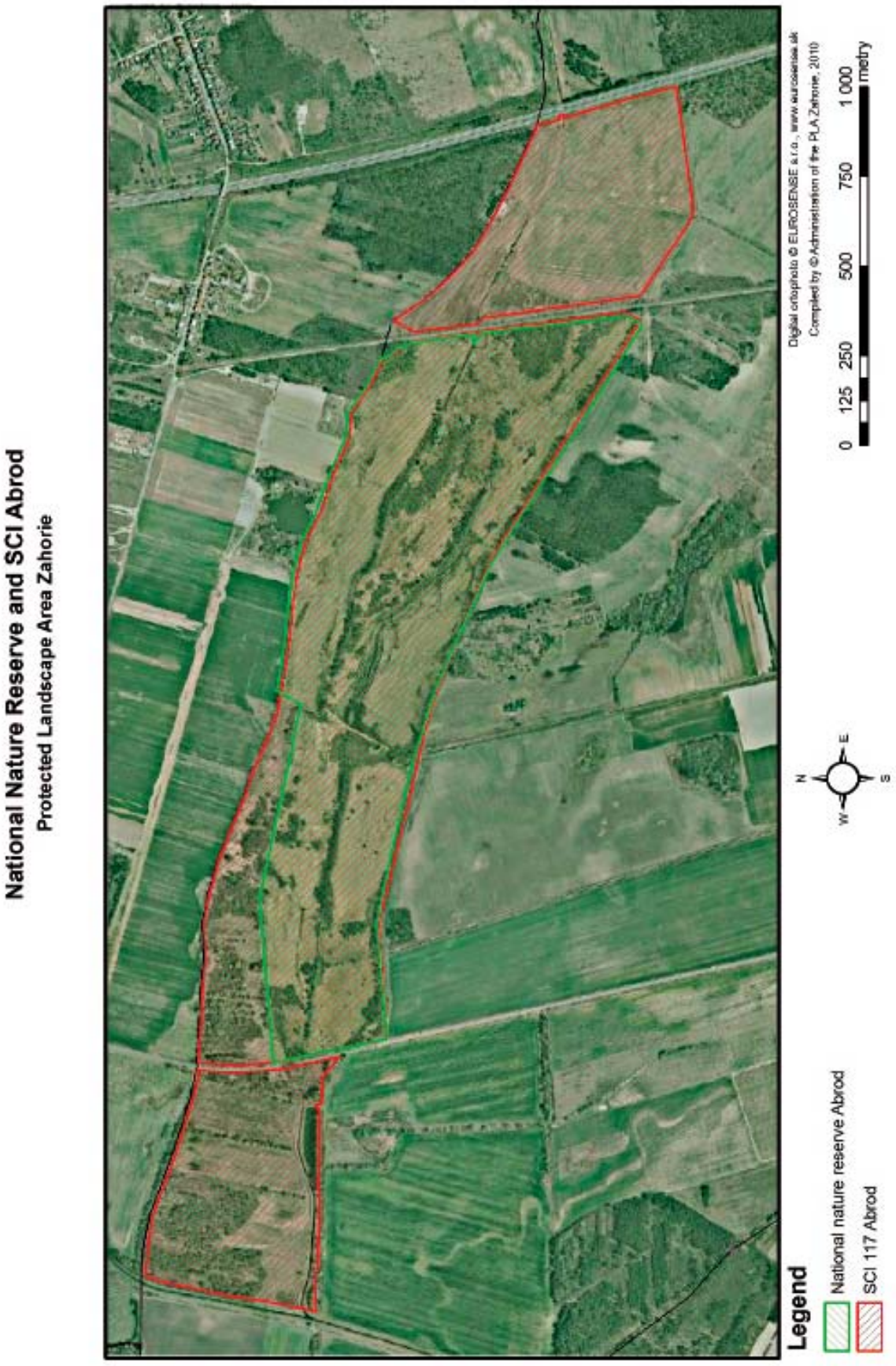


Figure 1. Aerial photo, showing the National Nature Reserve Abrod (green lining) and Special Conservation areas (red lining).

HYDROLOGY

A comprehensive hydrological survey was carried out in the reserve between 2001 and 2009 in order to understand the hydrogeological system that supplies Abrod with water. Several tens of groundwater tubes were installed within the reserve and in the wider Porec catchment to monitor the groundwater level dynamics. The research showed that between 2001 and 2003 the mean annual groundwater level in Abrod was 32 cm below the soil surface. High seasonal fluctuation of the water levels was recorded in all monitoring sites. The mean spring groundwater level (April to June) was close to the annual average (-33 cm), however in summer (July and August) groundwater drops to - 62 cm on average. The mean autumn level (September to November) is higher than in spring (-26 cm). The average lowest summer level is –88 cm and the average maximum level (at late autumn or early spring) is -1 cm below the soil surface. This high seasonality of the groundwater dynamics corresponds to the precipitation and temperature regime of the site, as the typical features of the summer weather are high temperatures (average temperature in July is 21 °C) combined with low precipitation (50mm in August on average, compared to ca. 80mm in June and July).

Analysis of groundwater levels (Fig. 4) showed that the groundwater flows more or less in the same direction as the Porec River. Some groundwater from the north east joins in with the main groundwater flow, which locally improves water conditions in the reserve.

Significant changes of groundwater dynamics were observed during the second monitoring period (2006 – 2009). The water levels increased substantially compared to 2001 – 2003 and were on average ca 30 cm higher. Also the seasonal fluctuations decreased. The cause of these changes was the installation of a large irrigation system in the valley flank to the north of the reserve. This area was used for growing of lawn turf, and intensively irrigated during the summer months. Irrigation

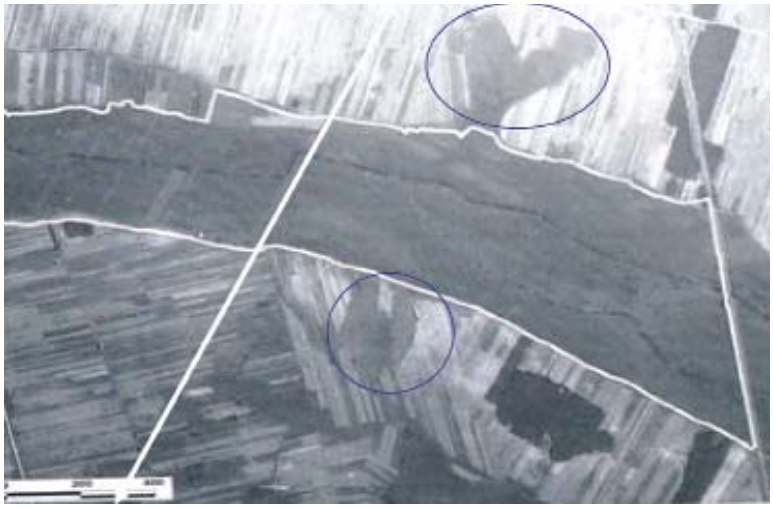


Figure 3. Aerial photograph of Abrod made in 1949 showing the most likely position of the geological fault (white arrows). The blue circles indicate wetlands on both sides of, which appear to be equally wet as Abrod and were also used as meadows for a long time (Stanová & Viceníková 2003).

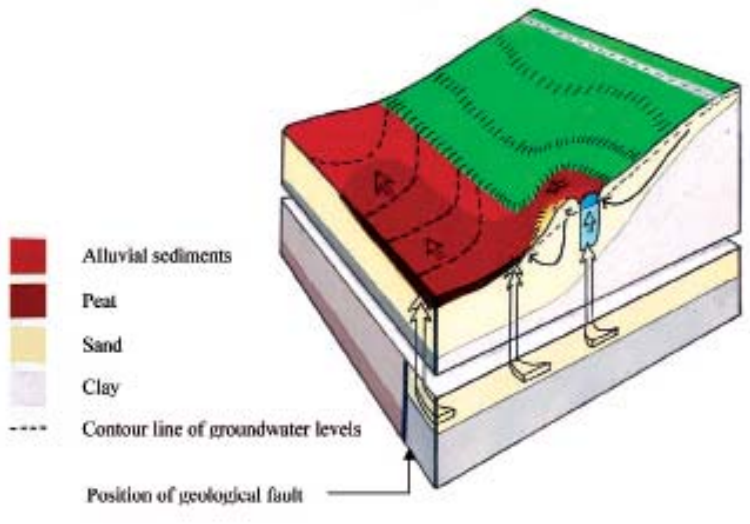


Figure 4. Possible geohydrological situation in Abrod. The geological fault crosses Abrod, and forces groundwater from a deeper aquifer to come to the surface. In the past this extra groundwater possibly gave rise to peat formation. The presence of a geological fault would also explain why the water level in the man-made gravel pit is much higher then in the nature reserve. The removal of sand and gravel could have facilitated groundwater flow from the deep aquifer to the valley flanks.

water that infiltrates in these high lying fields flows to the nature reserve and causes an increase in groundwater levels there. These commercial activities may be positive for maintaining high water levels in the reserve, but they also could become a high risk for groundwater quality in the reserve, because growing lawn turf requires large amounts of nutrients and pesticides.

Water chemistry

The values of the total dissolved solids from shallow groundwater vary from 340 to 1830 mg.l^{-1}, with a mean value of 830 mg.l^{-1}, which represents rather calcareous groundwater with transitions into Ca-Mg-SO_4 from areas with dolomite/gypsum. The pH values were between 6 and 7.4. It is worth mentioning that the chemical composition of the groundwater in Abrod is very similar to that of the Porec creek, which is also calcareous due to contact with calcareous sediments in the region (Pannonian and Pliocene time periods; Čech and Zváč 1993).

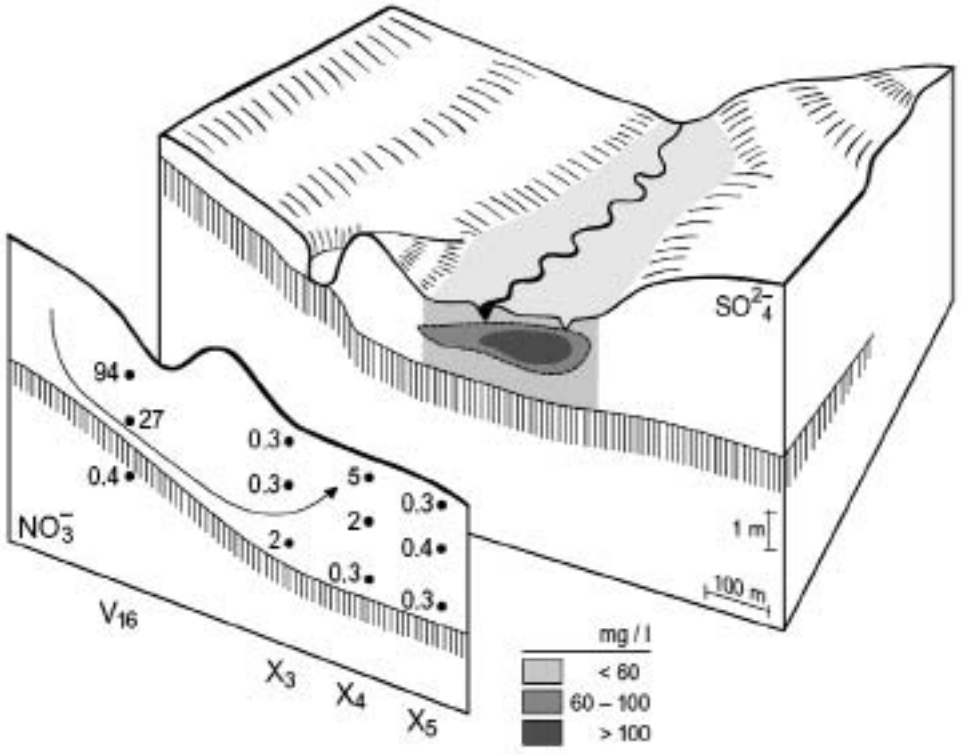


Figure 5. SO_4^{2-} and NO_3^-(mg/l) content in the water of cross-section X, July 2003. Point V16 is positioned in the alder forest in the depression that is collecting groundwater from the field, where intensive grass sods are being produced, using large amounts of fertilizers. This polluted groundwater further proceeds to the Abrod reserve (from: Grootjans et al 2010).

The surface water in the Creek upstream of the reserve is not only calcareous, but also rich in nutrients, such as phosphorus, nitrogen and potassium, which points to influence of anthropogenic activities in the watershed. The reserve clearly acts as a sink of nutrients (and also other chemical species), at the concentration of nutrients decreases within the reserve to only one quarter of the concentration at the input.

In the groundwater composition of the shallow groundwater in the reserve we also see an influence of acidification in the top layer. Calcium and sulphate concentration are exceptionally high, especially in the southern part of the reserve. These high values are probably the result of oxidation of pyrite and dissolution of $CaCO_3$ in the top soil, due to low water levels in the summer. Near the northern border, where nowadays grass sods are cultivated for horticulture, very high values of nitrate and potassium have been found. This polluted groundwater is caused by intensive fertilization on the valley flanks and this situation is a serious threat to the nutrient poor vegetation types in the reserve.

FLORA AND FAUNA

Degen et al. (1923) mentions Abrod for the first time as an important flora locality; he describes it as a patterned mire with pools and hummocks. The pools were filled with water and the hummocks were formed by Sphagnum species and sedge species. Species that were found in the mire were: *Trichophorum alpinum*, *Carex echinata*, *C. viridula*, *Sphagnum palustre*, *S. subsecundum*, *Viola stagnina* and *Drosera rotundifolia*. In that time such detailed descriptions as were given for the Abrod locality were for Slovak standards extremely rare.

In 1965 control of the Morava River flooding regime and the regulation of the Porec River resulted in a large decrease of ground water levels in the reserve. In the most effected eastern part of the reserve the drop in water level was almost 120 cm. Lack of water due to extensive drainage and drought led to degradation of all typical mire communities. We were able to evaluate the vegetation changes that occurred after the drainage activities and the stream regulation, because in 1970 Dr. Bosáčkova published a floristic and vegetation survey, which was carried out between 1962 – 1966, so before the interferences with the hydrology.

From the comparison with Bosáčková-data we can see, that actually the biodiversity has increased due to the spread of a large number of xerophytic, synanthropic and forest species, despite the decline of typical and mire species. The most important species of that catagory that have become extinct are: *Liparis loeselii*, *Trichophorum alpinum*, *Drosera rotundifolia*, *Succisella inflexa* and several *Sphagnum species* (*S. contortum*, *S. compactum*, *S. girgensohnii*, *S. palustre*, *S. subsecundum* and *S. teres*). The drying out is visible mainly in the eastern part of the reserve. Lack of water due to extensive drainage and drought led to the degradation of most of the mire. The almost total extinction of fen communities was the most significant change that has occurred in Abrod within the last 40 years. Originally the fen communities occupied an area of 11.2 ha and were located mainly in the eastern parts of the reserve. Only small fragments could be found in the western parts. In the 1960-ties the fen communities occupied 13 % of the entire area of the reserve. The following associations were located here: *Caricetum davallianae*, *Sphagno warnstorfiani-Caricetum davallianae*, *Caricetum goodenowii* and *Caricetum paradoxae*. These fen communities are now all gone, although many species that normally are found in real fens are still present in the meadows. The main ecological problem is the excessive fluctuation of groundwater levels in the summer period that have stopped the peat formation and initiated an intensive mineralization of organic matter. The more sensitive fen species, including five species of the Sphagnum family, have now become extinct within the territory of the reserve.

Surprisingly we also found quite a number of rare and threatened species that established a population after the drainage activities in the second half of the 1960ties. For example, *Achillea aspleniifolia* was an extinct species for Slovak flora (Maglocký et Feráková, 1993). *Dactylorhiza ochroleuca* is an entirely new species for Slovak flora. Species like *Schoenus nigricans* (Fig. 4) and *Gladiolus palustris* (Fig. 5) have in Abrod the only one locality within the whole Slovakia. Fen grasslands provide good ecological conditions for 17 orchid species and 33 sedge species, some of which are considered to be threatened (*Carex hartmanii*, *C. hostiana*, *C. cespitosa*). The locality provide habitat for 89 Slovakian Red List plant species. *Gladiolus palustris* and *Cirsium brachycephalum* are registered among the species of European significance. Another important change is the local appearance of typical salt marshes such as: *Colobium taraxacoides*, *Plantago maritima*, *Carex distans*, *Cirsium brachycephalum* (Stanová & Viceníková 2003).

HABITATS

6410 – Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion coeruleae*)
This is the most widespread habitat type in the reserve and probably the largest area of this community in the whole of Slovakia. Total area of this community is covering about 33 ha. There is a dominance of grassland species such as *Molinia caerulea*, *Ranunculus acris*, *Deschampsia cespitosa*, *Festuca pratensis*, *Succisa pratensis*, *Gymnadenia conopsea*, *Dactylis glomerata*, *Salix rosmarinifolia*,

although many fen species also occur; *Carex panicea*, *C. hartmanii*, *C. nigra*, *C. davalliana*, *C. hostiana*. The presence of sub-halophitic species *Cirsium brachycephalum*, *Carex distans* and *Scorzonera* parviflora at this site is a matter of considerable interest. Protected species include *Achillea aspleniifolia*, rare species of the family *Dactylorhiza*, *Gentiana pneumonanthe*, *Dianthus superbus*, *Lathyrus pannonicus*, *Orchis coriophora*, *Schoenus nigricans* (Stanová & Viceníková 2003).

Figures 6. and 7. The production of grass sods for horticulture requires intensive fertilization and irrigation with water. Since this production field is part of a local infiltration area that is feeding Abrod, negative environmental effects will harm the nutrient poor vegetation types in the reserve.

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EVALUATION OF IMCG EXCURSION PARTICIPANTS

Participants of the IMCG were very surprised that permission had been granted to carry out economic activities that are clearly not compatible with the long term survival of the vegetation in the National Nature Reserve Abrod. Signs of eutrophication at the northern border of the reserve were evident. The presence of a “buffer zone” does not prevent pollution via the groundwater and surface water flows that reach the reserve. From an international point of view it is very hard to understand that short term economic profit, aimed at producing sod turfs for foreign football stadions, is allowed in the infiltration area of an internationally recognised nature reserve that has the highest protection status under Slovak law, and that has been established already in 1923. Within the frame work of Nature 2000 these activities are surely a violation of Slovak law as well and should be stopped as soon as possible. The IMCG participants advised that legal action should be taken to prevent further damage to the reserve.

Participants of the IMCG excursion discuss eutrophication problems in Abrod on 6-7-2010. The reed encroachment due to eutrophication by ground- en surface water from the adjoining agricultural fields is visible in the background (photo: Truus Laimdota).

MORAVA FLOODPLAIN GRASSLANDS OF DEVÍNSKE JAZERO

Compiled by: Viera Šefferová Stanová

The Morava River is a middle-European watershed and is one of the Danube's largest tributaries. The Morava is a border river – it flows through three countries, the Czech and Slovak Republics and Austria and it forms the border between the Slovak Republic in the lowest part and Austria and between the Slovak and Czech Republic's in the middle part.

The lower section of the Morava River floodplain is located in the most western part of Slovakia and is situated along the former "iron curtain", which was established in 1951 and stood as a barricade until 1989. The whole floodplain area was under strong military protection and local farmers had only limited access for mowing of meadows. Since 1989's political transformation, the Morava River floodplain is now open to the public and it has experienced massive changes and now constitutes both a popular recreation and important economic resource.

In 1993, 51 km^2 of the floodplain area on the Slovak side of the river was designated as a Ramsar site. In addition, the Morava River floodplain contains many species of migrating birds, including ones that are threatened on a European and global scale, and is designated as an Important Bird Area (IBA) by Bird Life International.

The floodplain grassland ecosystems in lowland river valleys are a result of extensive floods and sustainable human use. Species-rich floodplain meadows of the alliance *Cnidion venosi* Bal.-Tul. 1965 are not only the most distributed grasslands of the Morava River alluvium, but they are also the largest meadow complex in Central Europe with an area covering approximately 3 450 ha in Slovakia, Czech Republic and Austria (Fig. 1). In the Slovakian part of the Morava River Floodplain
1 913 ha of floodplain grasslands is present. In the Czech Republic many meadows were ploughed as a result of river regulation. Six hundred ha of grasslands were protected at the confluence area of the Morava and Dyje. However, their low quality with respect to biodiversity is a result from lack of floods and also from abandonment. In Austria, there are about 940 ha of grasslands in the Morava-Dyje floodplains (Šeffer, Stanová 1999).

The locality Devínske Jazero (Fig. 2), is not only one of the best-preserved core areas on the Slovak side of the Morava River floodplain area, but it is also very large with an area of 12 km^2 long and
3 km wide. The locality is influenced by both the Morava and Danube – when the water is high in the Danube, it raises the water levels in the Morava over a length of 25 km.

Figure 1. The *Cnidion venosi* communities are characteristic for Morava River alluvium
Photo: Jaro Mikuš

GEOLOGICAL LANDSCAPE SETTING

The Morava River floodplain is part of two geomorphological units; the Záhorská nížina lowland and the Juhomoravská Panva that belongs to the Vienna Basin. The relief is the result of both fluvial and eolic processes. The plains of the central section of the Záhorská Nížina lowland are less fertile, more sandy and they covered by pine forest. The terraces of the Morava River, however, contain very

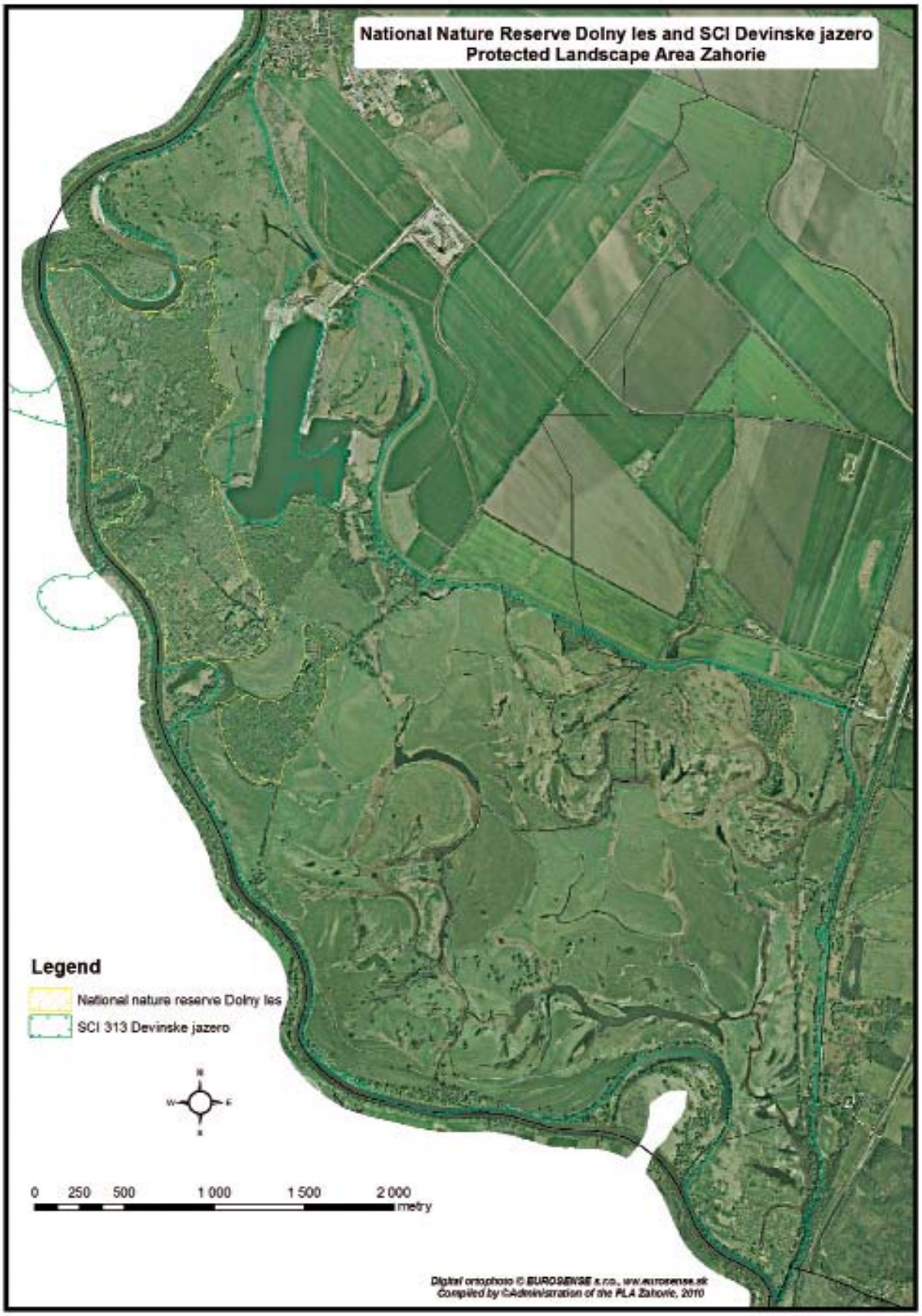

Figure 2. Aerial photo, showing the National Nature Reserve Dolny Les, which was established for the protection of the floodplain forests (yellow lining). Also shown is the Special Conservation area Devínske Jazero, which was established for the protection of floodplain grasslands (blue lining).

fertile soils. Among the soil types, fluvisols and phaeozems are most common. Fluvisols (alluvial soils) predominate in the riparian zone up to a width of approximately one km, and phaeozems dominate in more elevated parts of the floodplain where floods occur only temporary. Waterlogged soils with more clay (gleysol) are found in depressions in the alluvium (Šeffer, Stanová 1999).

HYDROLOGY

The regulation of the Morava River has been the main cause of wetland loss. During this century, more than 90 % of the river's course has been regulated, including dike construction, canalisation, and elimination of all major meanders. In the study area the length of the Morava River has been shortened from 97 to 79 km on the supposition of flood protection. This move resulted in the shrinking of the naturally inundating floodplain to only 24 % of its former area, and in a deepening of the river bed. GIS evaluations yielded data on the precise historical extent, the nature and the location of the form,er wetlands. We found that in the past the total floodplain and wetland area was 159.4 km^2, while today the floodplain is only 38.72 km^2. The river can now transport more than twice its former volume, accommodating 440 m^3 instead of 210 m^3. The losses to biodiversity include those associated with the reduction of extensive floodplain meadows, loss of shallow river and river bank habitats, and also of desiccation of oxbows and floodplain forests (Šeffer, Stanová 1999).

Photo 3. and 4. The view from the Devín Castle on the lowest part of Morava River Floodplains during floods (3) and after floods (4). Photo: Viera Stanová

Figure 5. *Clematis integrifolia* is vulnerable species for Slovakia and has a significant population in the Morava River floodplain grasslands. Photo: Viera Stanová

FLORA AND FAUNA

From a phytogeographical point of view, the study area belongs to the phytogeographical region of the Pannonian flora. A total of 479 species of higher plants, of which 61 are Red List species, have been recorded in the grasslands of floodplain area (Šeffer, Stanová 1999).

The most important species are: *Allium angulosum*, *Centaurium erythraea*, *Carex melanostachya*, *Clematis integrifolia*, *Cnidium dubium*, *Dichodon viscidum*, *Gratiola officinalis*, *Iris sibirica*, *Plantago altissima*,

Pseudolysimachion longifolium, *Tithymalus lucidus*, *Molinia caerulea*, *Scutellaria hastifolia*, *Stellaria palustris*, *Silene otites*, *Thalictrum flavum*, *Thalictrum lucidum*, *Viola pumila*.

The meadows provide important sources of food and habitats for a wide range of birds, including many rare and endangered species. It is one of central Europe's major nesting and wintering sites. 215 species have been recorded in Morava river floodplains, including 126 breeding species (Kalivodová et al. 1994). Slovakia is very important for the conservation of priority species as *Numenius arquata*, *Asio flammaeus* and *Milvus milvus*.

HABITATS

6440 Alluvial meadows of river valleys of the Cnidion dubii alliance

The *Cnidion venosi* communities differ from other moist meadow communities both phytosociologically and ecologically. They are situated in warm and relatively dry regions on subhalophilous soils and contain species that are able to tolerate both long term inundation and low soil water availability in the upper part of soil profile. Many of these species have a Continental distribution. Moist meadows are flooded in spring, and as a result of decreasing water table, are dry in summer. The species diversity of these types is high – in some cases there can be 30 species per square meter (Šeffer, Stanová 1999).

Dominant species are: *Alopecurus pratensis*, *Poa pratensis*, *Carex praecox*, *Elytrigia repens*, *Phalaroides arundinacea*.

Diagnostic species are: *Carex melanostachya*, *Cnidium dubium*, *Lathyrus pratensis*, *Potentilla reptans*, *Symphytum officinale*, *Ranunculus repens*, *Lychnis flos-cuculi*, *Lysimachia nummularia*, *Clematis integrifolia*, *Filipendula ulmaria*, *Galium boreale*, *G. verum*, *Glechoma hederacea*, *Gratiola officinalis*, *Inula salicina*, *Iris pseudacorus*, *Persicaria amphibia*, *Plantago lanceolata*, *Poa palustris*, *Poa trivialis*, *Pseudolysimachion longifolium*, *Rorippa austriaca*, *Rumex crispus*, *Sanquisorba officinalis*, *Serratula tinctoria*, *Taraxacum* sect. *Ruderalia*, *Vicia cracca*, *Acetosa pratensis*, *Cardamine pratensis*, *Colchicum autumnale*, *Lysimachia vulgaris*, *Lythrum salicaria*, *Carex vulpina*, *C. acuta*, *Festuca pratensis*, *Cardamine pratensis*, *Potentilla anserina*, *Thalictrum flavum* .

MANAGEMENT

Mowing at least once per two years and at most once a year is recommended. Traditionally, the first mowing was in end of May or early June. However, it is now necessary to delay the first cutting to protect nesting birds.

LITERATURE

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THE NATURE RESERVE MOCIAR; waiting for restoration measures

Compiled by: Daniel Dítě, Anna Dobošová, and Viera Šefferová Stanová

The Nature Reserve (NR) Močiar (also known as Stankovianske Travertines) is located in the valley of the river Váh, on the foothill of Šíp (elevation of 1.169 m, Šípska Fatra mountain), a hill dominating the landscape west of the village of Stankovany. The elevation of the reserve is 430 metres. The area of the protected territory is 6.75 ha. The locality was declared a reserve in 1993, and it was declared a Special Area of Conservation in 2004, with an area of 8.13 ha (Fig. 1).

Figure 1. Aerial photograph of the Nature Reserve Močiar with travertine deposition. The River Váh can be seen in the foreground.

GEOLOGICAL LANDSCAPE SETTING

Figure 2. Photo: Katarína Sujová, Daniel Dítě

Močiar posseses a unique geological phenomenon, in the form of flat, peaking travertine formations (Fig. 2). Along a geological fault, mineralized, hydro-carbonate-sulphate, calcium-magnesium water springs out, in which calcium carbonate coatings are created by sedimentation. Unlike in similar localities in Slovakia, no calcium carbonate cascades or hills were formed here. Instead, we can observe here flat, peaking calcium carbonate formations here, which is rather unique in the West Carpathians. In the surroundings of Stankovany 10 very active mineral springs are registered, some of them supply the area of the reserve with groundwater. Two have been artificially drilled (Krahulec et al. 1977). The Močiar Nature Reserve represents the largest travertine spring fen reserve in Slovakia where still active precipitation of calcium carbonate and calcium sulphate takes place. The vegetation is very species-rich and a well-developed.
The start of travertine sedimentation in the locality was dated to be more than 10 thousand years ago. The thickness of the sediment is 420 cm (Horsák et al. 2009).

FLORA AND FAUNA

The vegetation types belonging to the habitat types 'calcareous fens' (with many elements of the alliance Caricion davallianae Klika 1934) are bound to the specific water regime of this locality. Because the discharging groundwater is very rich in dissolved minerals, in particular calcium, bicarbonate and sulphate, even a number of halophytic species are present in the vegetation. Not so abundant as in some other travertine localities in the region of Spiš (e.g. Sivá brada), where you find the typical vegetation of the *Glauco-Trichophoretum pumili* association. In Mociar this is not the case. Calcium carbonate shields with mineral water flowing over them are almost without vegetation. Some species that can survive in such extreme environments are: *Triglochin maritima* (Fig. 3), *Primula farinosa*, *Pinguicula vulgaris* and *Centaurium littorale* subsp. *uliginosum* (Fig. 4). The spring system is very dynamic, not only do the amounts of groundwater discharging from the springs may vary a lot, but also the flow direction of the small streams may change. And even sites with active precipitation

Figure 3. Photo: Daniel Dítě

Figure 4. Photo: Daniel Dítě

Figure 5. Photo: Daniel Dítě

may change position regularly and consequently the vegetation can be literally “cemented” in calcium carbonate coatings within a few months. At the same time, new spots where the plants can establish themselves are created. In this dynamic environment the calcium carbonate shield can travel even a few meters in the period of a few months. If the time period is longer, it can be tens of meters.
The areas with intensive travertine precipitation are associated with a vegetation dominated by *Schoenus ferrugineus*. One of the two largest and most vital populations of this species in Slovakia can be found here. Along with it, a number of fen species grow here, such as *Blysmus compressus*, *Carex davalliana*, *C. dioica*, *C. distans*, *C. hostiana*, *Dactylorhiza incarnata*, *Eleocharis quinqueflora*, *Epipactis palustris*, *Eriophorum latifolium*, *Equisetum variegatum*, *Gymnadenia densiflora*, *Pedicularis palustris*, *Triglochin palustre*, *Taraxacum* sec. *Palustria*, and *Tofieldia calyculata*. Typical fen moss species are represented by *Bryum pseudotriquetrum*, *Campylium stellatum*, *Drepanocladus cossonii*. The vegetation is ‘enriched’ with a few halophytes, too. In addition to the species mentioned earlier, *Carex distans*, *Lotus tenuis*, *Trichophorum pumilum* (Fig. 5), *Schoenoplectus tabernaemontani* (Dítě & Pukajová 2003) and *Trifolium bonannii* may be found near the springs.
In the western part of the area, the sedge vegetation borders a vegetation dominated by *Cladium mariscus* (ca. 1 ha). The population of this species is the largest and most vital within Slovakia (Eliáš et al. 2003).
In the eastern part of the territory, Molinion meadows occur, and the edges of the reserve are lined by shrub willows. To the North-West of the reserve we can find several springs systems at the slope of a shallow valley. A small cascade of precipitating calcium carbonate, covered with a calcareous fen vegetation with species such as *Cladium mariscus*, *Schoenus ferrugineus*, and others, is located at the slope above the western edge of the reserve.
Pupilla alpicola is a tiny land snail which was recorded on the site. This rare glacial relict is presently limited to treeless calcareous tufa-forming fens of the Western Carpathians (Škodová 2009).

HABITATS

1340 – Carpathian travertine swards

6210 – Dry grasslands and scrubland facies on calcareous substrates (*Festuco – Brometalia*) *important orchid sites

6410 – Molinia meadows on calcareous, peaty or clayley-silt-laden soils (*Molinion coearuleae*)

7210 – Calcareous fens with Cladium mariscus and species of Caricion davallianae

7230 – Alkaline fens

MANAGEMENT

There are quite a number of springs in the Nature Reserve Močiar, but some of the discharging groundwater is intercepted and leaves the reserve through artificial bore holes. Travertine precipitates in the surroundings of springs and bore holes, thus creating ‘shields’ of travertine layering, which are

Figure 6. This pool was used for bathing in the past by local people. (photo: Daniel Dítě in April 2005).

Figure 7. Iron pipes that discharge groundwater to the surface

Figure 8. The original lake was excavated and enlarged; the sensitive peat-travertine substratum was harmed by heavy machines. Photo: Daniel Dítě, April 2006.

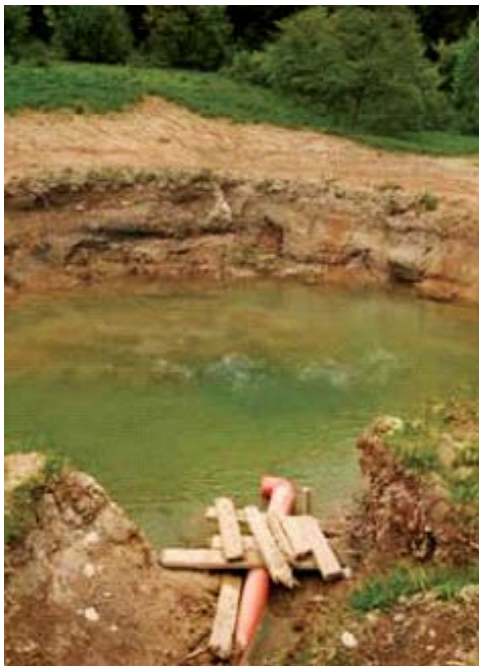

Figure 9. Drainage pipe that caused lowering of the water level (photo: www.IMCG.net).

flooding by discharging groundwater. The largest natural spring in the reserve has created a small lake within the travertine area. Its sides were lined by trees in the past and it was used for bathing by local people, even shortly after the Second World War. Its diameter in that time was about 3 m and its depth about 70 cm (Fig. 6). When this type of use had stopped, the fen vegetation regenerated here in the course of the following decades.

In the past a a hydro-geological survey has been carried out in the reserve in order to investigate if the springs could be used for the exploitation of spring water (spa). But these plans have been abandoned because of the springs and bore holes did not produce enough water.

Quite recently the National Reserve has been damaged by excavating en enlarging the small pond until it had a width of 13.7 m and a depth of 3 m at minimum. The reserve was also damaged because dumping the excavated material to the direct surroundings of the pit. Also, a trench was cut for placing a draining pipe (Fig 9). These activities were stopped and the lake has been partly restored after public protests. Much damage was caused also by the presence of heavy machines in the reserve. We have calculated that the vegetation was damaged over a total area of 3.015 m^2. Out of this total, 642 m^2 has been damaged due to trench digging, 2.091 m^2 due to excavating the large pit and dumping material into the surroundings and 459 m^2 of habitats were damaged due to the presence of heavy machines (Fig. 8).

Not only have this Special Areas of Conservation (habitats 7210* and 7230) been partially destroyed and much additional damage have been done to populations of protected plant species (*Eleocharis quinqueflora*, *Hippochaete variegata*, *Pinguicula vulgaris*, *Primula farinosa*, *Taraxacum* sect. *Palustria*, *Triglochin maritima*, *Trichophorum pumilum*, *Centaurium littorale* subsp. *compressum*, *Cladium mariscus*), but also the groundwater regime has been negatively impacted in certain parts of the reserve. It is clear that the protected status of reserve has been violated due to all aforementioned activities. Despite efforts to improve the situation, the unfavourable state has persisted in the locality until now. In 2006 the Office of the Malá Fatra Mt. National Park, which is in charge of administering the protected area, filed a claim to the Slovak Inspection of the Environment (SIE). The Office elaborated a statement on the degree of habitat and species damage, and made several suggestions how to restore the situation. The SIE gave a fine of 5.000 Euro to be paid by the village of Stankovany for the violation of the Act No. 543/2002 on Nature and Landscape Protection. Following the SIE's decision, the County Office for the Environment in Ružomberok ordered the village of Stankovany to carry out restoration measures in the area before November 1 2007, in cooperation with the Office of the Malá Fatra National Park. Also, the County Office issued a notification stating that the owners were obliged to keep the protected area in a good state.

The Stankovany Municipal Office filed an appeal against the decision to the Regional Office for the Environment in Žilina, but the decision Slovak Inspection of the Environment was confirmed by this Regional Office. The SIE of the SR participated in the meeting of the Local Council in Stankovany and submitted a project proposal for the restoration of the locality, including an optional plan for building an educational trail. The Municipal Office, however, insisted on maintaining "the pool" and its exclusion from the Nature Reserve. Since the restoration measures were not carried out, the SIE in Žilina started a new proceedure and fined the Municipal Office in Stankovany again. Upon appeal, the fine was decreased and subsequently paid by the village.

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EVALUATION OF IMCG EXCURSION PARTICIPANTS

Participants of the IMCG were glad that legal action had been taken to stop the illegal activities under Slovak law. Filling up the swimming pool again would in their opinion only increase the eutrophication. It was recommended that the immediate surroundings of the pool would be cleaned from debris that had been dumped there, during the excavation of the pool. The present water level of the pool appeared to be sufficiently high to prevent further drainage.

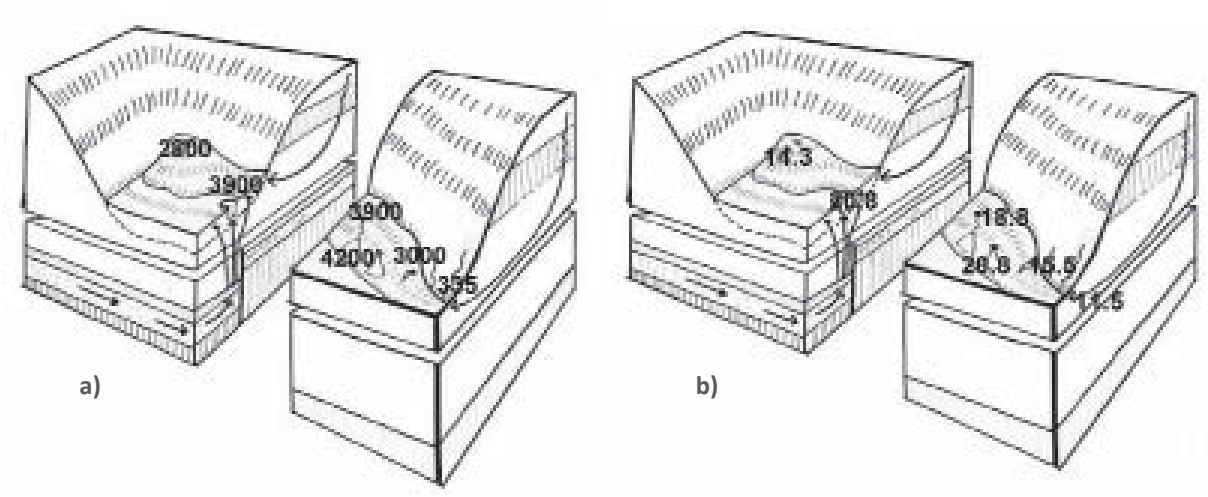

Figure 10, a, b. Measurements of electrical conductivity (in µS/cm) and temperature (in °C) depicted in a 3D conceptual ecohydrological model of the Nature Reserve Močiar. The concentrations of dissolved minerals from the springs are ten times higher then normal calcareous groundwater and the temperatures are more then ten degrees higher then groundwater from aquifers from some ten of meters depths. These measurements point to the presence of thermal springs in Močiar. Such groundwater is warmed up by the earth and comes from very deep layers (possibly more then 1000 meters deep). Local groundwater from the mountain appears to discharge at the edges of the reserve as well, because temperatures and EC are much lower there.

Measurements of temperature and electrical conductivity (EC) in the springs and artificial bore holes suggest that the several springs, including the larger central spring systems, are in fact thermal springs, feed by warm groundwater from very deep layers (Fig 10). Thermal springs originate from rainwater that percolates very deep into the earth layers, where it becomes heated. The temperature increases at a rate of 2-3˚C per 100 m due to the geothermal gradient (Press and Siever 1986). The groundwater in the main spring is 20.6 degrees, which is about 15 degrees higher then “normal groundwater from deep aquifers. So, this water may have reached a depth of more then 500 meters. Geological faults are typical structures that may force groundwater from deep aquifers to the surface. Figure 10 also shows that groundwater with different characteristics is also discharging at the periphery of the reserve. These springs and rivulets are more rich in iron, the temperature is much lower (up to 11.5 degrees, and the EC is also much lower (335 µS/cm). This groundwater appears to originate from the nearby mountain.

THE NATURE RESERVE POŠ

Compiled by: Daniel Dítě, Slavomír Celer, and Ema Gojdičová

The Nature Reserve (NR) Poš is located at the southern foothills of the High Tatra Mountains, near the village of Stará Lesná (appr. 1 km to the west). The elevation of the reserve is 780 metres. The area of the protected territory is 20.82 ha. The locality was declared a nature reserve in 1991, and it is now also proposed as a Site of Community Interest (SCI) with an area of 26.7 ha (Fig. 1).

GEOLOGICAL LANDSCAPE SETTING

The nature Reserve Poš is situated in the catchment of Studený Potok (creek), in the area with glacio-fluvial sediments (Strnka et al. 1989).

FLORA AND FAUNA

In the southern and south-eastern foothills of the High Tatra Mountains many mires have still remained in a good condition. Poš NR is such an example and still has a poor fen vegetation that is typical for that region. Plant communities belonging the alliance of *Spahgno recurvi-caricion canescentis* Passarge (1965) 1978 cover the largest part of the fen area (Dítě et al. 2006) and host many typical species such as *Carex canescens*, *C. echinata*, *Eriophorum angustifolium, Pedicularis palustris* or *Viola palustris.* Population of protected and threatened species *Comarum palustre* is abundant here. The central part of the mire consist of a complex of bog pools and its vegetation belongs mainly to the alliance of *Sphagno-Utricularion minoris* (T. Müller et Görs 1960). In Slovakia this vegetation type has been recorded only in Poš NR so far. *Utricularia minor*, one of the endangered and rare species has found its home here together with species such as *Carex dioica*, *C. limosa*, *Oxycoccus palustris*, *Drosera rotundifolia*, *Menyanthes trifoliata*, *Parnassia palustris*, *Pinguicula vulgaris*, and *Carex panicea*.

Comarum palustre, species with a Circumboreal distribution, is protected by the law in Slovakia. Photo: Daniel Dítě

Mire edges are overgrowing by birch woods of the alliance *Betulion pubescentis* Lohm. et Tx. in Tx. Just a few years ago *Carex lasiocarpa*, has been recorded in these woods and Poš Nature Reserve is one of the three known sites of the species in the Tatra region (Dítě and Pukajová 2004). *Eriophorum vaginatum* can be found here too.

Fragments of rich fen communities of the alliance *Caricion davallianae* Klika 1934 are also present at the site but due to, lowered groundwater levels these fen are being overgrown with *Molinia caerulea*. Other species typical for the *Molinion alliance* (litter meadows) grow here – *Carex hartmannii*, *Iris sibirica*, *Salix rosmarinifolia*, and *Gentiana pneumonanthe*.

Bryophytes are represented by *Aulacomnium palustre*, *Calliergon stramineum*, and *Callieronella cuspidata*, *Campylium stellatum, Dicranella heteromalla, Leucobryum glaucum, Pohlia nutans, Scapania undulata, Sphagnum centrale*, *S. magellanicum*, *S. palustre*, *S. platyphyllum*, *S. fallax*, *S. riparium*, *S. subsecundum.*

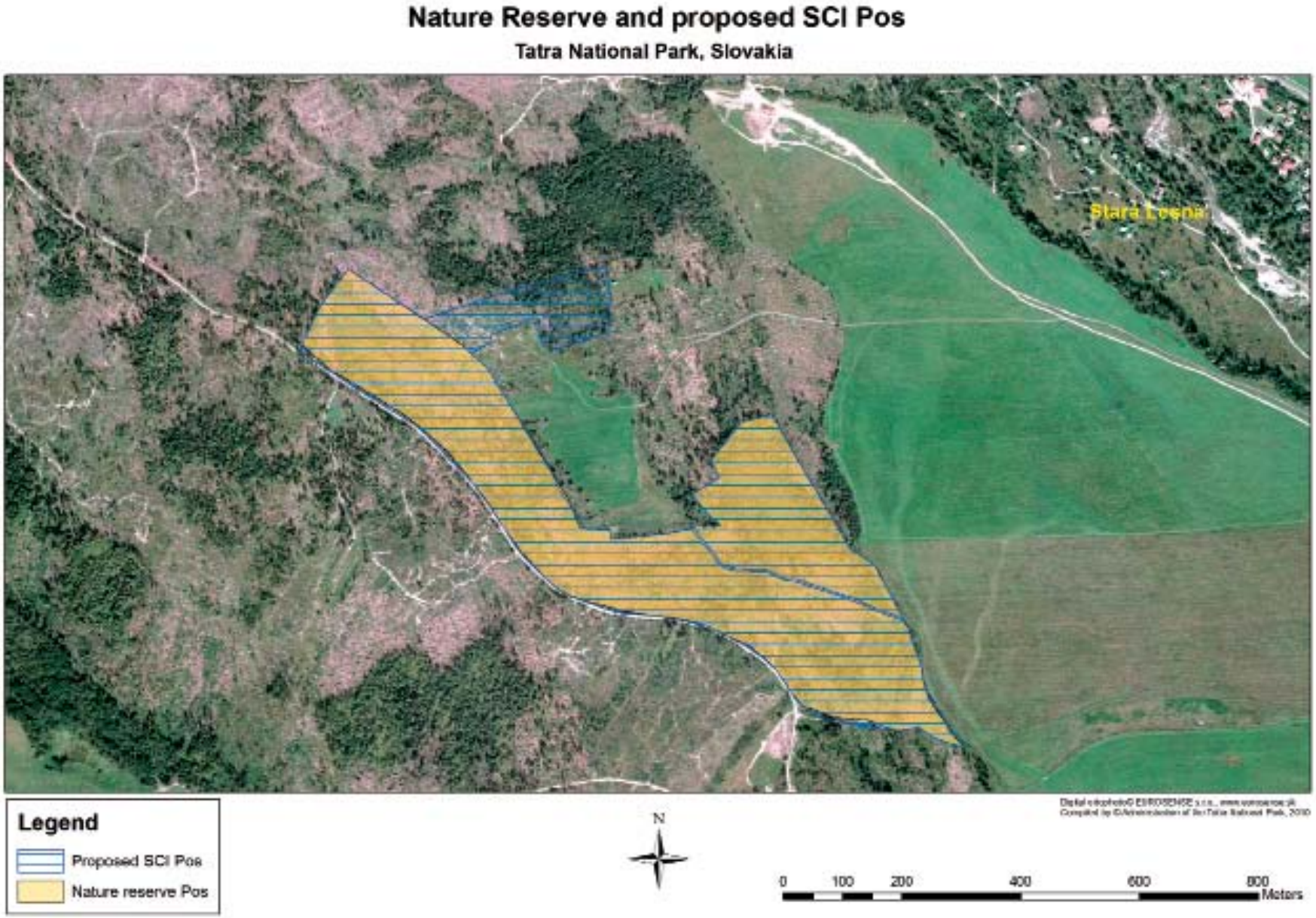

Figure 1. Aerial photograph of the Nature Reserve Poš

HABITATS

7140 – Transition mires and quacking bogs

91D0 – Bog woodland

9410 – Acidophilous spruce forests belonging to the Vaccinio-Picetea class.

MANAGEMENT

Forest stands surrounding the fen cover a major part of Pos NR. They were damaged by wind calamity in November 2004.

LITERATURE

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BELIANSKE LÚKY MEADOWS

Compiled by: Mikuláš Madaras, Ab Grootjans, Viera Šefferová Stanová

Belianske lúky Meadows is located in Spišská kotlina, at an elevation of 670 - 695 m n. m., located on the edge of continuous forest complex of the High Tatra Mountains, between the streams Biela (in the north) and Beliansky (in the south). In 1983, the Belianske lúky Meadows were declared protected and today the po registered as a national nature reserve (89.42 hectares). The 4th degree of protection (the highest but one) is applicable here. The site itself and some surrounding remnants of fens were included in the Natura 2000 network, which makes it a site of European importance. After it was extended, its total area now reached 105.77 hectares (Fig. 1).

Belianske lúky represent fine example of a little disturbed spring mire complex (Grootjans et al. 2005). It is largest spring mire system of Slovakia, and very important from a biodiversity point of view. The main problem in the area is an overgrowth of shrubs and trees, due to a lack of traditional management, principally periodic mowing. The hydrology of the spring system has also been influenced by intensive upstream drainage systems, which are now abandoned, but which still have a negative impact on the springs within the reserve.

GEOLOGICAL LANDSCAPE SETTING

The reserve belongs to the Tatra Mountain system. The eastern limestone part of this system is called Belianske Tatry and it is located upstream of the study area (Fig. 2). Underlying bedrock of the reserve is flysch of Tertiary age, consisting of alternating layers of non-calcareous sandstone and clay stone. The morphology of the area is also influenced by glaciation and fluvial processes. Although the mountain glacier didn't reach the area, subsequent post-glacial erosion of moraine sediments cover all downstream parts due to so-called fluvioglacial sedimentation (glacial outwash material).

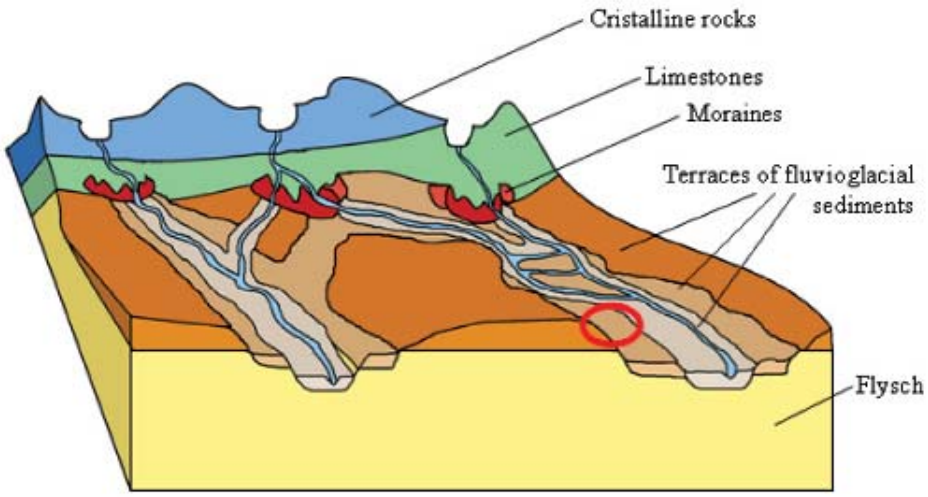

Figure 2. Illustration of geology of the studied area and surroundings (position of the reserve is represented by red circle).

Belianske Lúky is located at a fluvioglacial terrace, which has been deposited during the Riss glaciation (Lukniš 1973). Most of these deposits are rather shallow, not deeper then several meters, but they form the natural aquifer in the region since the material consists of calcareous and non-calcareous gravel and cobble stones, which is very permeable for water flow. The top of the terrace is covered with recent sediments and loamy solifluction sediments, with depths ranging from several decimetres to more than 2 meters. Due to a low water permeability of these sediments, their thickness is important for groundwater flow, especially in parts where groundwater in the aquifer is under (artesian) pressure.

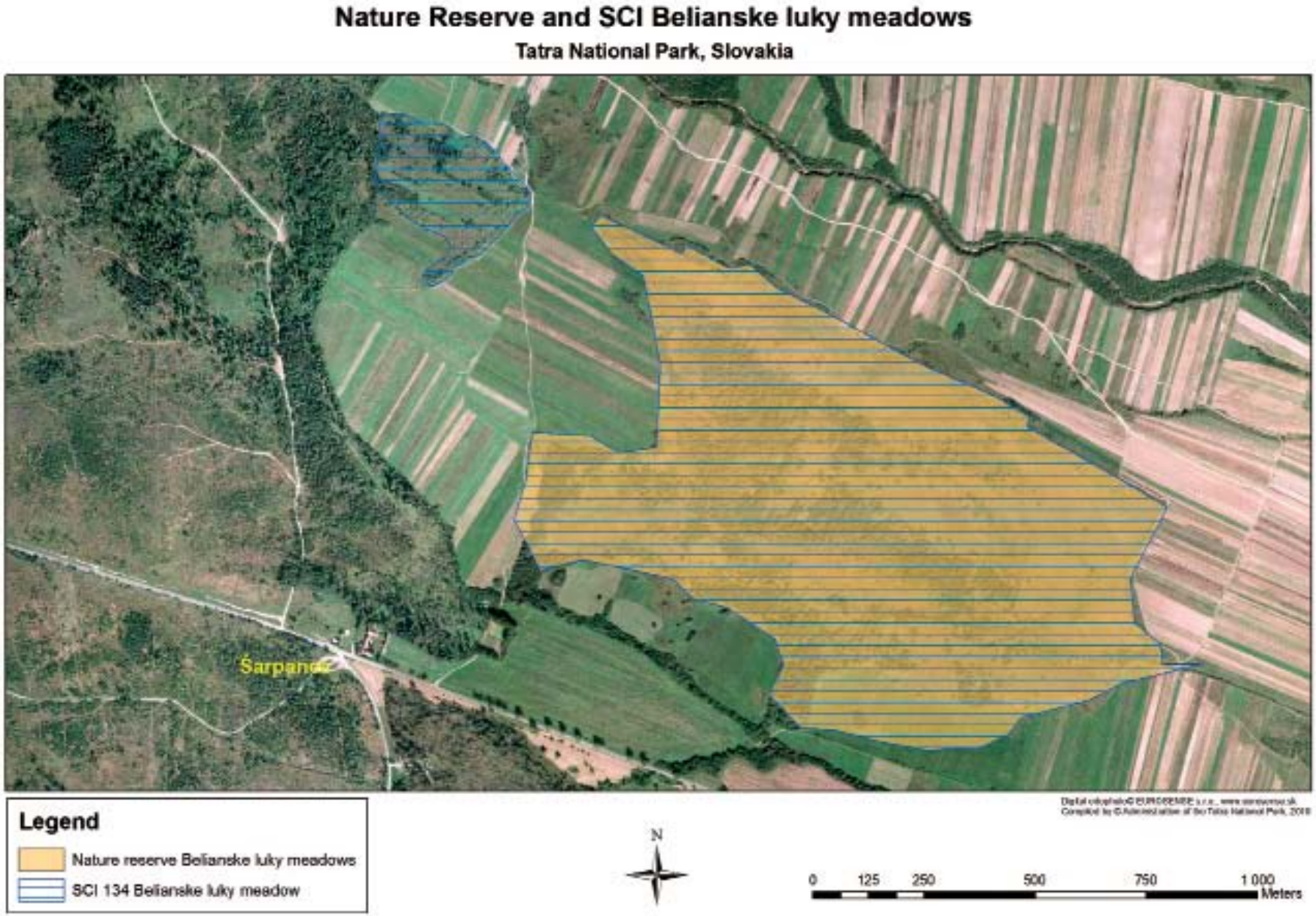

Figure 1. Map with location of the reserve

The southwest part of the fen lies on the slope of flysch deposits, which surfaces due to erosion. The central part of the reserve lies at the terrace deposited during the Riss period; the northern and northeast parts of the reserve are positioned at the lower terrace step (probably a younger stadial of the Riss glaciations). Fluvial activity of the Biela River during the interstadial between the older and younger Riss glaciations had opened the gravel aquifer. This had enabled groundwater discharge and had created conditions for Holocene peat formation.

The aquifer of fluvioglacial sediments below Belianske Lúky, therefore, is packed between two layers of low water permeability (Fig. 3). Thus, water can discharge (1) at the side, where the aquifer has been exposed by erosion, or (2) upward, when the cover heavy textured solifluction sediments are thin enough to allow the upward seepage of the water. The most intensive discharge zone is at the transition of one terrace to another, as can be deduced from the deepest peat profiles, which are located there.

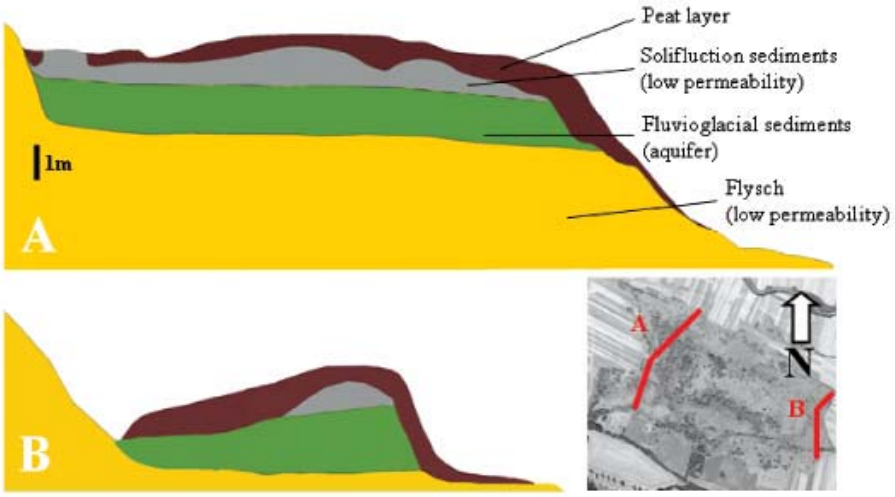

Figure 3. Simplified sketches of the geological setting along two cross-sections of Belianske Lúky . At the northern (right) sides of the transects, another terrace towards the Biela River is present.

HYDROLOGY

The pattern of groundwater levels (Fig. 4) shows that the position of zones of high groundwater levels follows the terrace slope and also the shallow valley of the local stream Belianka. The most eastern side of the reserve is also very wet. The most stable water levels were recorded here, with high water levels even in the very dry summer of 2003. Low groundwater levels were measured only in the central part of the reserve and at the south-eastern part, where mineral soils (flysch rock diluvium) are present.

The extreme summer drought of 2003 can help to distinguish the parts that are supplied by local groundwater (high and immediate effect on the groundwater level) and that are supplied by deeper groundwater (small effect). During this year, the decrease of water level depths was measured in all water tubes and groundwater levels had dropped also in areas, which normally had high and stabile groundwater levels. It points to a substantial proportion of local groundwater in the discharge zone. However, less sensitive areas were the east side of the reserve (P1, P2, P3), at north-east part (areas supplied by two springs around P 11) and in the south of the reserve (P 8).

Hydrology of shallow water pools

From a scientific point of view, the pools at the slope of spring mire represent a very interesting phenomenon. They are usually positioned in the flattest parts of the peat body and are more or less elongated perpendicularly to the slope. But in several cases they occupy the steepest parts of the slopes. In winter, the pools are often not frozen, even when the air temperature is below zero,

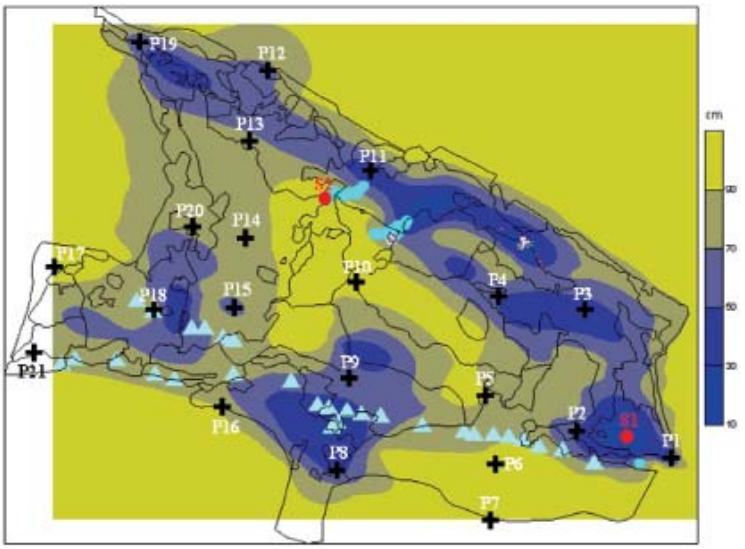

Figure 4. Groundwater levels (cm below the surface), measured August 12th, 2003). Only a part of the water tubes is shown. Blue triangles – Belianka stream, blue lines – springs eroding the peat at the slope. S1 and S2 show localization of surface water samples.

which points to the presence of a strong groundwater discharge. One would expect that during summer the discharge of groundwater have a cooling effect on the water in the pools, but this is not the case. The pools contain very warm water during summer. Apparently, the flow of surface water in the pools is slow enough to allow this warming up during warm summer days. Research showed that groundwater discharges at one side of the pool and infiltrates again in the peat layer at the other (downstream) side. Consequently, soil between the pools is warmed up as well. High temperatures and water plants in the pools favour precipitation of calcium carbonate. That is why most of the calcium carbonate is found in the pools itself. But also further down slope a thinner layer of calcium carbonate can be found. Not all pools show this calcium carbonate deposition. Some pools at the eastern side, with a very strong discharge of cold groundwater have, as expected a very low temperature of around 7 ° all the year round.

FLORA AND FAUNA

In the reserve, there is a unique complex of calcareous spring fens and wet meadows habitats. A large number of plant and animal species find their home here. At Belianske lúky Meadows, 266 plant species were found (Stanová, 2001), of which 55 species are considered endangered in Slovakia (Dražil et al 2010). The site is hosting the largest population of *Carex limosa* in Slovakia (Dítě & Pukajová, 2002). *Pedicularis sceptrum-carolinum* only occurs in the Tatra Mts. region in Slovakia and Belianske lúky is hosting the most important population of this species. Fen sedges are numerous and their populations have significant occurrence at the site. Examples are *Carex dioica*, *C. davalliana*, *C. diandra*, *C. hartmanii*, *C. hostiana*, *C. lepidocarpa* and *C. appropinquata*., which all have rather large populations here. Many orchid species are present as well; *Dactylorhiza incarnata* subsp. *incarnata*, *D. incarnata* subsp. *haematodes*, *D. incarnata* subsp. *pulchella*, *D. lapponica*, *Epipactis palustris*, *Gymnadenia conopsea* and *G. densiflora* all occur in Belianske lúky, some of them in quite large numbers.

7 nationally threatened moss species based on Red Data Book have been recorded as well (Kubínska et al. 2001), of which *Calliergon trifarium* belongs to the category of critically endangered species. It is the only locality of this species in Slovakia. The species is growing at the edges of fen pools. Species belonging to the category of endangered speciesinclude *Meesia triquetra* and *Campylium polygamum*. *Calliergon giganteum*, *Catoscopium nigritum*, *Dicranum bonjeani* and *Fissidens osmundoides* represent the category of potential threatened species.

Figure 5. A striking species, the *Pedicularis sceptrum-carolinum*, grows only in the Tatras region in Slovakia.
Photo: Viera Šefferová Stanová

Figure 6. A most numerous population of the rare mud sedge *Carex limosa* is in Slovakia known from this locality.
Photo: Daniel Dítě

Figure 7. *Calliergon trifarium* is in the whole area of Slovakia known just from the Belianske lúky meadows.
Photo: Daniel Dítě

One of the most diverse groups of animals living in Belianske lúky Meadows are molluscs. So far, 19 species have been found here. The presence of the narrow-mouthed whorl snail (*Vertigo angustior*) and the Geyer's whorl snail (*Vertigo geyeri*), which are registered among the species of European significance, is considered the most important. The Geyer's whorl snail is a critically endangered species (Horsák 2005)

Figure 8. Rare molluscs, the narrow-mouthed whorl snail (*Vertigo angustior*) and the Geyer's whorl snail (*Vertigo geyeri*), are tiny – their shell reaches barely 2 mm. Photo: Michal Horsák

HABITATS

Habitat map was prepared in 2004, when the whole locality was mapped.2 habitats of European importance were recorded – alkaline fens and dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*).

7230 – Alkaline fens

Alkaline fens consist of very well developed communities of the alliance *Caricion davallianae*, typical by open low-growing small sedge vegetation. The vegetation has a mosaic structure of pools, pioneer communities and peat-forming moss-sedge communities. The following vegetation types were recorded at the site:
Caricetum davallianae Dutroit 1924 is a peat forming fen community dominated by the small sedge *Carex davalliana*.

Valeriano simplicifoliae-Caricetum flavae Pawlowski et al. 1960 is a typical Carpathian fen community with *Valariana simplicifolia* and *Carex flava* as characteristic species

Pools – *Amblystegio scorpioidis-Caricetum limosae* Osvald 1923 is very rare pioneer community occurring around the pools with dominance of mosses and *Carex limosa*.

6210 – Dry grasslands

At the northern edge of the reserve communities of dry grasslands of the alliance *Cirsio-Brachypodion* have developed. These grasslands are species rich, with dominance of *Brachypodium pinnatum* and *Inula salicina*. They cover only about 1 ha.

Wet grasslands

Wet grasslands of the *Calthion palustris* R.Tx. 1937 alliance are relatively widespread in Belianske lúky. They are dominated by *Cirsium rivularis*, *Polygonum bistorta* and *Trollius europeaus*. This type is primarily found on clayey mineral soil with an organic layer of less than 10cm. It occurs on top of the mineral hill and along flanks of the terraces on which little or no peat was formed. They are covering 19.8 ha.

Mesophytic grasslands

This habitat is small scale (0.4 ha), occurring in the driest part of mineral "island" located in the centre of the reserve and belongs to the community *Polygalo-Cynosurenion*, with dominance of *Festuca rubra*, *Agrostis capillaris* and *Thymus pulegioides*.

Tall sedges

Tall sedges are growing in western part of the reserve in field depressions, flooded in spring, covering about 1 ha. The dominant sedge species is *Carex acutiformis*.

Degraded alkaline fens

Degraded fens are located on drained part of the mire with dominance of *Molinia caerulea* and *Calamagrostis varia*. Mosses and fen species are rare. This type is located in the north-eastern part of the reserve and covers 3.32 ha.

Secondary growth of willows, birch, pine and spruce

Forest established due to secondary succession after abandonment of regular management. This vegetation type is about 40 years old. The peat layer has been decomposed severly and no fen vegetation is present anymore under the forest canopy. Forest and shrub covers a significant part of the reserve – 32.4 ha.

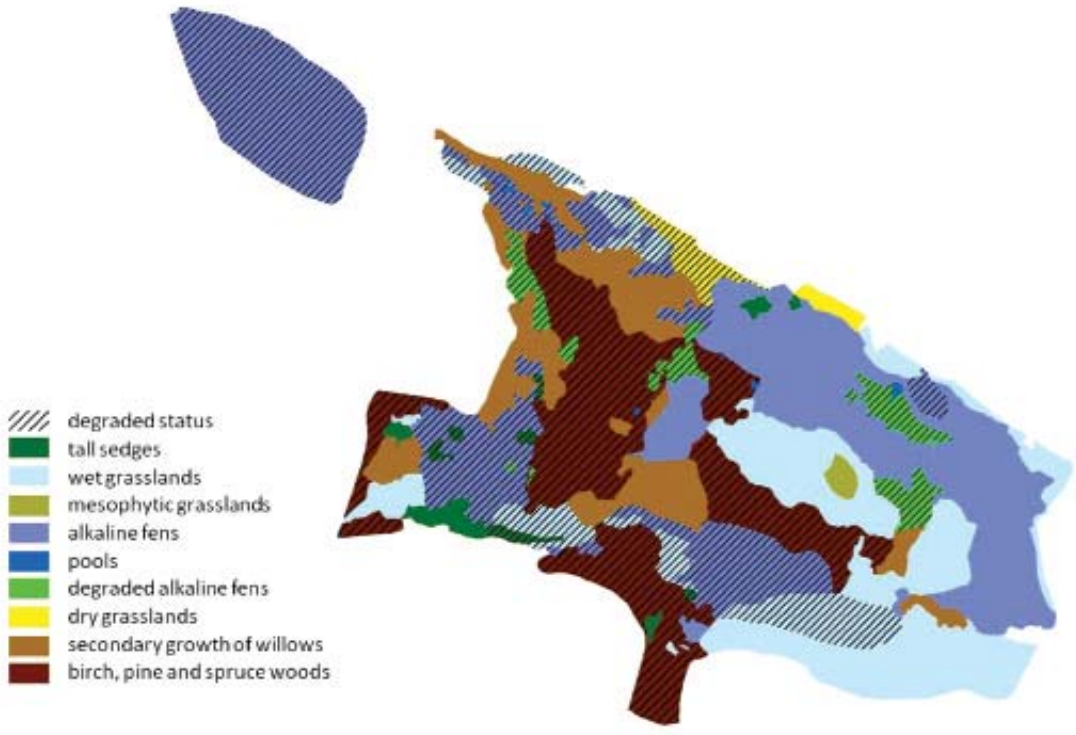

Figure 9. Habitat map (after Dražil et al. 2010)

MANAGEMENT

In the past almost the whole fen used to be mown. This traditional way of management was abandoned after mechanisation was introduced in the 2nd half of the 20th century. Since 1950s, people in the area started to lose interest in the traditional way of management, which caused the fen biotopes to be gradually overgrown by woods, especially by birches and willows. Reed spread in the area as well. Fens are extremely sensitive to changes in the water regime. As a result of the melioration of the neighbouring lands, the groundwater level in the reservation dropped. This, together with the forest succession, negatively influenced the fen and fen meadow habitats.

In the years 2007 – 2009, with support of UNDP GEF project non-forest fen communities were restored in a large area and long-term management of the fen meadows was introduced. An area of 34 hectares was cleared of trees and shrubs and another 46 hectares was mulched once and subsequently mown on an annual basis using lightweight machines

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SIVÁ BRADA; the largest active travertine hill in Slovakia

Compiled by Daniel Dítě and Tomáš Dražil

The travertine hill Sivá Brada (ca. 20 ha) is located in the Hornádska valley (ca. 20 ha) near the town of Spišské Podhradie. It has been a national nature reserve since 1979 (Fig. 1) and is also part of a larger Special Area of Conservation named 'Travertines', which was created by the town of Spišské Podhradie in 2004. The 'Travertines' consists of six travertine hills and one of them is Sivá Brada. Considering its natural-, landscape- and cultural values, Sivá Brada (Fig. 2a, 2b), with its springs and a geyser, is an exceptional and unique phenomenon. Its importance exceeds the borders of Slovakia.

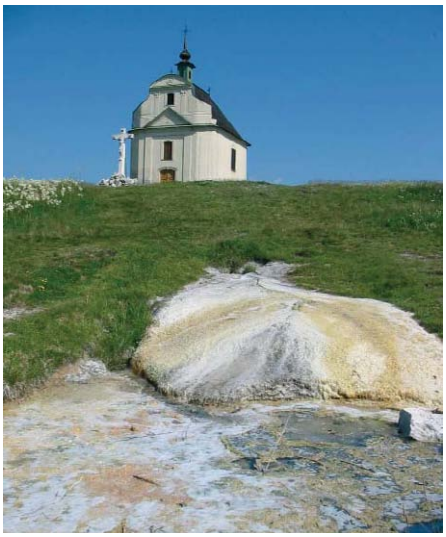

Figure 2a, 2b. View on Sivá Brada travertine springs and travertine hill with height of 492 m. Photo: Milan Barlog

GEOLOGICAL LANDSCAPE SETTING

The large travertine hill has a height of 492 metres and is one of six travertine hills in the area. Travertine hills are formed due to long-term sedimentation of $CaCO_3$ and other calcium minerals, which originate from 'super-saturated' groundwater that discharges almost continuously in areas where geological faults force the groundwater, flowing in interrupted deep aquifers, to the surface. The oldest travertine hills are called 'Dreveník' and 'Spišský Hrad'. They are very old and started to develop in the Pliocene. The others evolved in the quaternary period. The above mentioned travertine hills have no longer an active spring. At present Sivá Brada is the only one where springs are still active and producing coatings of almost pure calcium carbonate. The hill is approximately 10,000 years old. Sivá Brada has about 12 springs, situated mostly at the foothill of the hill. Two of the springs have been straightened to allow usage for bottling the mineral water. The others flow freely down the slope, resulting in sedimentation of calcium carbonate deposits along the slope in a kind of in cascades (Krahulec et al. 1977). The groundwater pressure in the spring that feeds the top of the hill has been gradually weakened during the last decades, due to hydrological interferences at the base of the hill. This has resulted in frequent drying-out of the small pond.

FLORA

The flora of Sivá Brada contains many species of calcareous spring fens, salt marshes and calcareous dry grasslands. Both the halophytic species and the calcareous spring fen species are very rare in Slovakia. Obligatory halophytes are *Glaux maritima* (Fig. 3), *Plantago maritima* (Fig. 4), and *Triglochin maritima*. Facultative halophytes are: *Carex distans* (Fig. 5), *Centaurium littorale* subsp. *uliginosum*, *Lotus tenuis*, *Schoenoplectus tabernaemontani*, *Scorzonera parviflora*, and *Trichophorum pumilum*. On the eastern foothill also Juncus gerardii can be found (Pukajová et al. 2003). A very rare occurrence is the Bryophyte species *Bryum marratii* which only occurs at Sivá Brada and nowhere

Figure 1. Map with location of the reserve

Figure 3. and 4. *Glaux maritima* and *Plantago maritima* are obligatory halophytes typical for Carpathian travertine swards. Photo: Milan Barlog

Figure 5. *Carex distans* is facultative halophyte, not so rare as previous species. Photo: Milan Barlog

else in Slovakia. Campylium elodes is another moss species that is quite abundant in this type of habitat, (and very rare as well in Slowakia). Other rare fen species that occur in the surroundings of springs are: *Blysmus compressus*, *Pinguicula vulgaris*, *Primula farinosa*, and *Juncus articulatus*. Xerophilous and thermophilic species that are growing on the decayed calcium carbonate coating at Sivá Brada include: *Allium montanum*, *Alyssum montanum*, *Astragalus danicus*, *Carex humilis*, *Pseudolysimachion spicatum*, *Sedum album*, *Silene otites*, *Trifolium montanum* and *Galium boreale* (cf. Šmarda 1961). A large population of *Orchis coriophora* is found on the southern slope of the travertine hill (Eliáš et al. 2004). This species is critically endangered in Slovakia.

HABITATS

1340 – Carpathian travertine swards‘

The most interesting plant species and their associations can be found around the springs, where they are in close contact with the discharging groundwater. They represent a unique habitat, what is sometimes called the ‘Carpathian travertine swards’. The discharging groundwater, which is very rich in dissolved mineral, provides a very suitable habitat for several obligatory and facultative halophytes (salt marsh species). Together with a set of species of calcareous fens they form a unique association: the *Glauco-Trichophoretum pumili* belonging to the alliance *Caricion davallianae*. In Slovakia, this association can be found only around the outflows of spring waters in the Hornádska and Popradská valleys. In addition to Sivá Brada, they include localities near the villages of Baldovce, Gánovce and Hôrka. Less typical forms of this vegetation type, which are missing some of the typical species, can be found in the surroundings of the village of Spišská Teplica and in several localities within the Liptovská kotlina valley (Dítě et al. 2004). The largest area of this association is situated at the western foothill of Sivá Brada. In other localities, *Epipactis palustris*, *Equisetum variegatum*, *Pedicularis palustris*, *Dactylorhiza incarnata* may also occur in this association; also typical (fen) mosses, e.g., *Drepanocladus cossonii*, *Campylium stellatum*, *Bryum pseudotriquetrum* may be found there (Pukajová et al. 2003). Such species belong to habitat type 7230 (Calcareous fens from Annex 1 of the Habitat Directive).

6210 – dry grasslands and scrubs on calcareous substrates

In areas outside the influence of the spring water, the bare calcium carbonate deposits have been overgrown with vegetation types that contain many xerophilous and thermophilic plant species. The type of habitat that in which these species occur can be classified as *Festuco –Brometalia*. Some of the halophytes, for example, *Plantago maritima*, can also survive here for a relatively long time. Some inactive travertine hills in the surroundings have managed to preserve dry grasslands with a typical ‘steppe’ character. Here, the endemic species *Pulsatilla slavica* and *P. subslavica* are present in large

numbers. In the area around Dreveník the critically endangered species *Dracocephalum austriacum* reaches its most northern distribution in Slovakia and in a place called Peklo (Hell) another relict species *Carex pediformis* has managed to survive on one of the towers of the town, which is mainly build from travertine rocks.

MANAGEMENT

The famous 'Carpathian travertine swards' are rapidly declining, in particular around the Sivá Brada foothill. Instead of a very nice *Caricetum davallianae* vegetion with transition towards the *Caricetum diandrae* that was still recorded in 1960, now *Phragmites australis* is dominating the vegetation.
This expansion of reeds is mainly caused by intensive agricultural use in the surrounding agricultural landscape, which causes increased runoff of nutrients in the wetland. Also abandoning the traditional management (mowing) stimulated the spread of eutrophic species. Both factors caused the development almost mono-dominant reed stands, which even intrude into the protected halophyte vegetation.
The western part of the reserve also suffered from reed expansion, but here remnants of halophyte or fen vegetation have been preserved. Since 2003, this part of the reserve is mown. The mowing takes place twice a year on an area of 0.5 ha. In order to determine the best time of mowing, a long-term experiment has started on the impact of mowing on the vitality of *Phragmites* (Dražil, Barlog, Bryndzová ined.). The area is now mown twice a year: the first time at the end of June or in July, when *Phragmites* starts flowering, and the second time in late September, when most of the reed turns yellow. The neighbouring lower-situated locality (0.5 ha), where reed is growing, but where hydrologically good conditions for the restoration of the halophytic and fen vegetation exist, has been mulched only once or twice a year, so far.
The reed's reaction to mowing was to form an even denser vegetation due to sprouting around individual reed stems. This trend was persistent for some time, but since 2009 the number of stems decreased. The maximal and average height of the reed dropped already since 2007. The reed is now becoming less vital, leading to a general decrease in cover. However, also some target species, such as *Glaux maritima* have decreased since the mowing has started. Such species may not be adapted to frequent mowing.

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EVALUATION OF IMCG EXCURSION PARTICIPANTS

The discharge of groundwater appears to decrease, not only in Sivá Brada, but also in neighbouring travertine hills. In Sivá Brada the decrease of water pressure may be partly caused by drilling a bore-hole at the base of the hill, but it may also be the result of abstraction of groundwater for the production of mineral (bottle) water. We advise to start an independent hydrological research on this question and not to rely on hydrological research carried out by the bottling company, who claims that the chemical signature of their water is different from that of the Sivá Brada springs. In our opinion that does not prove that the water pressure is not influenced by abstracting groundwater from another aquifer.

THE NATURE RESERVE BOR

Compiled by: Daniel Dítě, Slavomír Celer, and Ema Gojdičová

The Nature Reserve (NR) Bor is also located in the Tatras foothill area, near the village of Podspády at an elevation of 910 – 980 metres. The area of the protected territory is 133.61 ha. The locality was declared a reserve in 1991, and it is included in the Natura 2000 network within a larger Site of Community Interest named Tatry (Fig. 1).

GEOLOGICAL LANDSCAPE SETTING

The Nature Resereve Bor is situated in the area with glacio-fluvial sediments. The underlying bedrock is flysch of Terciary age (Šomšák et al. 1996).

FLORA AND FAUNA

Forests dominating in the National Reserve Bor hide the largest raised bog in the Tatra region. The bog covers an area of almost 11 ha. The peat layer reaches a thickness of 3.20 metres (maximum), which is equivalent to 120 000 m^3 of peat (Raučina 1968).

The bog is surrounded by spruce woods of the alliance *Piceion excelsae* Pawlowski in Pawlowski et al, 1928. The under storey is poor in species and dominated by species such as *Vaccinium myrtyllus*, *V. vitis-idaea*, *Equisetum sylvaticum*, *Calamagrostis villosa*.

In the central part of the mire more open places with a high water level can be found. The environment is nutrient poor and the vegetation consists of typical bog species. Plant communities belong to the alliance of *Spahgnion medii* Kästner et Flössner 1933 and the *Spahgno recurvi-caricion canescentis* Passarge (1965) 1978. They are in close contact with calcium-poor ground water. The vegetation is not very rich in species but hosts typical bog species: *Carex canescens*, *C. nigra*, *C. rostrata*, *Eriophorum angustifolium*, *Eriophorum vaginatum*, *Drosera rotundifolia*, as well as species of lag zones such as: *Carex canescens*, *C. nigra*, *C. rostrata*, and *Juncus effusus*. Some older botanical records mention the occurrence of *Rhynchospora alba* (Šomšák et al. 1996) and *Ledum palustre*, however, these species have not been confirmed in the area recently (Dítě & Pukajová 2004).

A most numerous population of the rare orchid *Listera cordata* in Slovakia can be found in NR Bor. Photo: Daniel Dítě

The bog edges and spruce woods are interesting because of the occurrence of a tiny orchid, *Listera cordata* that has its largest population in Slovakia here.

The Bryophyte flora is dominated by *Sphagnum* species: *Sphagnum magellanicum*, *S. fallax*, *S. cuspidatum* and *Polytrichum strictum*, *P. commune*. *Pseudobryum cynclidiodes*, a glacial relic species, was recorded in the site in the past as well.

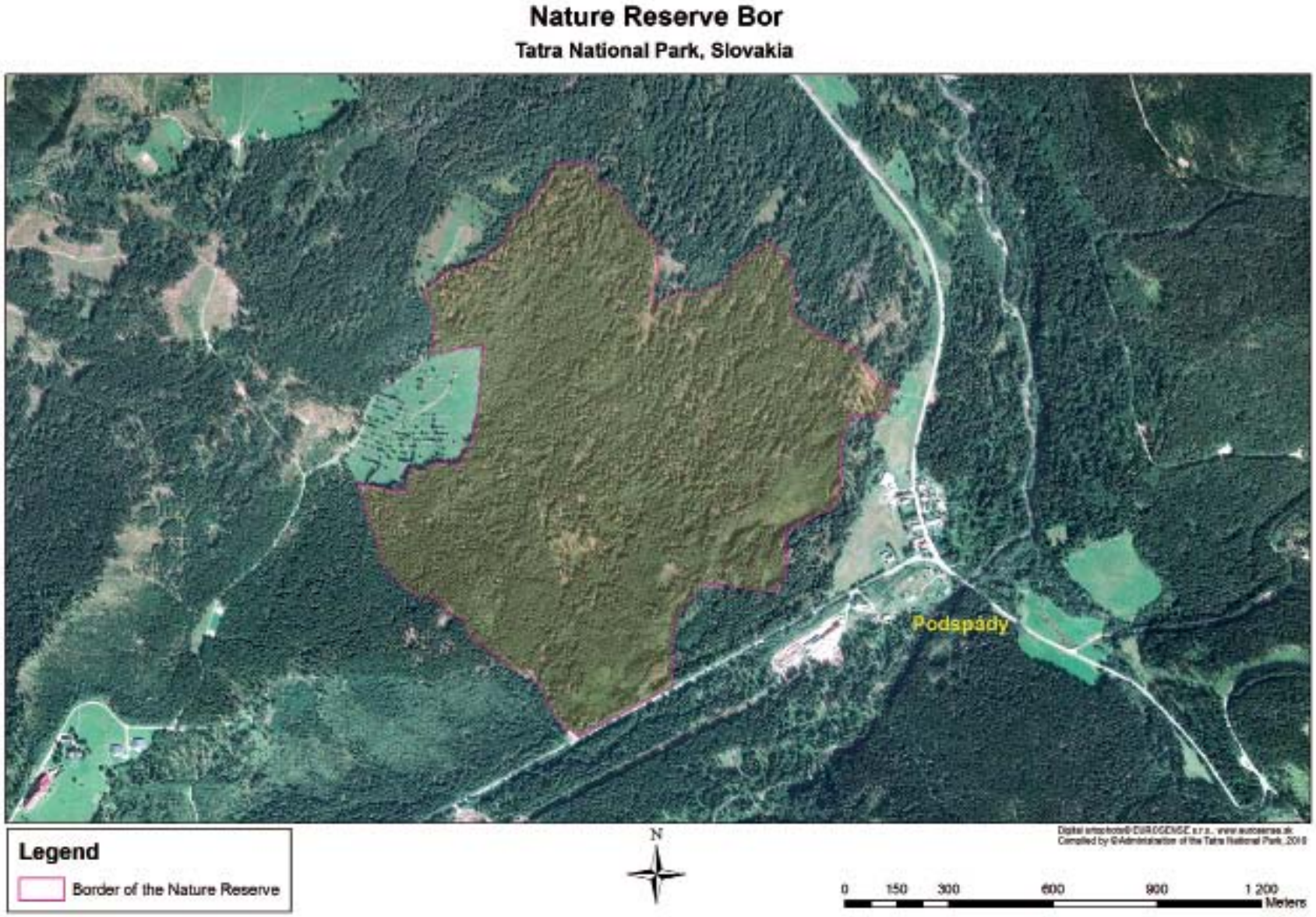

Figure 1. Aerial photograph of the Nature Reserve Bor

HABITATS

7110 – Active raised bogs

7140 – Transition mires and quacking bogs

91D0 – Bog woodland

9410 – Acidophilous spruce forests (Vaccinio-Picetea)

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EVALUATION OF IMCG EXCURSION PARTICIPANTS

We noted that in the reserve some small drainage ditches were still operative and should be closed. We also noticed that the forest road was constructed straight across the mire and was causing damage to the mire. The stagnating water on the road carries fine particles and these are deposited on the peat when the road discharges surface water to the mire. This will cause some eutrophication in the mire.

View on a small drainage ditch in the mire and on the forest road crossing the mire.
Photos: Eric Munzhedzi.

MIRES OF THE ORAWSKO-NOWOTARSKA BASIN

Compiled by: Anna Koczur

The Orawsko-Nowotarska Basin is a tectonic depression situated at the elevation of 490 to 650 m a.s.l. in the northern foothills of the Tatra Mountains. The complex of raised bogs, poor and rich fens, and forested bogs that have developed in this area, is the largest in the Polish Carpathians (Fig. 1).

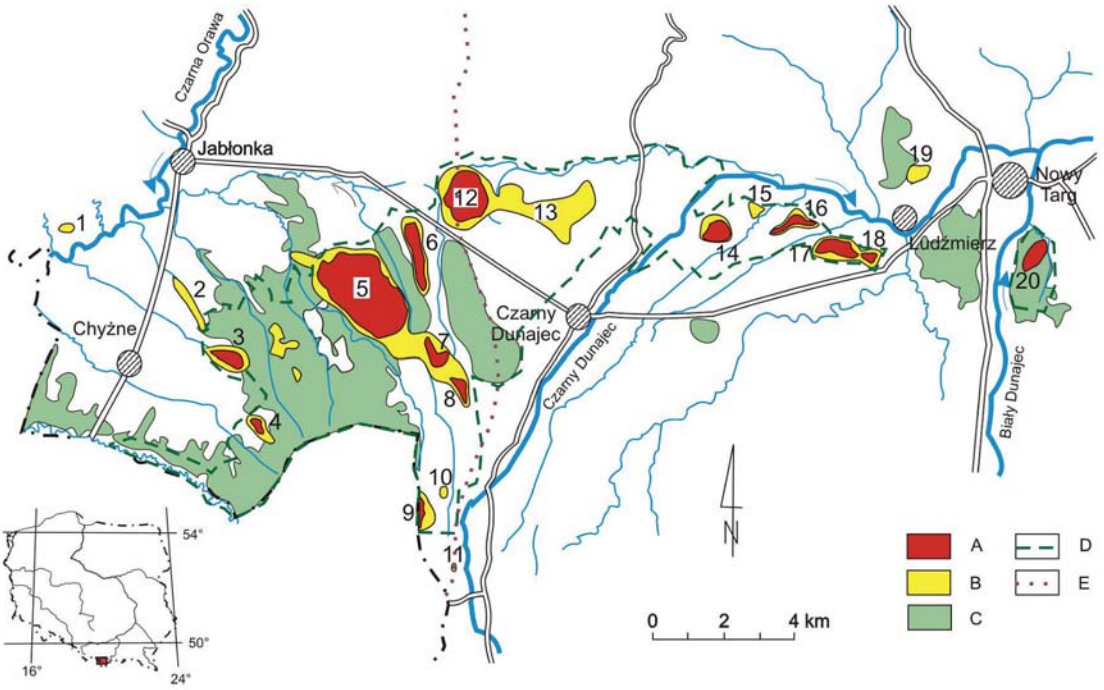

Figure 1: Distribution of raised bogs and coniferous bog forests in the Orawa-Nowy Targ Basin in the Polish part of the Tatra Mountains.
1 – Janowiackie; 2 – Puścizna Jasiowska; 3 - Łysa Puścizna; 4 Pustać Cyżne; 5 – Puścizna Wielka; 6 – Puścizna Mała; 7 – Kaczmarka; 8 – Bór za Lasem; 9 – Puścizna Przybojec; 10 – Bacuch; 11 – Kosarzyska; 12 – Baligówka; 13 – Puścizna Rękowiańska; 14 – Puścizna koło Wróblówki; 15 – Cyrla; 16 – Puścizna Franków; 17 – Młaka Brzeże; 18 – Przymiarki; 19 – Do Grela; 20 – Bór na Czerwonem.
A – raised bogs; B – fens, transitional mires and post-exploitation areas; C – the complex of forests with considerable contribution of coniferous bog forests; D – border of Natura 2000 area.

Numerous attempts to establish a network of nature reserves, a landscape park of even a national park have met with fierce opposition of local inhabitants (Lubicz-Niezabitowski 1922, Obidowicz 1977, Denisiuk 1993). The only successful case to establish a nature reserve was the Bór na Czerwonem peatland, which was established in 1925 (Obidowicz 1977). New hope to preserve the mires in this region is rising due to the establishing of the Natura 2000 site „Torfowiska Orawsko-Nowotarskie" (Orawa - Nowy Targ Peatlands) in 2008 (Fig. 1).

GEOLOGICAL LANDSCAPE SETTING

The tectonic basin of Orawa–Nowy Targ has developed in the younger Tertiary. The surface of the depression is covered with various alluvial fans (Fig. 2) that have developed during three glaciations episodes during the Quaternary.

The fans consist of thick gravel deposits, covered with a thin layer of weakly permeable clays (Łajczak 2006). Mires started to grow on top of them ca. 10,000 years ago (Baugmart-Kotarba 1992, Koperowa 1962). They differ in age (4-9 thousands years), and their depth ranges from a few centimetres to 10 m (Obidowicz 1990). Torfowisko Baligówka (Fig. 3) is one of the oldest and the largest peatlands in the region.

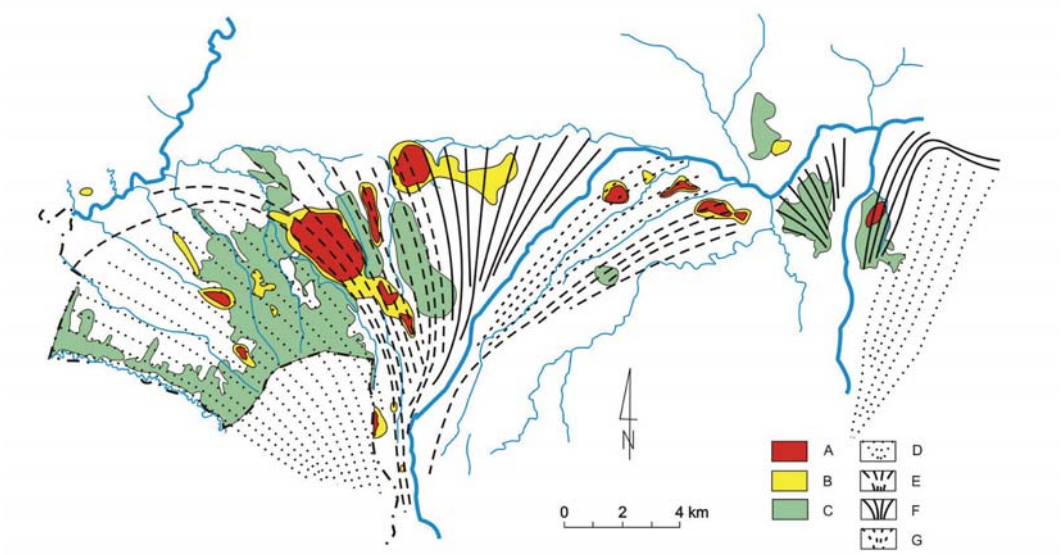

Figure 2: Distribution of peatlands and bog woodlands in the Orawsko-Nowotarska Basin with fluvioglacial fans of different age.
A – raised bogs; B – fens, transitional mires and post-exploitation areas; C – the complex of forests with considerable contribution of coniferous bog forests; D – fluvioglacial fans of the oldest glaciation, E – fluvioglacial fans of the one before last glaciation; F fluvioglacial fans of the last glaciation; G – postglacial fluvioglacial fans.

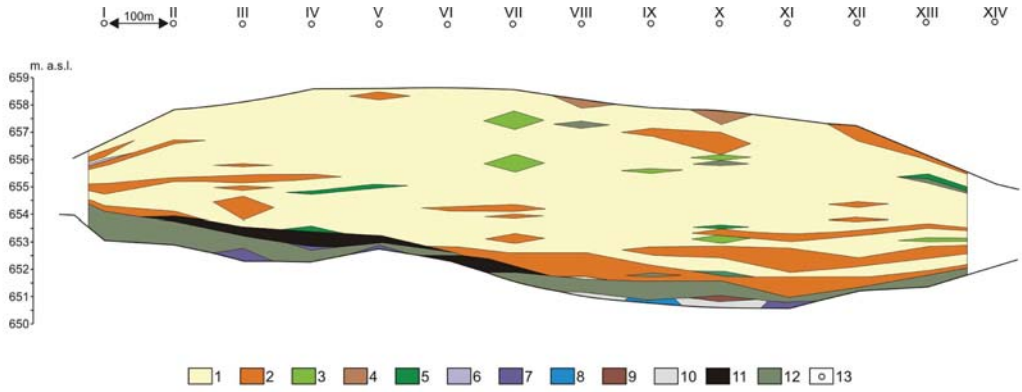

Fig. 3. Stratigraphic section across the Baligówka (Puścizna Rękowiańska) bog (ac. to Obidowicz 1990). 1 – Eusphagneti-peat +Sphagnum magellanicum-peat + Sphagnum acutifolia-peat; 2 – Eriophoro-Sphagneti-peat; 3 – Cuspidato-Sphagneti-peat + Majus-peat; 4 – Spagnum papillosum-peat; 5 – Sphagnum angustifolium-peat; 6 – Cariceti-peat; 7 – Equiseti-peat; 8 – Bryalo-Parvocaricioni-peat; 9 – Drepanocladus-peat; 10 – Minero-Sphagnioni-peat + Cariceto-Sphagneti-peat; 11 – Pino-Betuleti-peat + Alno-Betuleti-peat + Pino-Sphagneti-peat; 12 – Sphagno-Scheuchzerieti-peat; 13 – boring sites.

HYDROLOGY

The Orawsko-Nowotarska Basin is drained by two rivers: the River Dunajec and the River Orawa. The remaining bogs are situated on the watersheds of local streams, in spring areas, in small valleys and on elevated river terraces (Łajczak 2006).

FLORA AND FAUNA

The area harbours many rare and endangered plant species. Five of them are listed on the Polish Red Book (Kaźmierczakowa, Zarzycki 2001), and 21 on the red list of endangered vascular plants (Zarzycki, Szeląg 2006). *Rubus chamaemorus* was also recently found in the basin (Koczur 2004). Other rare and protected species are: *Andromeda polifolia*, *Carex limosa*, *Carex pauciflora*, *Drosera anglica*, *D. rotundifolia*, *Empetrum nigrum*, *Eriophorum gracile*, *Ledum palustre*, *Oxycoccus microcarpus*, *Oxycoccus palustris*, *Rhynchospora alba*, *Scheuchzeria palustris*, *Sparganium minimum*, *Pinus* x *rhaetica* and *Vaccinium uliginosum*. Species that primarily grow in the lagg zones of bogs, and in fens are: *Calla palustris*, *Carex davalliana*, *Carex dioica*, *Carex pulicaris*, *Comarum palustre*, *Dryopteris cristata*, *Eleocharis quinqueflora*, *Epipactis palustris*, *Juncus alpino-articulatus*, *Juncus squarrosus*, *Menyanthes trifoliata*, *Pedicularis palustris*, *Pedicualaris sylvatica*, *Pinguicula vulgaris*, *Potamogeton alpinus*, *Utricularia minor* and *U. vulgaris*. Bryophytic species are also numerous, but still insufficiently studied.
Interesting animal species include butterflies like *Colias palaeno* and *Chlorocysta infuscata* (Cisło, Cichocki 1994), the dragonfly *Coenagrion ornatum*, molluscs, such as *Unio crassus* and *Vertigo geyeri*, fish species *Lampetra planeri* and *Sabanejewia aurata*, amphibians like *Bombina variegata* and *Triturus montandoni*, and mammals such as *Canis lupus* and *Lutra lutra* (Perzanowska 2008). The Orawsko-Nowotarska Basin hosts one of the largest populations of the Black Grouse *Tetrao tetrix* in Poland.

HABITATS

The valuable and protected Natura 2000 habitats of the area include mostly different mire types, such as:

7110 – Active raised bogs
Active raised bogs usually consist of the following plant communities: *Sphagnum papillosum* comm., *Sphagnetum magellanici*, *Eriophorum vaginatum-Sphagnum fallax* comm., *Pino rhaeticae-Sphagnetum*, *Ledo-Sphagnetum magellanici*, and the *Empetro nigri-Sphagnetum fusci*.

7120 – Degraded raised bogs
The degraded bogs, which are mostly covered by a plant community dominated by *Calluna vulgaris*, seem to be still capable of regenerating into more natural systems after restoration measures would be taken.

7140 – Transition mires and quaking bogs
These mires may contain the following plant communities: *Caricetum rostratae*, *Caricetum distichae*, *Caricetim limosae, Caricetum lasicarpae, Sphagnum recurvum-Eriophorum angustifolium* comm., *Carici canescentis-Agrostietum caninae*,and the *Caricetum nigrae*.

7150 – Depressions on peat substrates
This habitat type we usually find in wet depressions in peat areas and the vegetation belongs to the *Rhynchosporetum albae*.

7230 – Alkaline (Basiphilous) fens
Alkaline fens, also called basiphilous fens consist of well-developed communities which belong to the alliance *Caricion davaillianae*. The following associations have been recorded: *Valeriano-Caricetum flavae, Caricetum paniceo–lepidocarpae*, and *Eleocharitetum quinqueflorae*.

91D0 – Forrested bogs
Forrested bogs consist of the following plant communities: *Betula pubescens* comm., *Vaccinio uliginosi-Pinetum, Calamagrostio villosae-Pinetum*, and the *Sphagno-Piceetum*.

6230 – Species-rich Nardus grasslands
These nutrient-poor grasslands are found on siliceous substrates in mountain and submountain areas. Plant communities that are found are the associations *Hieracio vulgati-Nardetum*, and *Nardo-Juncetum squarrosi*.

6510 – Extensively managed hay meadows of the planar to submontane zones
These sub-mountain grasslands belong to the association *Arrhenatheretum elatioris* and they are more productive then the former habitat type;

6520 – Species-rich mesophilous hay meadows of the montain and sub-alpine areas
This habitat type contains the grassland association *Gladiolo-Agrostietum capillaries*.

Wet grasslands
Some interesting wet meadows belonging to the *Calthion palustris* Alliance (e.g. *Angelico-Cirsietum oleracei, Cirsietum rivularis, Epilobio-Juncetum effusi*) are present in the area. They are not included in the Natura 2000 program.

MANAGEMENT

Peat exploitation by local people started in several mires in the middle of 19th century (Jostowa 1963). Since 1967 peat is also mined in an industrially way. At present only 13.2 ha is used for peat mining in the Puścizna Wielka bog, where initially ca.100 ha was planned to be mined (Koczur 2008). These activities resulted in considerable decrease in area of the majority of peatlands (Fig. 4) or even in a complete disappearance of some of them (Koczur 1996, Łajczak 2006).

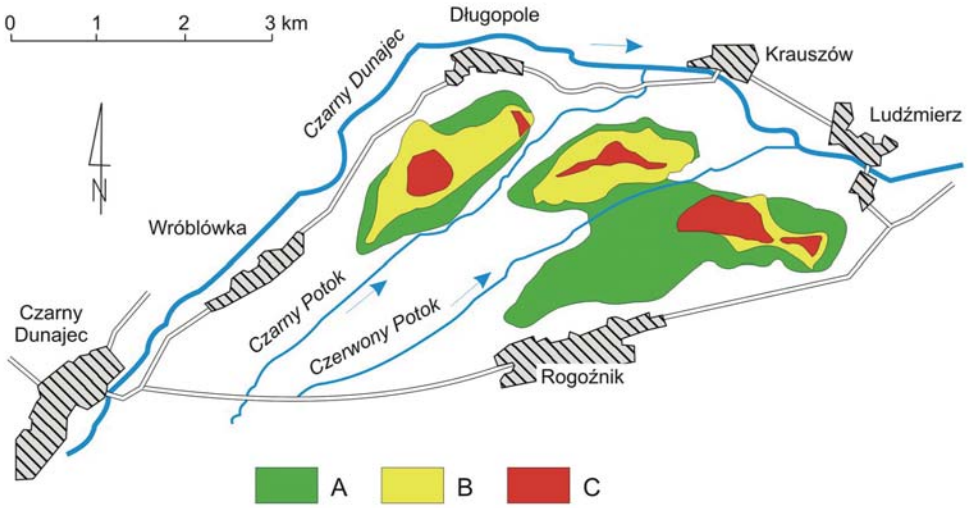

Figure 4. Changes in the area of raised bogs in the environs of Ludźmierz in the last century.
1 – Przymiarki; 2 – Puścizna Franków; 3 – Puścizna koło Wróblówki.
A – initial areas of bogs after Lubicz-Niezabitowski (1922); B – areas of bogs in the years 1934-1939 according to the map WIG 1 : 100 000); C – present area of bogs.

Signs of desiccation and vegetation degradation are visible on the surviving parts of bog cupolas, and the original vegetation of the lagg zone has almost completely been destroyed.
In the recent years some initiatives have started aiming at improving the condition of the mires and communicating nature protection messages to a wider public. For example, a nature trail has been constructed in the Baligówka bog, and another one is under construction in the bog Bór na Czerwonem. In the latter also active management measures are performed (removal of pine and blocking of the ditches in the lagg zone). Recently also some closing of the ditches has been carried out in the drained part of the Puścizna Wielka bog.

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CALCAREOUS FENS OF THE NIDA BASIN

Compiled by: Alojzy Przemyski and Lesław Wołejko

Nida Basin is a large cretaceous depression, bordered by Paleozoic and Mesozoic mountains in the north (Holy Cross Mts.) and the Wisła proglacial valley (now filled with Quaternary deposits) to the south. To the west, it is bordering the Jurasic outcrops of the Kraków-Częstochowa Uplands. Ponidzie, the central part of the region is named so after the river Nida (Pilichowie 1985, Drzał 1988). It is build of Miocene marine sediments, mainly the calcareous sandstones, marls, silts and gypsum. The latter occurs here in form of peculiar cristalls 0.5 – 3.5 m long, sometimes called swallow's tail (Nowak 1986). The Miocene rocks form individual hills, ridges and belts, divided by depressions, now filled with Pleistocene and Holocene deposits. In the southwestern part of the region thick layers of loess deposits are found, in which sometimes older calcareous rocks are being exposed. In the gypsum rocks of Ponidzie classical surfacial and subterranean karstic forms have developed (Drzał 1988).

Nida, the main river of Ponidzie is a left hand tributary of the Vistula River. It is a typical lowland river, which may be 6 to 60 m wide. Because of its small depth the river often floods the valley. Except for a small regulated section near Pińczów the river has retained its natural character, with large bays and old river beds. In certain places, its course splits into several smaller branches, forming a kind of inland delta.

GEOLOGICAL LANDSCAPE SETTING

Calcareous rocks of older geological periods are the main source of deep ground water flows that discharge in springs. Numerous springs are found in Pińczów Upland, where sometimes small karstic ponds are present. Saline (sulphuric) springs occur in the surroundings of Busko Zdrój and Solec Zdrój. The climate of the region grades from west to east, while the temperature amplitude increases towards the east, signaling a gradual transition from Atlantic to Continental climate influence (Drzał, Kleczkowski 1988). In the middle of the Nida Basin yearly precipitation ranges between 500 – 600 mm (the maximum of 90 – 100 or even 160 mm in July). Average yearly temperature is ca. 8 °C, and the lenght of vegetation season is 214 days.
Due to suitable climatic and hydrologic conditions, as well as fertile soils Ponidzie has been under continuous human pressure since early Neolithic times. Most of the area is deforested, but its vegetation is quite interesting due to its long time (extensive) traditional land management. We find here well-developed xerothermic grasslands, meadows and halophytic vegetation.

FLORA AND FAUNA

In the xerothermic vegetation of Ponidzie a relic plant community, *Sisymbrio-Stipetum capillatae* is among the most interesting, associated with steppe vegetation of Pannonian Province. The list of communities includes *Koelerio-Festucetum sulcatae*, *Festucetum pallentis* as well as the *Thalictro-Salvietum, Adonido-Brachypodietum, Inuletum ensifoliae*, which are very rich in flowers and have developed on less dry and more eutrophic habitats. Other associations such as the *Seslerio-Scorzoneretum* and the *Carex flacca-Tetragonolobus maritimus* community are known only from Ponidzie. They are rich in rare plant species, such as *Arabis recta, Lathyrus pannonicus, Carlina onopordifolia, Cypripedium calceolus, Dorycnium germanicum, Dictamnus albus, Lathyrus latifolius, Linum hirsutum, Sisymbrium polymorphum, Reseda phyteum* and *Orchis purpurea*. It is worth mentioning, that some calcareous mires of the region have developed in close vicinity of xerothermic grasslands (Głazek, 1984).
Halophytic vegetation is associated with mineral-rich springs and occurs within the extensive meadows of the Nida valley. Examples of such halophytic vegetation are associations belonging to the *Cnidion dubii* alliance. They contain species such as *Allium angulosum, Cnidium dubium, Gratiola*

officinalis, Bupleurum tenuissimum, Atriplex hastatum and *Melilotus dentatus*.
Mire vegetation is found mainly in the central part of Ponidzie. The alkaline fens, in particular, are rich in rare and protected species, but other fen types occur as well. For Poland, the plant communities of the *Ctenidio molluscae-Seslerietum* and the *Schoentum ferruginei* are unique.
The forest vegetation of Ponidzie is mostly represented by a broadleaved forest community *Tilio-Carpinetum*. Other forest types include pinewoods and mixed forests as well as remnants of alluvial woods in river valleys.
In the Nda basin occur 14 out of 18 known Polish amphibians and 6 out of 9 reptiles (Juszczyk et al. 1988). Birds are represented by 197 species and mammals by 58 species (Čmak 1988).
Natural values of Ponidzie are being protected in a network of conservation areas. There are 3 Landscape Parks: (i) Kozubowski L.P. (6,643 ha and the buffer zone 11,333 ha); (ii) Nadnidziański L.P. (22, 875 ha and the buffer zone 17,559 ha); and (iii) Szaniecki L.P. (10,358 ha and the buffer zone 13,880 ha). Furthermore, there are 7 "habitat" Natura 2000 sites and 1 "bird" site, and 12 nature reserves and numerous other nature protection forms.

EXCURSION POINTS

Places where groundwater discharges at the soil surface are situated at the lower parts of hills at the valley flanks. Such places are usually small, ranging from a fraction of a hectare to few hectares. Usually there is only seepage without outflow, but sometimes real springs occur. The largest and most interesting sites in respect of flora are situated near villages Zwierzyniec, Sędowice, Bełk, Gartatowice and Borzykowo (Fig. 1).

Sędowice Mire

The area is situated at the border of two mesoregions: Jedzrzejów Upland and Wodzisław Ridge. Here in the valley of river Mierzawa a complex of extensive meadows and wetlands is well preserved. Some of the mires are calcareous fens (7230-2), supplied with deep groundwater originating from calcareous rocks (gaizes and cretaceous marls). One of the largest wetlands of this type is found near the village of Sędowice. It is mostly covered by *Phragmites australis* but within dense stands of reed there are sometimes relatively open areas where interesting mire species occur (Fig. 2). It is likely that these spots represent hydrologic windows where calcareous groundwater reaches the surface. Water levels are usually very close to the surface and do not drop much, except in very dry years.

Figure 2. Overview of Sędowice Mire

The mire has not been sufficiently studied yet. Preliminary observations suggest that the peat deposit is composed of moss-sedge-phragmites peat. The mire vegetation belongs to *Caricetum davallianae* association, but has also many species of the *Phragmitetea* class. The vegatation is three layered: shrub layer is formed by young individuals of *Alnus glutinosa* and *Betula pendula*; in the herb layer co-dominate *Phragmites comunis* and *Carex davalliana*, accompanied by *Carex panicea, C. rostrata, C. lepidocarpa, C.flacca, Menyanthes trifoliata, Succisa pratensis* a.o. Interesting species include: *Epipactis palustris, Liparis loeseli, Pinguicula vulgaris, Dactylorhiza majalis* and *Schoenoplectus tabernaemontani*.

The mire, meadows and the river Mierzwa (with *Ranunculion fluitantis* vegetation) are all part of the newly established Natura 2000 site "Dolina Mierzawy".

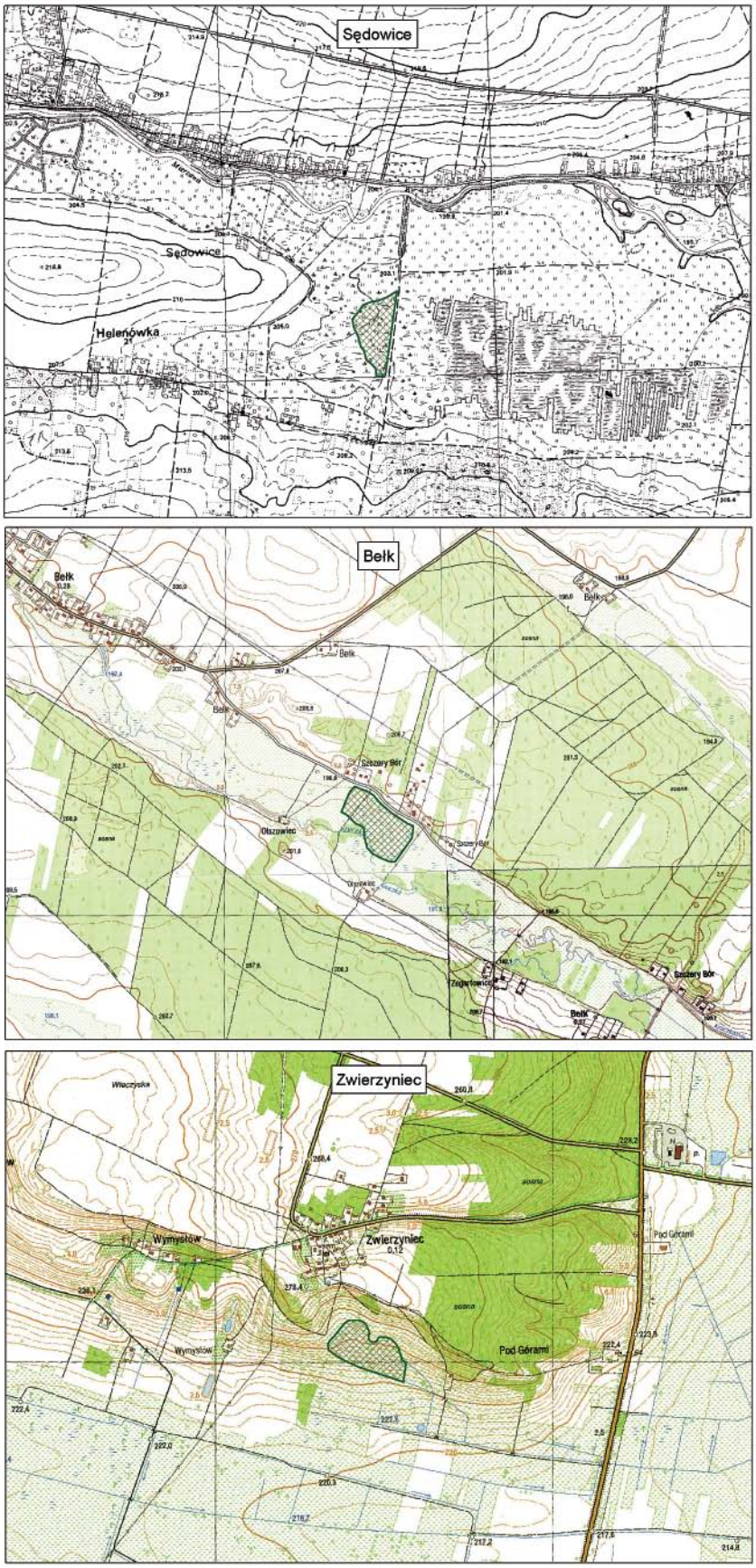

Figure 1. Maps of Sędowice, Bełk, and Zwierzyniec.

Bełk Mire

The mire is situated in the Suchedniów Upland mesoregion (Kondracki 2002), at the flank of the river valley Kruczka (Mierzawka), which is a small tributary of the River Nida. The valley lies in partly eroded cretaceous marls and is partly covered by quaternary sands. The mire is fed by alkaline ground water from calcareous rocks. The peat profile consists of moss-sedge peat with a large content of fine mineral particles and sandy layers, underlain with fluvial sands, in places with willow wood (Fig. 3).

Water levels are close to the surface. The vegetation consists of a dense moss layer. The syntaxonomic position of the present vegetation is not clear. Meadow species of both of *Arrhenatheretalia* and *Molinietalia alliances* are present together with *Scheuchzerio-Caricetea nigrae*, (mainly *Caricion davallianae*) elements. In small local depressions *Chara species* occur. *Phragmites australis* and *Schoenoplectus tabernaemontani* are dominating the vegetation (Fig. 4).

Figure 3. Photos of a 2.5 m. long peat profile from Bełk Mire

Figure 4. Vegetation of Bełk Mire dominated by *Phragmites australis* and *Schoenoplectus tabernaemontani*

Commonly occur: *Carex panicea, Eriophorum latifolium, Carex flacca, Parnasia palustris* and *Mentha verticillata*. Rare and protected species include: *Carex davalliana, Epipactis palustris, Dactylorhiza majalis, D. incarnata, Liparis loeseli, Pedicularis palustris*. The mire is situated close to the village, so it is very likely that these meadows are occasionally mown or even grazed. However, the encroachment of alder and willows appears to be spreading.

Zwierzyniec Mire

Situated between villages of Zwierzyniec and Mikułowice this area occupies the lower portion of the slope where seepage occurs. The steep slope above the wetland is covered by dry grassland communities of *Festuco-Brometea* class, once agriculturally used, with numerous xerothermic, calciphilous species. Meadows in the valley below the mire are covered with vegetation of *Arrhenatherion* alliance.

The peat profile of the sloping mire is composed of layers of reed-tall sedge peat interspaced with layers of mineral deluvial material (Fig. 5).

The profile taken in 2010, analyzed in field by prof. S. Żurek is as follows (the profile has been further analyzed and dated in the laboratory of the Botanical Institute PAS):

0 – 15 cm reed-tall sedge peat with silt
15 – 62 cm spring calcareous mud
62 – 82 cm sedge-reed peat with mollusks
82 – 100 cm dark brown mud
100 – 223 cm gray-brown spring mud
223 – 240 cm alder peat
240 – 278 cm sedge-moss peat
278 – 280 cm sand
280 – 290 cm moss peat
290 – 300 cm medium loose sand

The vegetation of the fen belongs to the *Caricion davallianae* alliance (code: 7230-2), and according to Matuszkiewicz (2007) should be classified as *Schoenus ferrugineus community* (Fig. 6).

Figure 5. Photos of a 3 m. long peat profile from Zwierzyniec Mire

Figure 6. Overview of Zwierzyniec Mire

Głazek (1989, 1992) originally described the plant association of this locality as *Lipario-schoenetum ferruginei*. In the present vegetation *Phragmites australis* is dominating. Species that also occur here are: *Schoenus ferrugineus, Carex davalliana, Epipactis palustris, Liparis loeselii, Eriophorum latifolium, Pinguicula vulgaris* subsp. *bicolor, Sesleria uliginosa* and *Molinia coerulea*. As in several similar sites a pronounced tendency for tree encroachment can be observed here, mostly consisting of *Alnus glutinosa* and several species of *Salix*. Wood remnant of alder and willows were also found at different depths in the peat profile (Fig. 4). This leads to the conclusion that the open character of the vegetation is the result of both edaphic and hydrologic conditions and the management practices (mowing and pasturing). At present, the fen is not used and undergoes succession towards shrub and forest. It forms a part of the Szaniecki Landscape Park and has been included in the "Szaniec – Solec" Natura 2000 site.

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TORFOWISKO SOBOWICE MIRE – refuge for extraordinary rare lepidopterans and vascular plants

Compiled by: Paweł Pawlikowski

Torfowisko Sobowice Nature Reserve (95.46 ha) (Fig. 1, 2) contains a fen with extremely rare plant and invertebrate species. The reserve was established in 2004 and in the framework of Natura 2000 an even larger area (175.4 ha) was later established under the same name to protect the unique natural values of the site. Locally the area is better known as “Zawadówka”.

Figure 1. Torfowisko Sobowice nature reserve – open sedge-moss communities and litter meadows (photo by Marek Czerwiński).

GEOLOGICAL LANDSCAPE SETTING

The fen is fed by calcareous groundwater, which originates from the Chełm Hills region. In this region Upper Cretaceous carbonate rocks (limestone, marl) are often exposed to the surface. A large spring cupola (ca 0.08 ha), consisting mainly of peat, arises in the central part of the fen (Fig. 3).

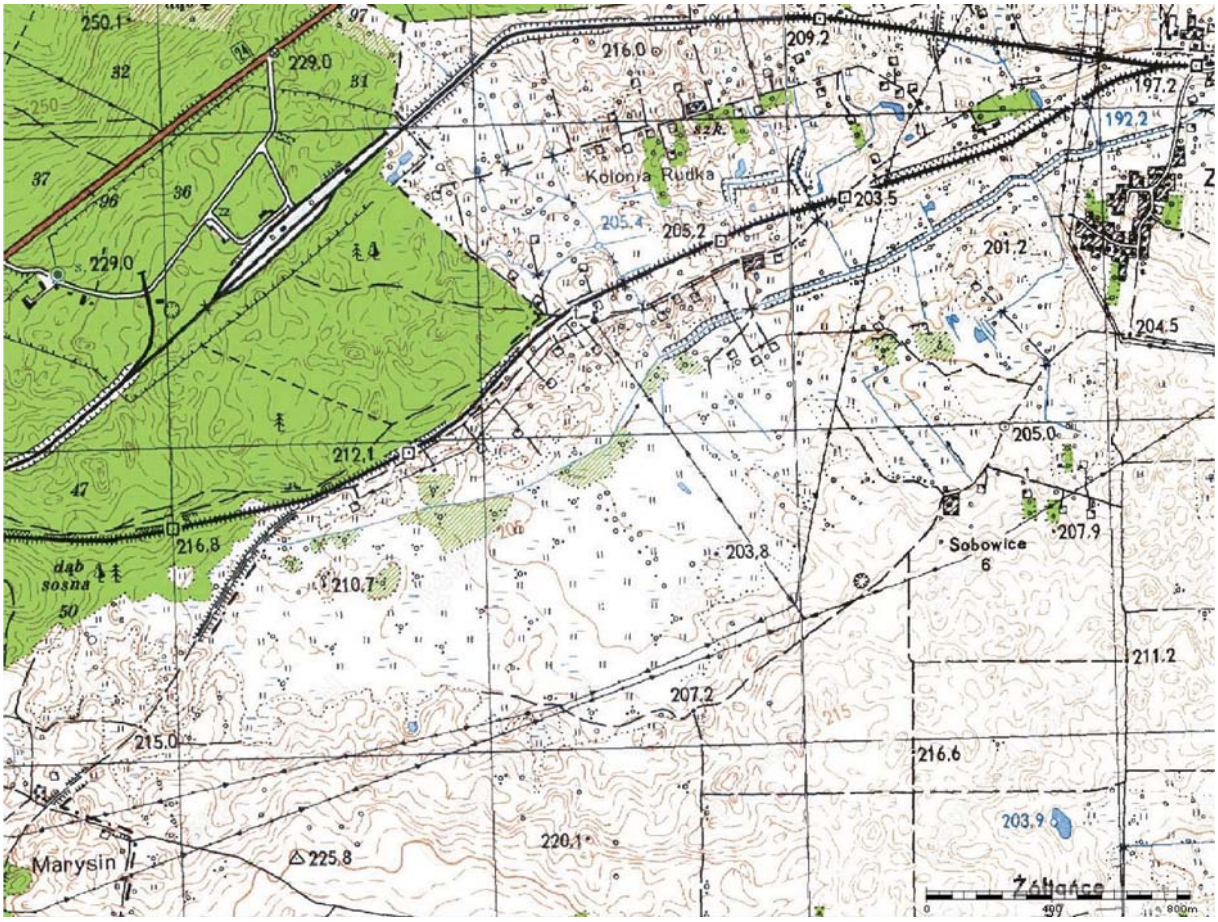

Figure 2. Location of the Bagno Sobowice mire (source: geoportal.gov.pl)

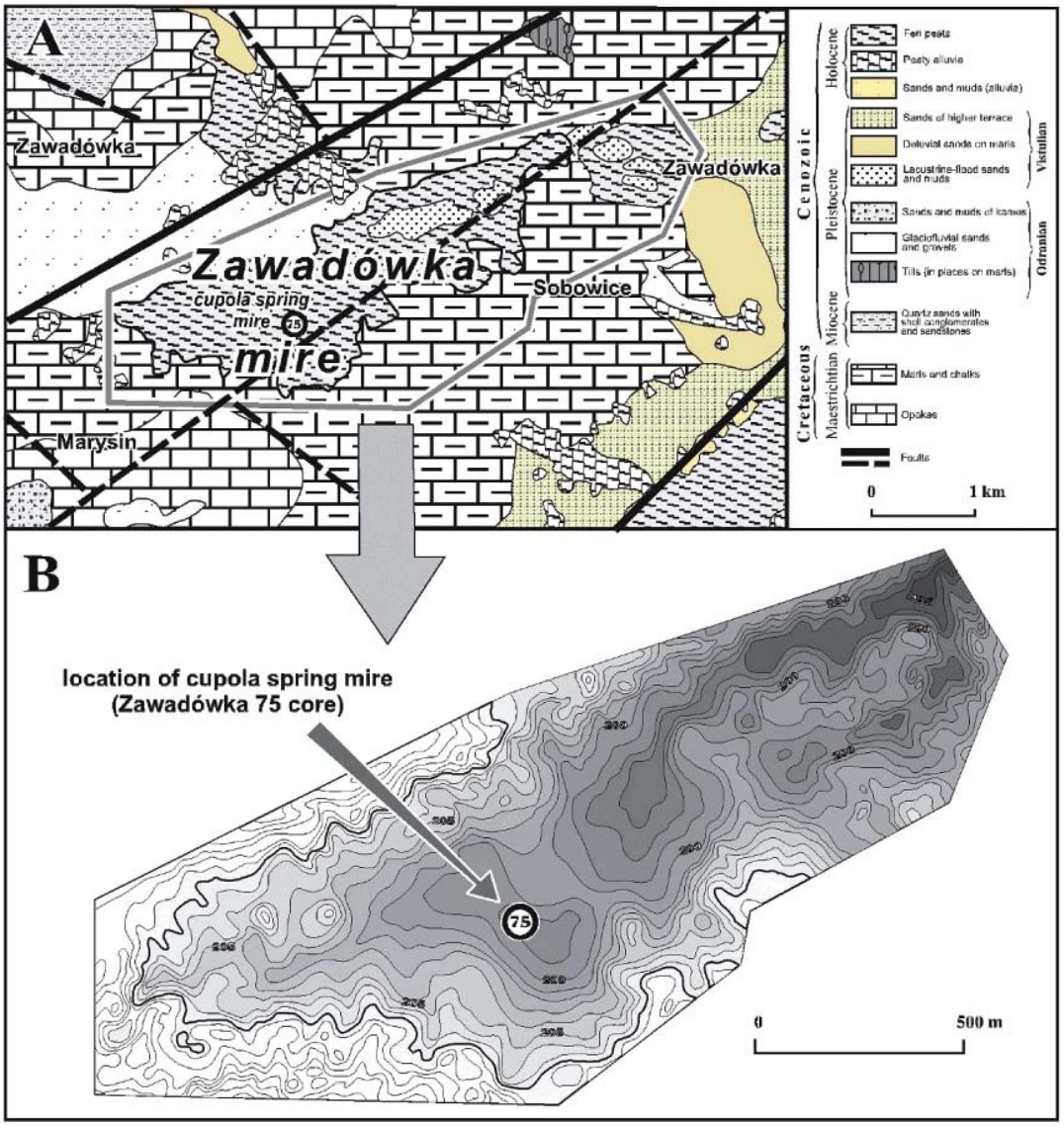

Figure 3. Geological structure of the Bagno Sobowice mire and adjacent areas: A – map of surface deposits; hypsometry of the mire depression (after Dobrowolski et al. 2005).

The stratigraphy and development of this peat cupola has been thoroughly studied by R. Dobrowolski and his collaborators (Dobrowolski 2000, Dobrowolski et al. 2005). Peat formation in the peat cupola started ca. 9900 years BP. Four main stages in the peat development can be distinguished:

1) 9900-6600 BP; 5.45-4.0 m: Start of peat formation. In the beginning the accumulation rates were slow (ca. 0.3 mm·yr.$^{-1}$). The peat was strongly decomposed and consisted of reed and sedge. Later also calcareous tufa was deposited with an equally low accumulation rate;
2) 6600-5000 BP; 4.0-3.13 m: This stage represents the main tufa deposition, although also strongly decomposed reed-sedge peat is found, which is probably related to increased spring activity. Mean accumulation rates of this peat/tufa stage are similar as in the former stage (0.3 mm·yr.$^{-1}$);
3) 5000-200 BP; 3.13-0.38 m: Stage of decreasing of spring discharge. The open fast flowing spring systems changed into almost stagnant spring systems with little flow of groundwater. As a consequence more reducing conditions developed, which stimulated peat formation. In this stage moderately to strongly decomposed reed-sedge peat was deposited with low amount of amorphous calcium carbonate. Mean accumulation rates in this stage were relatively high (c. 0.7 mm·yr.$^{-1}$);
4) the last 200 years, 0.38-0 m: re-activation of the spring system leading to very rapid reed peat formation with increased tufa content (ca. 1.85 mm·yr.$^{-1}$). This increased discharge of groundwater was most probably due to the deforestation in the catchment area.

HYDROLOGY

The spring cupola rises about 1.5 meters above the mire surface. A small spring (limnokren) is situated on the top of the cupola, and discharges groundwater with a flow rate of 1 litre per second. The Torfowisko Sobowice nature reserve is severely threatened by groundwater abstraction in the near vicinity. Groundwater is abstracted here for the production of drinking water for the large city of Chełm, which has almost 70 000 inhabitants and where numerous industrial facilities also use large amounts of water. Another threat for the reserve is on-going exploitation of an open-pit quarry where chalk is mined. These deep pits around the town drain the mires and this leads to increasing desiccation and larger groundwater fluctuations in the mire. During the summer ’2008 water levels in the sedge-moss fen dropped 30 to 60 centimetres below the surface.

FLORA AND FAUNA

The vegetation of the fen consists of small sedge-brown moss communities with *Schoenus ferrugineus* (Fig. 4), *Carex davalliana* and *Carex lasiocarpa* fens, as well as fen meadows (Fig. 5). Both sedge-moss and litter meadow communities host a variety of rare and threatened plant species, including three UE Habitat Directive species, such as the *Ligularia sibirica* (Fig. 6), *Liparis loeselii* and *Angelica palustris* (Fig. 7). Furthermore, a number of rare *Caricion davallianae* species occur in the fen (e.g. *Swertia perennis* ssp. *perennis*, *Carex buxbaumii, Epipactis palustris, Tofieldia calyculata, Ctenidium molluscum* and others, like *Betula humilis, Dianthus suberbus, Gentiana pneumonanthe, Gladiolus imbricatus* (fot. 8), *Iris sibirica* (fot. 9), *Veratrum lobelianum* (fot. 5), *Cirsium canum, Aconitum variegatum, Trollius europaeus* and *Phyteuma orbiculare*. Fen and meadow vegetation borders with xerothermic grasslands and oak forests on chalk substrate, with rare species like Iris aphylla and *Peucedanum alsaticum*. A total of nearly 450 vascular plant species have been recorded within the Torfowisko Sobowice Peatland and the adjacent area, four of them are on the Polish Red Data Book and 18 species are on other Polish Red lists.

Figure 4. Sedge-moss communities with *Schoenus ferrugineus* (photo by Paweł Pawlikowski)

Figure 5. Fen meadow with *Veratrum lobelianum* (photo by Paweł Pawlikowski)

The fen and fen meadows also hosts an extraordinary rich invertebrate fauna. Many of the species recorded here were known from only a few localities in Poland. Among the rare species are seven UE Habitat Directive lepidopterans: *Coenonympha oedippus*, Marsh Fritillary (*Euphydryas aurinia*), Scarce Large Blue (*Phengaris teleius*), Dusky Large Blue (*P. nausithous*) (Fig. 10), Violet Copper (*Lycaena helle*), Large Copper (*L. dispar*) and the moth *Xylomoia strix*. The latter was described as a new species in 1980. So far it is known from only a few localities in Europe (Finland, Latvia and Poland). At present the population in Torfowisko Sobowice nature reserve is the only one in Poland. Other rare butterflies include *Chariaspilates formosaria, Coenonympha tullia* and *Phengaris alcon*. The vertebrate fauna also has some noteworthy representatives, such as the European Pond Turtle *Emys orbicularis* and the Great Snipe *Gallinago media*.

Figure 6. *Ligularia sibirica* (photo by Wiktor Kotowski)

Figure 7. *Angelica palustris* (photo by Wiktor Kotowski)

Figure 8. *Gladiolus imbricatus* (photo: Paweł Pawlikowski)

Species	Polish Red Data Book category	Polish „red list" category
Angelica palustris	-	V
Betula humilis	EN	V
Carex buxbaumii	-	E
Carex davalliana	-	V
Dactylorhiza incarnata ssp. *ochroleuca*		
Dianthus superbus	-	V
Gentiana pneumonanthe	-	V
Epipactis palustris	-	V
Iris aphylla	VU	V
Iris sibirica	-	V
Ligularia sibirica	CR	E
Liparis loeselii	VU	E
Pedicularis palustris	-	V
Peucedanum alsaticum	-	V
Schoenus ferrugineus	-	E
Swertia perennis ssp. *perennis*	-	V
Tofieldia calyculata	-	V
Tomentypnum (Homalothecium) nitens		V
Utricularia intermedia	-	V

Table 1. Flora of the rare and threatened plant species of the Torfowisko Sobowice nature reserve

Figure 9. *Iris sibirica* (photo: Paweł Pawlikowski)

Figure 10. *Phengaris nausithous* (photo by Marcin Sielezniew).

MANAGEMENT

Moreover, lack of management (mowing) stimulated the succession towards shrubs (mainly willows), while intensive crop farming around the peatland caused eutrophication of the fen. During the last decade, active conservation measures have been applied. In the years 2007 – 2009 large-scale activities (shrubs removal on ca. 30 ha, mowing of ca. 50 ha – Fig. 11) were applied in the framework of a LIFE Nature project, carried out by the Wetland Conservation Centre and Regional Environmental Centre for Central and Eastern Europe, in co-operation with the Administration of the Chełm Landscape Parks. Most of the peatland area where the restoration measures have been carried out is state owned.

Figure 11. Torfowisko Sobowice nature reserve during the shrubs removal. (photo by Marek Czerwiński)

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EVALUATION OF IMCG PARTICIPANTS

The Sobowice Nature Reserve with well preserved fen and fen meadow vegetation has been recognised by IMCG participants as a very important European heritage. We were not able to visit the groundwater abstraction facilities, nor could we observe possible damage to the spring cupola. The participants discussed possible alternatives for drinking water abstraction that was competing for freshwater with the nature reserve. The opinion was expressed that if groundwater abstraction was carried out in the same aquifer that was feeding the mire system, it would end in severe threat to the fen and fen meadows. Such a situation would be in conflict with the aims and legislation of the Natura 2000 network. Responsible officials should stimulate the development of less damaging production techniques for the production of drinking water for the city of Chełm and also for industrial use of groundwater. Monitoring possible effects of groundwater abstraction would be an urgent first step in this process. A clear violation of Polish law was observed when we visited the border regions of the reserve. Here clear signs of pollution from adjacent agricultural fields led to visible eutrophication in the mire itself. In this situation protected ecosystems are no longer viable.

CALCAREOUS FENS NEAR CHEŁM:

Brzeźno, Bagno Serebryskie and Roskosz nature reserves – the last remaining large calcareous fens on chalk bedrock in Poland.

Compiled by: Paweł Pawlikowski

The Calcareous Fens of Chełm consist of three nature reserves: Bagno Serebryskie (established in the year 1991; 376.6 ha), Brzeźno (1973, 124.5 ha) and Roskosz (1990, 472.8 ha). They are all situated in the vicinity of the city of Chełm (Fig. 1). The calcareous fens are very species rich and have developed in depressions within the chalk bedrock. Two habitat and bird protection Natura 2000 sites ("Torfowiska Chełmskie" and "Chełmskie Torfowiska Węglanowe", respectively) and the Chełm Landscape Park were created to protect the area.

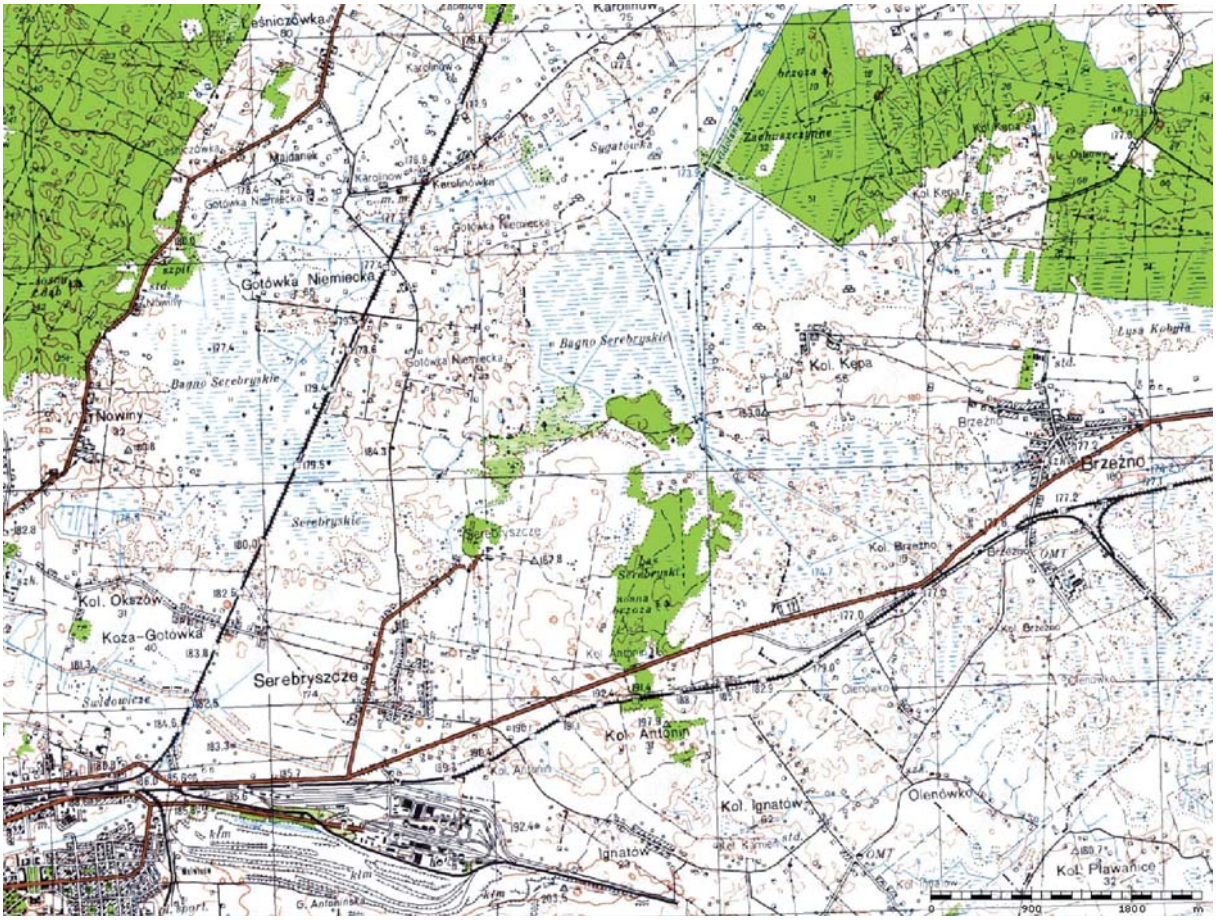

Figure 1. Location of the calcareous fens of Chełm (source: geoportal.gov.pl)

GEOLOGICAL LANDSCAPE SETTING

The calcareous fens are located in the Chełm Hills region, where Upper Cretaceous carbonate rocks (predominantly chalk) are surfacing. The fens are groundwater-fed and the peat is directly lying on the chalk bedrock (Fig. 2). Peat depth can be considerable, varying from 6-10 meters. Usually (calcareous) gyttjas occur within 1-4 meters of the lower part of the stratighaphical profile. They are covered by 1-2 meters of sedge, reed-sedge, reed or sedge-moss peat. Within the peatlands, a number of chalk islands occur, which have a xerothermic vegetation (Fig. 3).

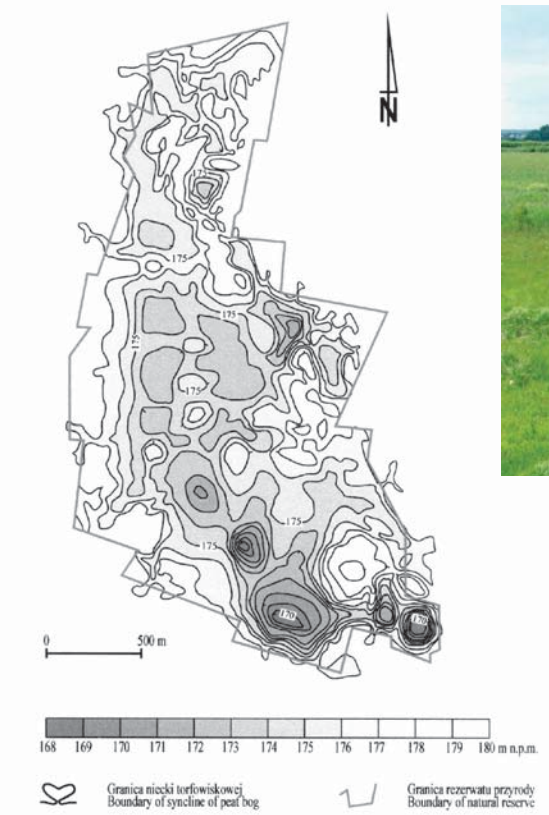

Figure 3. Mineral island with xerothermic vegetation (mainly *Brachypodium pinnatum*) bordering with a vast *Cladium* stand (photo by Marek Czerwiński)

Figure 2. Peat thickness in the Bagno Serebryskie mire (after Buczek 2005).

Figure 4. Calcareous fens in the Bagno Serebryskie nature reserve

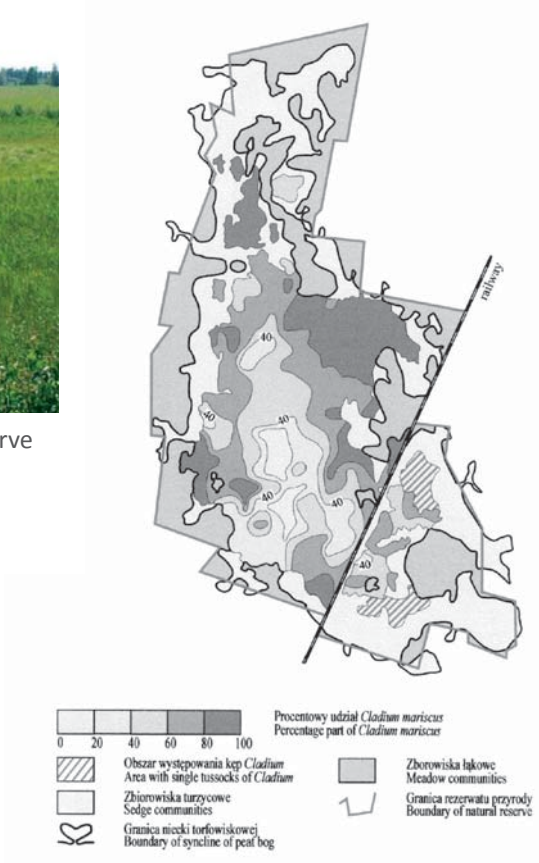

Figure 5. Vegetation map of the Bagno Serebryskie nature reserve and percentage cover of the *Cladium mariscus* within the area (after Buczek 2005)

MANAGEMENT

Calcareous fens used to be quite common in Chełm Hills region, but due to extensive land reclamation in the 60ties and 70ties of the last century, the area of mire vegetation decreased drastically. The three nature reserves now protect most of the remaining calcareous mire vegetation (Fig. 4). Outside the borders of the reserve hardly any mire vegetation is left, but drained peatlands are present. The fens and adjacent areas were once a part of a former state-owned collective farm (State Agricultural Farm). The fens were partially drained by ditches and mown. Adjacent areas were used for intensive crop farming. At present the fens that are still owned by the state,

have been abandoned, except for some fen meadows at the borders of the reserve. Unfortunately, large scale intensive crop farming in the surroundings still continues by private owners.

FLORA AND FAUNA

Just like the nearby Torfowisko Sobowice Nature Reserve, the hydrological conditions of the three nature areas here, are disturbed by open-pit chalk mining around the city of Chełm. It results in periodic desiccation of the fen and expansion of *Molinia caerulea*. In some areas *Phragmites australis* invades the species-rich meadows. The expansion of shrubs threatens both the fen meadows and the xerothermic graslands on the mineral islands and the margins of the fens. Regular burning of *Cladium* and *Phragmites* litter is also an important factor that affects the vegetation of the meadows. During the last decade conservation measures have been applied in some places in the framework of a LIFE Nature project on butterfly protection, which was mentioned before.

The *Cladium mariscum* now dominates in most of the mires (Fig. 5). This vegetation type has been extensively studied by A. Buczek. *Cladium mariscus* vegetation covers more than 670 hectares in the Roskosz, Bagno Serebryskie and Brzeźno reserves. Cladium vegetation includes both pure *Cladium* stands and various combinations with sedges, reed, *Molinia* and brown mosses. Moreover, *Carex elata, Carex appropinquata, Carex buxbaumii* and *Carex lasiocarpa* cover significant areas. On the margins of the fens, very species-rich small sedge- vegetation with *Carex davalliana* and *Schoenus ferrugineus* and *Molinia* fen meadows developed. Some very rare species occur here, such as a subspecies of *Pinguicula vulgaris* (ssp. *bicolor*), *Ophrys insectifera* (Fig. 6), *Ligularia sibirica, Pedicularis sceptrum-carolinum* (Fig. 7), *Gentianella uliginosa, Senecio macrophyllus* and a yellow form of *Dactylorhiza incarnata* (ssp. *ochroleuca*) (Fig. 8).

Especially the transition zones between small sedge communities, fen meadows and xerothermic grasslands on chalk (with *Inula ensifolia*) are very species rich, particularly with respect to orchid species (Fig. 9). In these transition zones a mixture of fen, meadow and dry grassland species can be found growing together. Five Polish Red Data Book vascular plants occur in the Brzeźno, Bagno Serebryskie and Roskosz reserves along with 24 species of vascular plants and mosses which are also on Polish Red Lists.

Figure 6. *Ophrys insectifera* (photo by Paweł Pawlikowski)

Figure 7. *Pedicularis sceptrum-carolinum* (photo by Marek Czerwiński)

Figure 8. *Dactylorhiza incarnata* spp. *ochroleuca* (Photo by Paweł Pawlikowski)

Figure 9. *Orchis militaris* (photo by Paweł Pawlikowski)

Species	Polish Red Data Book category	Polish „red list" category
Angelica palustris	-	V
Bryum neodamense		E
Carex buxbaumii	-	E
Carex davalliana	-	V
Carlina onopordifolia	-	V
Dactylorhiza incarnata ssp. *ochroleuca*	EN	-
Dactylorhiza maculata	-	V
Dianthus superbus	-	V
Gentiana pneumonanthe	-	V
Gentianella uliginosa	-	E
Epipactis palustris	-	V
Iris sibirica	-	V
Ligularia sibirica	CR	E
Ophioglossum vulgatun	-	V
Ophrys insectifera	VU	R
Orchis militaris	-	V
Pedicularis sceptrum-carolinum	-	E
Pedicularis palustris	-	V
Pinguicula vulgaris ssp. *bicolor*	CR	-
Ranunculus lingua	-	V
Scorpidium scorpioides		V
Senecio macrophyllus	VU	V
Swertia perennis ssp. *perennis*	-	V
Tofieldia calyculata	-	V
Utricularia intermedia	-	V
Utricularia minor	-	V

Table 1. Rare and threatened plant species of the Bagno Serebryskie, Brzeźno and Roskosz reserves in the Chełmskie Torfowiska Węglanowe area.

Large open fens and fen meadows of the Chełmskie Torfowiska Węglanowe area host a large number of rare animals. With respect to birds we can mention as the Aquatic Warbler (*Acrocephalus paludicola*), Great Snipe (*Gallinago media*), Short-eared Owl (*Asio flammeus*), Eurasian Bittern (*Botaurus stellaris*), Hen Harrier (*Circus cyaneus*), Montagu's Harrier (*C. pygargus*), Eurasian Curlew (*Numenius arquata*), Spotted Crake (*Porzana porzana*), Little Crake (*Porzana parva*) and Bluethroat (*Luscinia svecica*) are breeding there.

Other animal species include four UE Habitat Directive butterflies: Marsh Fritillary (*Euphydryas aurinia*) (Fig. 10), Scarce Large Blue (*Phengaris teleius*) (Fig. 11), Dusky Large Blue (*Phengaris nausithous*), Large Copper (*Lycaena dispar*) and European Pond Turtle (*Emys orbicularis*).

Figure 10. *Euphydryas aurinia* (photo by Marcin Sielezniew).

Figure 11. *Phengaris teleius* (photo by Marcin Sielezniew)

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LAKE MOSZNE – poor fens typical for the Polesie region

Compiled by: Lukasz Kozub

Lake Moszne and surrounding mires are the last remains of wetlands, which were once typical for the whole Polesie region. The mires of Lake Moszne were protected since 1974 as a nature reserve and since 1990 they are part of the Polesie National Park and recently they are also part of two Natura 2000 areas: the habitat area “Ostoja Poleska” (PLH060013, 10 159.1 ha) and the birdlife area “Polesie” (PLB060019, 18 030.9 ha).

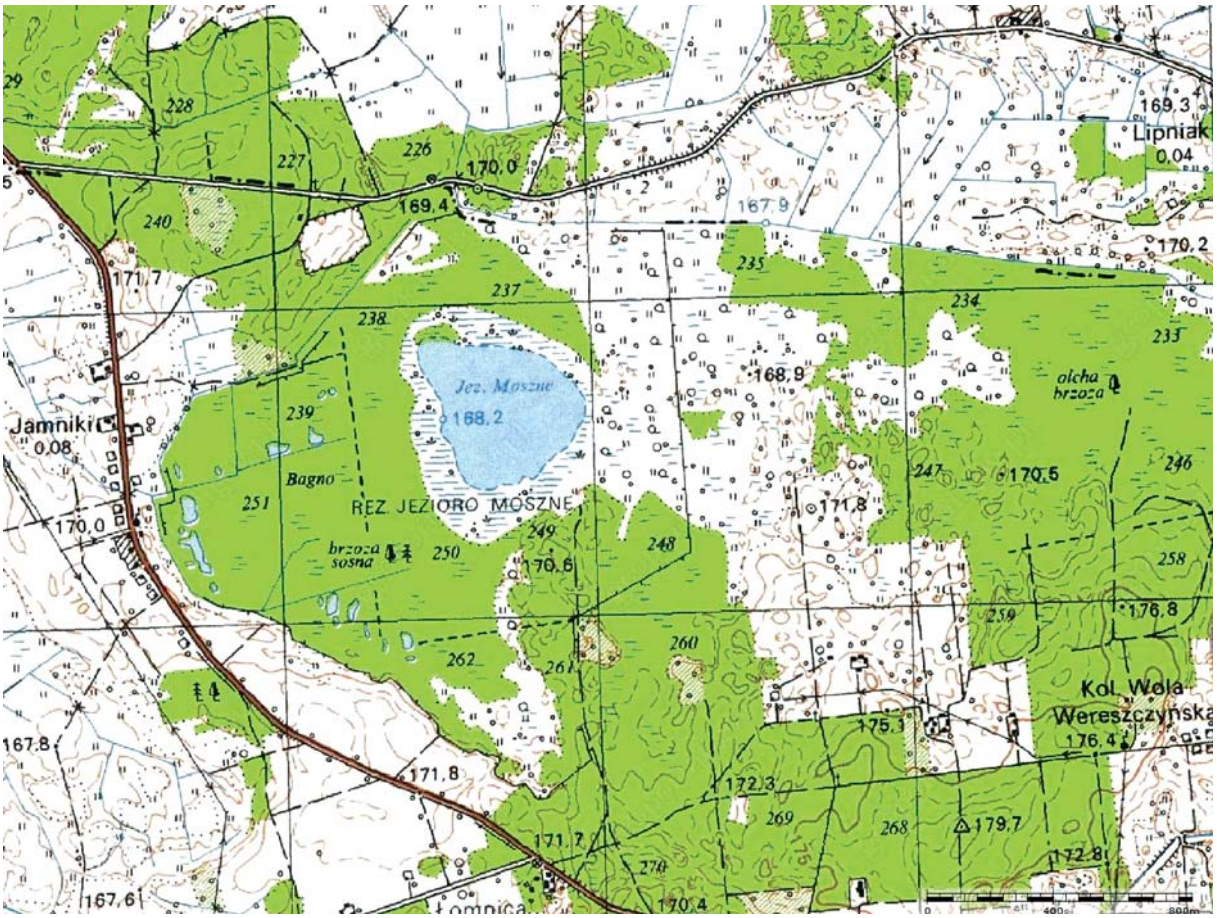

Figure 1. Map of Lake Moszne and surrounding mires. Source: www.geoportal.gov.pl

GEOLOGICAL LANDSCAPE SETTING

The lake itself covers 17 ha, and is just 1m deep. But the thickness of organic deposits under the lake may exceed 10m. The lake is surrounded by a belt of peatland underlain with lake deposits in the central part, which together with peat are between 1,5 to 6 m deep (Fig. 1). The whole Lake Moszne basin covers about two square kilometres of depression underlain with glacial till and filled with peat and lake sediments.

The origin of the lake is complex, and as in most of the lakes of Polesie, it is associated with karstic processes in limestone bedrock. The depression might have appeared after a collapse of a cave system before the glacial period. Then it was covered with glacial till with an impermeable layer which caused stagnation of water. The original lake was overgrown with a floating vegetation of the *Thelypteridi-Phragimitetum*, followed by sedge-moss communities with *Carex lasiocarpa* and brown mosses that today are hardly present. A poor fen with *Sphagnum mosses* and *Carex rostrata* developed instead (Fig.2.).

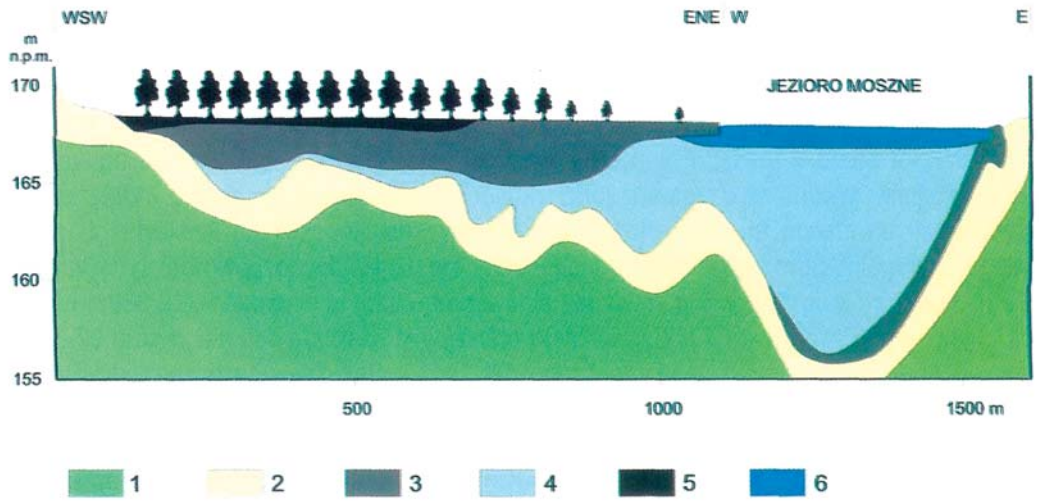

Figure 2. Cross-section of Lake Moszne mire complex. 1 – Cretatious limestone, 2 – glacial and fluvoglacial deposits, 3 – slightly degraded peat, 4 – lake deposits, 5 – degraded peat, 6 – water (from: Harasimiuk, 2009)

The system is still quite undisturbed but it suffered from a general drop in groundwater levels caused by the construction of the Wieprz-Krzna irrigation channel in the late 1950s. Some peat-cuts were dug in the margins of the mire before the Second World War, but now they are terrestrializing again.

HYDROLOGY

The surface water of Lake Moszne is characterised by a high pH (between 7 and 8) and has a relatively high electrical conductivity (200 µS/cm). The lakes harboured communities of the Characea class, with *Chara delicatula* in the mid 1990's. The surrounding mires are quite acid and are dominated by *Sphagnum mosses* and elements of bog vegetation.

FLORA AND FAUNA

The vegetation of the mire consists of various forest- mire communities forming ring-like structures around the lake. The outer belt is formed by pine – birch bog vegetation and alder forests. Close to the lake an open area of poor fen has developed, dominated by *Carex rostrata* and *Sphagnum fallax*. Some parts of these fens exhibita bog-like character with *Oxycoccus palustris, Drosera rotundifolia* and *Sphagnum cuspidatum, Sphagnum fallax* and *Sphagnum magellanicum*. The inner belt is in contact with calcareous lake water and consists of *Phragmitetea communities* (Fig. 3b).

A recent study of Sender (2008) showed that changes in plant communities seem to point to eutrophication of Lake Moszne. The disappearance of *Chara species* and expansion of *Myrophyllum spicatum* during the last decade are most probably the result of eutrophication, although Sender (2008) found that of the total phosphorous content in the lake water is still relatively low. Apart from eutrophication, the main threat for the mires around the lake is the expansion of trees towards the open mire vegetation.
Lake Moszne mire is also one of the places where *Salix myrtilloides* – a boreal relict, can be found. This small willow can be found within poor fen. Another relict willow species that occurs here is *Salix lapponum*. This species is associated with more minerotrophic conditions. Lake Moszne lies close to the south-western edge of the distribution of these species. Other rare species that occur in the reserve are *Betula humilis* and *Carex chordorrhiza*.

The Fauna of the lake and its surroundings contains many bird species. Worth mentioning are the occurrence of the Eurasian crane (*Grus grus*), and the Montagu's Harrier *Circus pygargus*. Another

worth mentioning animal species is European pond turtle *Emys orbicularis*, for which Polesie is its main refuge in Poland. This shy animal can be found in small eutrophic lakes and peat cuts, especially near sandy dunes. Another rare species associated with small shallow lakes and peat cuts is the Swamp Minnow (*Eupallaissella* (*Phoxinus*) *percnurus*). This fish species is widely distributed in Siberia, but is extremely rare in Poland. It reaches its south-western limit in Polesie.

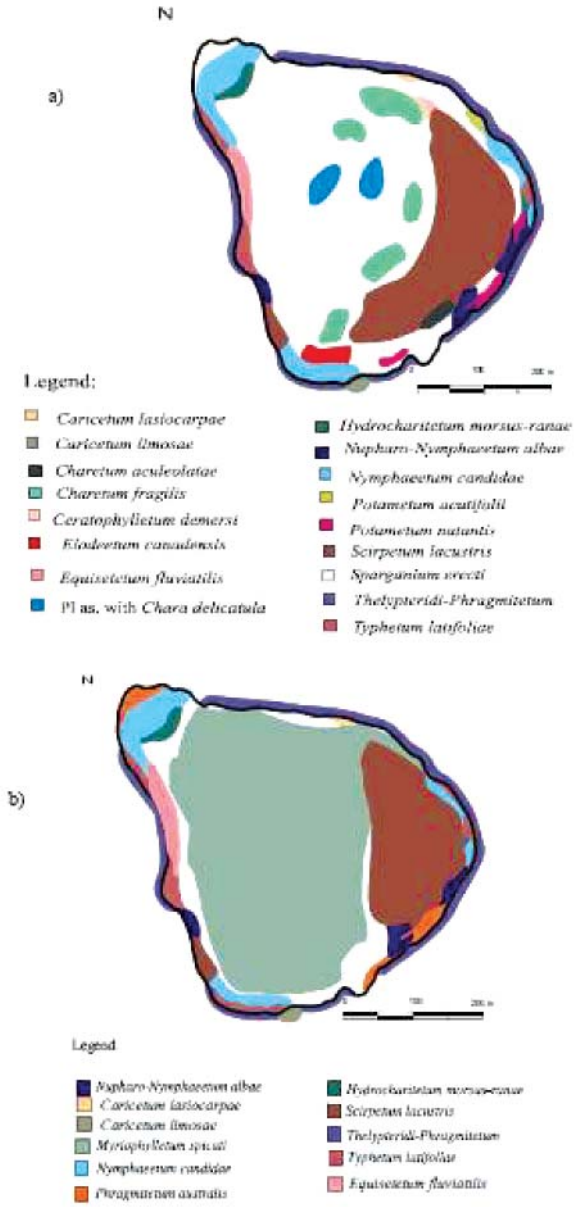

Figure 3. Changes in the vegetation of Lake Moszne between 1995 (fig 3a) and 2008 (Fig 3b; after: Sender, 2008).

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Standard Data Form of the Ostoja Poleska Natura 2000 habitat site.

Standard Data Form of the Polesie Natura 2000 birdlife site.

KROWIE BAGNO – the largest (drained) calcareous peatland in southern Poland

Compiled by: Lukasz Kozub

Krowie Bagno („Cow's Marsh") is the largest peatland complex in the Polish part of Polesie. It is situated east of the main complex of the Polesie National Park.
The whole Krowie Bagno (535.2 ha) is protected under the EU Birdlife Directive as bird life NATURA 2000 site "Krowie Bagno".

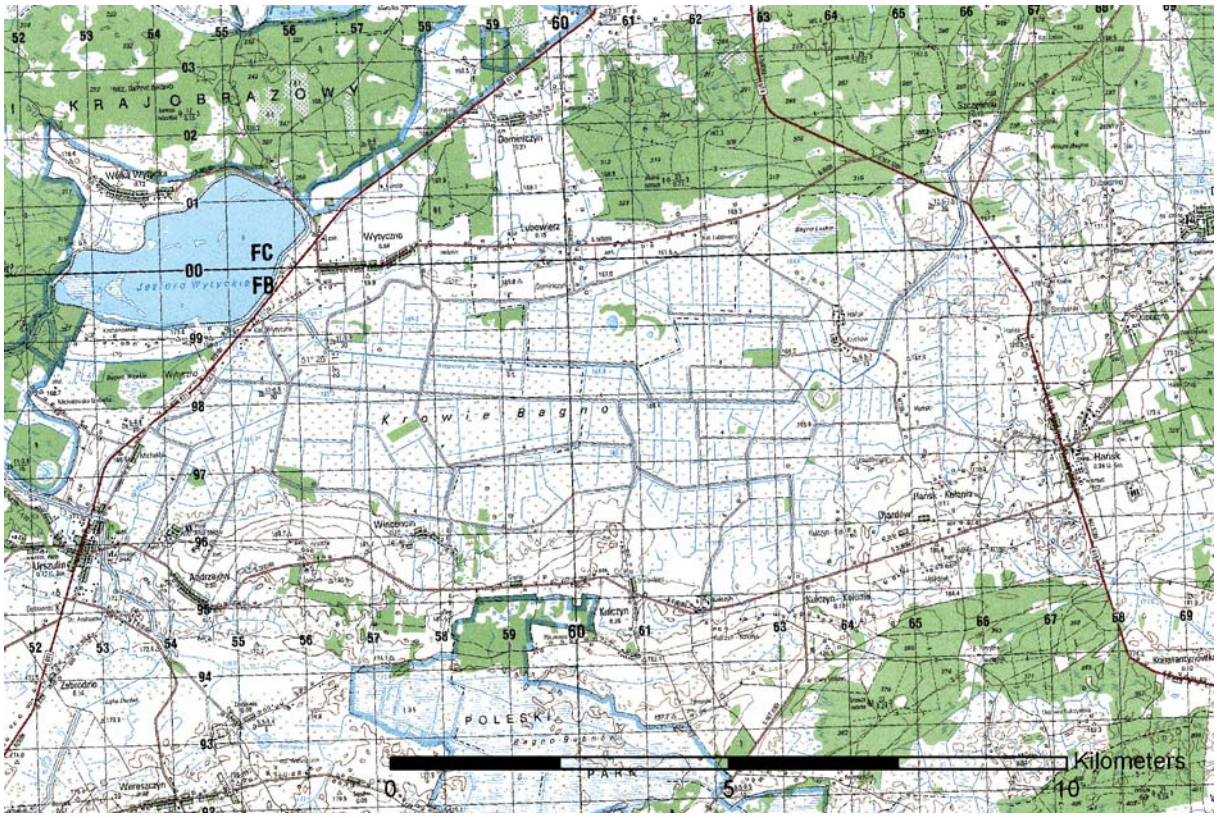

Figure 1. Map of the Krowie Bagno peatland

GEOLOGICAL LANDSCAPE SETTING

Peat deposits up to 5 m thick fill a large depression, which is 15 km long and more than 3 km wide (Fig. 1). The depression lies at the border between calcareous Cretaceous bedrock in the south and moraine till deposits in the north.

FLORA AND FAUNA

The flora of the wider Krowie Bagno area has been investigated since the late 19th century, which for this Polesie region is remarkably early. This floristic information combined with vegetation studies from 1950's enabled us to reconstruct the vegetation of Krowie Bagno before the land reclamation programme had been carried out. During the early 20th century the mires of Krowie Bagno consisted of a mosaic of different wetland habitats as well as four shallow lakes: Lubowież, Lubowieżek, Hańskie and Laskie. The southern border of the mire was flanked by with farmlands and calcareous grasslands on chalk bedrock. From these grasslands the following species have been reported: *Prunella grandiflora, Peucedanum cervaria, Inula salicina, Stachys recta, Brachypodium pinnatum, Vertrarum lobelianum*, and *Gentiana cruciata*. The main basin was a unique place of co-occurrence of nutrient-

Figure 2. *Betula humilis* in Krowie Bagno, phot. Paweł Pawlikowski.

poor rich-fen sedge-moss communities (with much *Betula humilis* and *Salix lapponum*) with patches of calcciphilous communities with *Cladium mariscus* and *Schoenus ferrugineus*. Also terrestrializing poor fens with *Sphagnum species, Carex lasiocarpa, Carex limosa* and *Carex diandra* added to the variation. The mineral islands within the mire as well as its edges were covered with species-rich *Eu-Molinion* litter meadows, in which *Gentiana pneumonanthe* and *Dianthus superbus* were present.

The mire complex and its surrounding meadows and calcareous grasslands was a real hot spot of biodiversity in the past, hosting many rare plant species. Some not mentioned above were: *Iris sibirica, Gladiolus imbricatus, Liparis loeseli* and *Swertia perennis*.

The effects of slight drainage became visible in the vegetation composition in the early 1960's. The peatland was then dominated by *Molinia* meadows with a high conservation value, where patches of fen communities were still present near the lakes and at the borders of the peatland (Fig. 3.)

The intensive land reclamation programme was carried out between 1970 and 1975. The mires were drained and both this drainage system and the lakes themselves were connected to the Włodawka river system. Before that time the mire did not have an outflow. The water level dropped up to 1,5 m. The dammed Wytyckie Lake should work as a reservoir of water for irrigation but it was rarely used. The drained peatland was turned into intensive grassland and sown with high productive grass species as *Festuca pratensis, Dactylis glomerata* and *Lolium perenne*. Although the whole area was intensely fertilised after the land reclamation, the

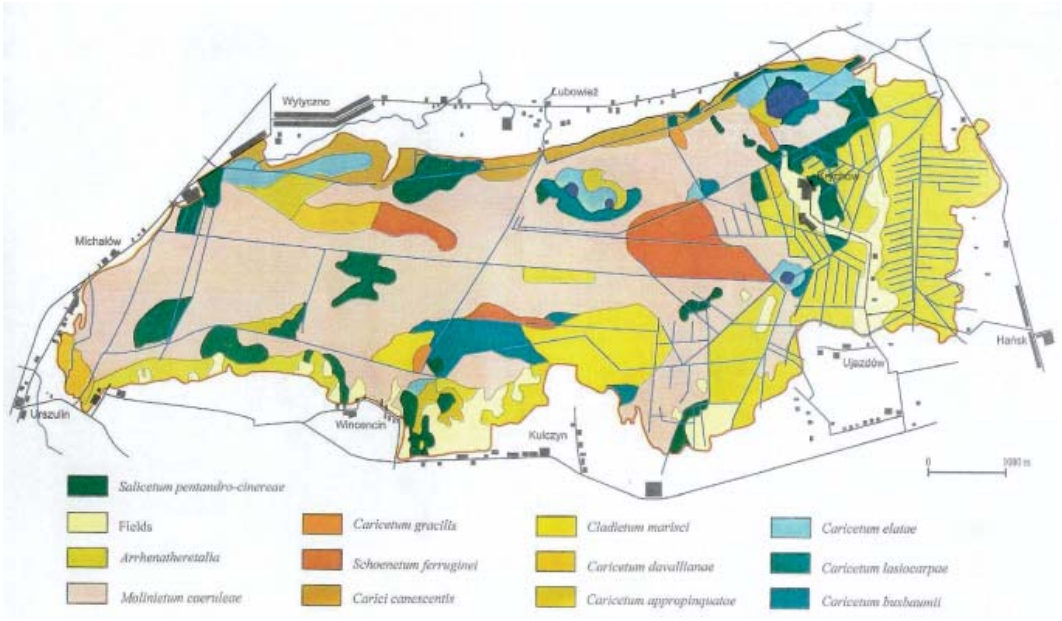

Figure 3. Vegetation map of Krowie Bagno made in 1967 (after: Buczek & Urban 2004).

productivity of the system collapsed quite soon due to mineralization of the peat and loss of organic matter. The sinking of the peatland surface led to increased inundation in some areas. Other dry and unproductive meadows were abandoned. During the late 1990's about 80% of the peatland was covered with species poor nitrophilous communities dominated by tall herbs and weeds, such as *Urtica dioica, Cirsium arvense, Calamagrostis epigeios* and *Cardaminopsis arenosa* (Fig. 4). Fiałkowski et al. (2000) showed that out of 174 rare and threatened species present in the mire before the land reclamation only 64 were found back at the end of the 20th century. Most of the remaining species were typical for grasslands on mineral soils and the surrounding peatland or they were typical species of poor fens overgrowing the lakes. Out of the 106 plant communities found in 1960's in the peatland and its vicinity only half had remained after forty years.

Remnants of natural and semi-natural vegetation survived mostly in the terrestrialisation mires along the lakes. Examples are: *Betula humilis, Carex limosa, Salix lapponum* and *Pedicularis septum-carolinum*. Also some remnants of *Molinion* litter meadows with *Gentiana pneumonanthe, Trollius europeus, Dianthus superbus* can be found within the peatland complex.

The fauna of Krowie Bagno is interesting mostly due to its bird life. The peatland is a place of nesting for the Montagu's Harrier (*Circus pygargus*), Corn Crake (*Crex crex*), and the Eurasian Crane (*Grus grus*). Also butterfly fauna that is associated with wet meadows and litter meadows is reach in species. Four of them are habitat directive species: the Large Copper (*Lycaena dispar*), the Large Blue *Phengaris* (prev. *Maculinea*) *teleius*), the Dusky Large Blue (*Maculinea nausithous*), amd the Marsh Fritillary (*Euphydryas aurinia*).

Today Krowie Bagno Peatland represents a very representative example of severely drained mires, with all negative effects of drainage on both flora and fauna and on the local economy. The land reclamation has had very negative consequences for land use perspectives as well. The abandoned grasslands of Krowie Bagno are a clear evidence of short-sighted policy of these 'land improvements'.

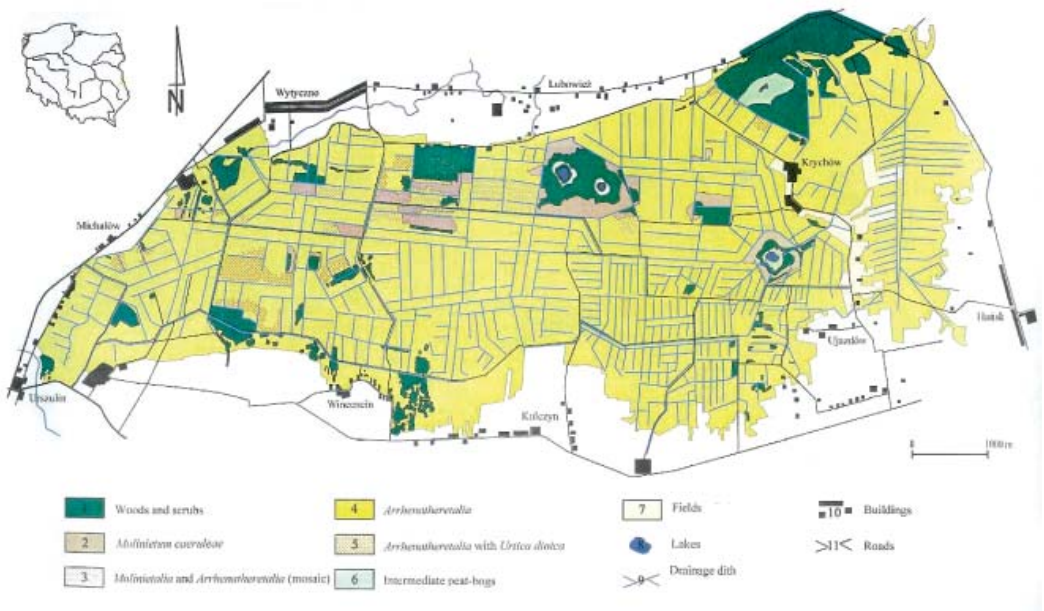

Figure 4. Vegetation map of Krowie Bagno made in 2003 (Buczek & Urban 2004).

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Standard Data Form of the Krowie Bagno Natura 2000 bird life site.

CAŁOWANIE PEATLAND
– feasibility of restoration in severely degraded fens.

Compiled by: Łukasz Kozub

Całowanie peatland (Torfowisko Całowanie) is one of the largest peatlands (ca. 3500 ha) of central Poland. It is situated at the eastern edge of the Vistula river valley just about 40 km southeast of the city centre of Warsaw. Its total length is about 15 km. The peat deposits form a wide belt of about 2 km along the marginal valley border. The site is protected under EU law under the habitat directive (NATURA 2000; "Bagno Całowanie", 3447.5 ha) as well as birdlife directive (Natura 2000; 4214.9 ha) and is included into the Mazowiecki Landscape Park.

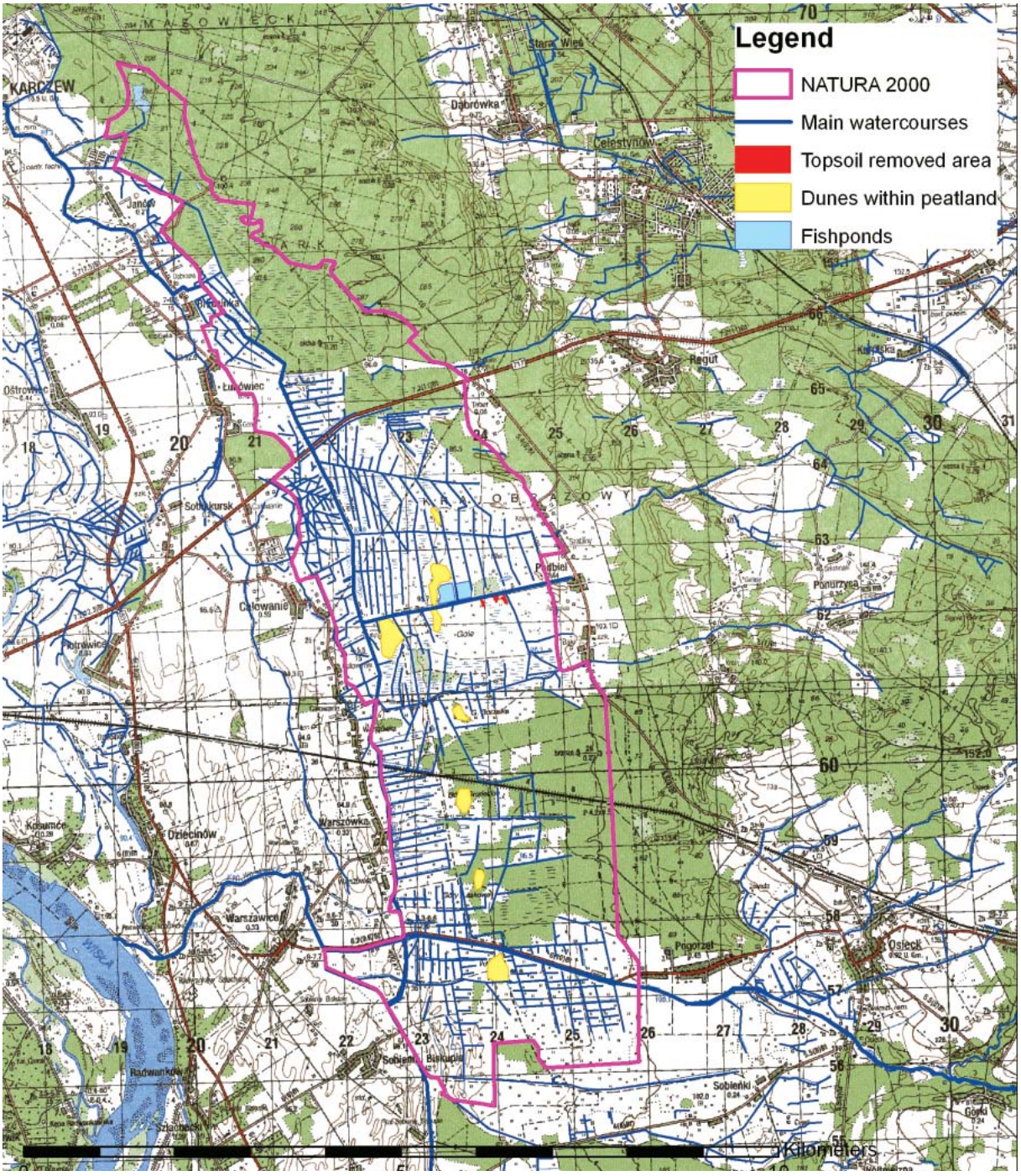

Figure 1. Map of the Krowie Bagno peatland

GEOLOGICAL LANDSCAPE SETTING

The mean peat thickness is 2 – 3 m, but in some places the peat thickness can be 6 m. Within the peatland some mineral islands occur, which originally were inland dunes from the early Dryas period. In a later stage most of these dunes were "overgrown" by peat. Such dunes may form a kind of "ridge" crossing the peatland in its central part from south to the north.

HYDROLOGY

Całowanie Peatland was originally a groundwater fed (soligenous) rich fen dominated by sedge-moss vegetation fed by iron- and calcium rich groundwater, which discharged under high pressure all along the slope of the valley. Most of the fen surface was covered with sedge-moss vegetation, while the northern parts were probably covered with swamp alder forests. The vegetation at the western side was under the influence of flood water from of the Jagodzianka River. It was dominated by tall sedge communities. Until 19th century the fen remained quite intact, although some parts were irregularly mown for litter. In the second half of 19th century the Jagodzianka River was straightened, and small streams were turned into ditches. Later the Warszowicki Channel was dug, which altered the hydrology of the mire considerably. The southern part of the Jagodzianka started to redirect the water in opposite direction causing a sort of water divide within the peatland. The original sedge-moss communities changes into fen meadows due to drainage and more intensive use of the fen. This was also the time of small-scale man-made peat cutting, which took place in the central part of the peatland. The shallow peat-cuts were quickly overgrown with sedge-moss vegetation and in a later stage they were mown again. Extensive areas of sedge-moss vegetation persisted near the village of Podbiel shortly after the Second World War.

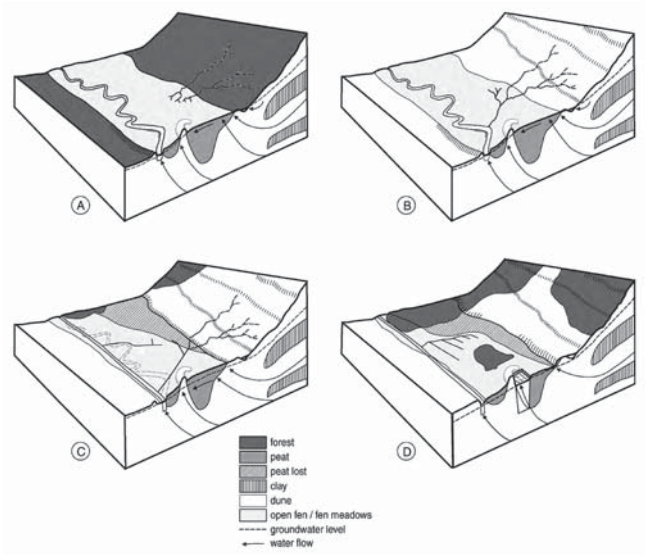

Figure 2. System changes of the Całowanie fen (scale not maintained): (A) natural situation of mire (<19th century), (B) semi-natural situation (c.1850), (C) semi-natural situation (c.1900), and (D) present situation (2004 – 2007) (From: Klimkowska et al. 2010).

FLORA AND FAUNA

Typical fen species of alkaline fens were found in that period. Examples are: *Pedicularis septum-carolinum, Liparis loeselii, Epipactis palustris, Carex dioica* and brown mosses, such as *Helodium blandowii* and *Tomenthypnum nitens*.
Intensive land reclamation projects started in the late 1950's and drained most of the original fen vegetation, changing it into nutrient-rich wet meadows with an aspect of *Polygonum bistorta*. After the 1950's all for-mentioned species of alkaline fens disappeared from the area. In the old peat-cuts where the moisture was more stable some fen species persisted if those places were mown.
The last phase of degradation of the fen took place in the 1990's. Socio-economical changes caused abandonment of most of the meadows, which resulted in secondary succession towards shrub and forest communities with low conservation values. At the same time illegal peat extraction increased which led to further drop of groundwater levels and to more severe degradation of the peat.

At present the vegetation of Całowanie consists mostly of moist to dry grassland communities that are species-poor and are dominated by *Festuca rubra, Holcus lanatus* or *Urtica dioica*. Untill recently

vast areas of peatland were overgrown by young alder and birch-alder forests with nitrophilous herbs in the herb layer. The northern part of the peatland is now covered with much more natural alder forests. (Fig. 3).

Only some meadows have remained that are still species-rich. They belong to the *Calthion palustris* alliance. Tall sedge communities still dominate the vegetation near the Jagodzianka River (now called Bielińskiego Channel). The last remnants of fen and fen-meadow vegetation can be found in old peat-cuts in the central part of the peatland. Locally, some litter meadows of the *Molinion* alliance are still present. Mineral dune islands within Całowanie are covered with species poor sandy grasslands of the *Corynerophorion* alliance but also with sandy grasslands of the *Koelerion* glaucae alliance, which is typical for calcareous habitats in which many rare species can occur.

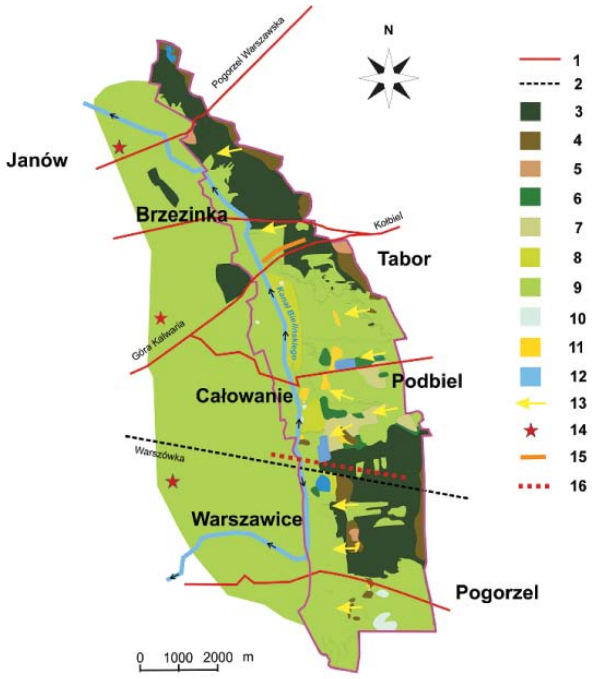

Figure 3. Habitats of Całowanie peatland, and it's hydrological features: 1 – roads, 2 – railways, 3 – alder forests, 4 – coniferous forests, 5 – oak-hornbeam forests, 6 – shrubs, 7 – sedge-moss fens, 8 – sedge reeds, 9 – meadows and pastures, 10 – litter meadows, 11 – dry grasslands, 12 – surface water, 13 – direction of groundwater flow, 14 – greenhouses d, 15 – damming effect of the road, 16 – border between drainage systems (from: Grootjans & Wołejko 2007).

Two types of habitats still hold valuable species in Całowanie Fen. One type consists of fen meadows with remnants of original sedge-moss communities in old peat-cuts (Fig. 4). Examples of such species are: *Betula humilis, Dactylorhiza incarnata, Eriophorum angustifolium*, and *Listera ovata* (Jabłońska & Pawlikowski 2004). The second type with many rare species consists of sandy grasslands and litter meadows. Typical species here are: *Succisia pratensis* (Fig. 5), *Pulsatilla pratensis* (Fig. 6)*, Ophioglossum vulgare, Gentiana pneumonanthe, Dianthus superbus, Iris sibirica, Polemonium caerelueum and Sanguisorba officinalis*. Valuable species are not restricted to these two habitat types. *Polygonum bistorta*, for instance, can locally occur abundantly in rather intensively used hay meadows. In some peat cuts and in the Jagodzianka River channel *Salvinia natans* is present.

The Całowanie Peatland owes much of its importance to its bird life. Eurasian Cranes (*Grus grus*) and Black Stork (*Ciconia nigra*), for instance, nest in the swampy alder forests, while nearly all villages host nests of the European White Stork *(Ciconia ciconia*). Old willows surrounded by meadows are home for the Hoopoe (*Upupa epops*) as well as Red-backed Shrike (*Lanius collurio*). Open wet habitats are nesting grounds for lapwing (*Vanellus vanellus*), which is present in relatively large numbers (about 50 males). Also Corn Crake (*Crex crex*) and common snipe *Gallinago gallinago* occur in such habitats. The most valuable bird species in Całowanie are Little Bittern

Figure 4. Vegetation with *Dactylorhiza incarnata* in an old peat-cut. Photo: Wiktor Kotowski.

(*Ixobrychus minutes*), Hen Harrier (*Circus cyaneus*), Montagu's Harrier (*Circus pygargus*), Spotted Crake (*Porzana porzana*), and Bluethroat (*Luscinia svecica*).

Wet and moist meadows in Całowanie Peatland are important habitats for invertebrates, especially butterflies which life cycle is connected to special plant species, which occur in Całowanie in abundance. Important host species for butterflies are, for instance, *Polygonym bistorta, Sanguisorba officinalis* and several species of litter meadows. Butterfly species that occur in Całowanie and are listed in the UE Habitat Directive are Violet Copper (*Lycaena helle*), Large Copper (*Lycaena dispar*) and Large Blue (*Phengaris* (prev. *Maculinea*) *teleius*).

MANAGEMENT

Całowanie Peatland is still suffering from illegal peat digging activities. The peat is sold as gardening soil or fertiliser for forest nurseries. During peat-digging the groundwater table is dropped and the peat cut area is connected to the agricultural drainage network. There is little doubt that the poor state of the meadows in the central part of peatland is caused by large-scale peat extraction in that area (Grootjans & Wołejko 2007).

Całowanie Peatland is one of the few areas in Poland different approaches in ecological restoration are being tested (Klimkowska 2008). In 2004 a project of experimental ecological restoration of fen meadows with topsoil removal was carried out in the central part of the peatland.

In 2006 Całowanie Fen was included a EU Life project on endangered butterfly species. The project ("Conservation and Upgrading of Habitats for Rare Butterflies of Wet, Semi-Natural Meadows") was coordinated by the Regional Environmental Centre (REC) and the Wetland Conservation Centre.

Figure 5. *Succisia pratensis*. Photo: Kamila Brzezińska/CMOK.

Figure 6. *Pulsatilla pratensis* in Kobyla Góra. Photo: Paulina Dzierża/CMOK.

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Standard Data Form of the Torfowisko Całowanie Natura 2000 habitat site.

Standard Data Form of the Torfowisko Całowanie Natura 2000 birdlife site.

BIEBRZA VALLEY – the largest semi-natural riverine fen system in Europe

Compiled by: Helena Bartoszuk & Wiktor Kotowski

The Biebrza Valley constitutes the largest system of relatively well-preserved riverine fens in Central Europe, with a well-preserved zonation of plant communities, bearing a marked influence of centuries of traditional agricultural management, and a high diversity of plant and animal species. Since 1993, almost the whole Biebrza valley, with the area of 106872.6 ha, is protected as Biebrza National Park (59223 ha) and its buffer zone (66 824 ha). It is also one of the largest Natura 2000 sites in Poland. In 1995 Biebrza National Park was inscribed in the RAMSAR list.

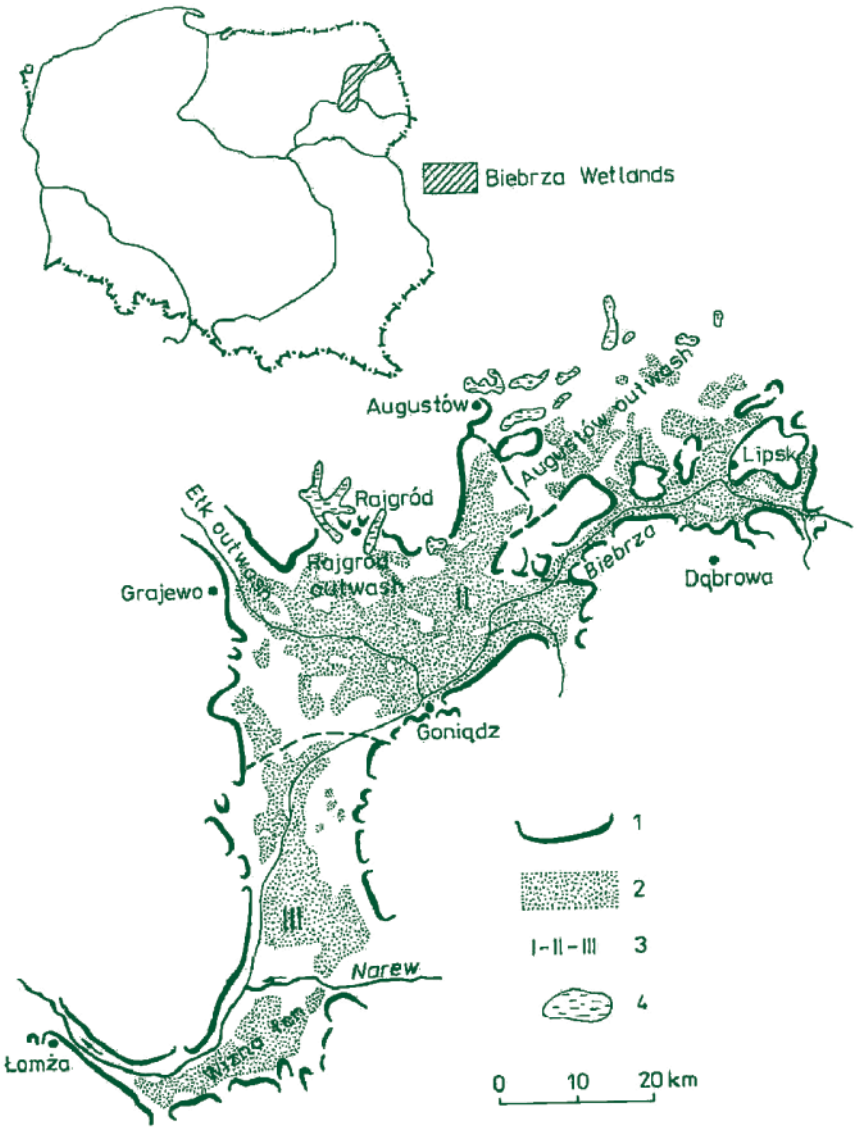

Figure 1. Site sketch of the Biebrza Valley. 1 – morainic plateau edge; 2 – wetland; 3 – basins; 4 – lake.

GEOLOGICAL LANDSCAPE SETTING

The Biebrza river is 156.5 km long, well-known for its meandering riverbed from the springs to the mouth. Its catchment area covers 7 062 km2. The Biebrza valley is from 1.5 up to 23 km wide and forms a broad, flat depression of a dozen to several tens meters below the surrounding uplands of morainic plateaux, filled with peat deposits of 1 to 6m thick. Characteristic features of the valley's relief are the so-called moraine outcrops in the upper its part, extensive sandy tracts transformed in many places by eolic processes to dunes partly submerged by peat. The valley, having only a slight gradient, is also supplied by groundwater flowing from the surrounding upland resulting in active peat-forming processes over a vast area. Numerous oxbows are situated in a 1 to 2 km wide alluvial zone along the river in the southern part of the valley.

Three basins

The valley is naturally subdivided into three distinct basins: upper, middle and lower. The basins differ with respect to geomorphology and preconditions of mire developments, resulting in dominance of different mire types, as well as with respect to human management history.

Upper basin – percolation fens

The upper (Northern) Basin of the Biebrza Valley is c. 40 km long and 1,5 – 3 km wide (Okruszko 1990). The flat and completely peat-covered valley bottom slopes down from about 130 m to 116 m a.s.l. The peat deposit is 3 to 6 m thick and in some places underlain by calcareous gyttja. The northern border of the valley is characterized by a series of morainic plateau islands formed in consequence of disintegration of the upland by glacial waters flowing from the north into the valley. In the north the valley joins without any distinct step with the rather flat sandy plain of the Augustów outwash. In the south the valley is delimited by erosive edges of the morainic plateau that the rises gradually from 125 – 135 to 160 or even 200 m a.s.l. (Żurek 1984).

Water feeding is stable here. Water loss from the surface run-off and evapotranspiration is constantly compensated by the groundwater inflow and precipitation. The Upper Basin is never flooded by the river. The catchments area is relatively small and the thick and loosely structured peat deposits absorb periodic water surpluses. Most of the peatlands in the Northern Basin are fed by calcareous groundwater coming from the moraines. This has led to development of mesotrophic soligenic fens, dominated by brown mosses and small sedges.

Middle Basin – litter meadows and poor fens as an effect of historical alterations in hydrology

The Middle Basin is a big trapeziform syncline 40 km long and 20 km wide (Żurek 1984). Its peat cover floor slopes down downstream from 115 to 109 m a.s.l. Peat deposits are less thick than in the Upper

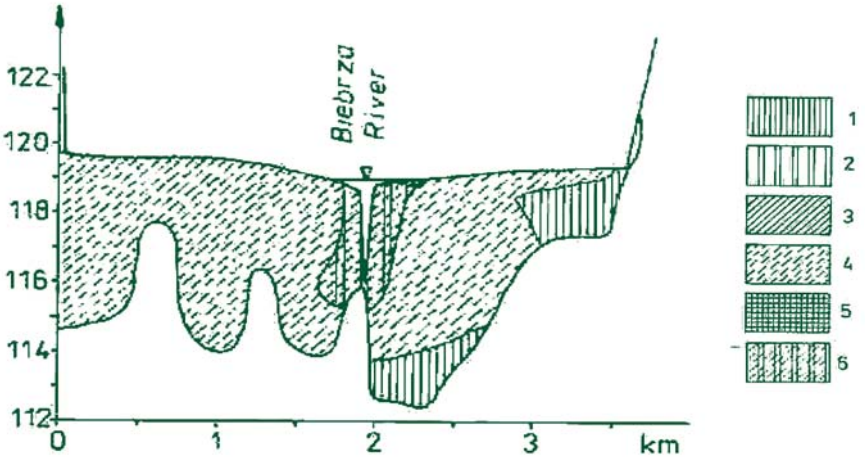

Figure 2. Cross section of the Biebrza Upper Basin near Suszalewo village. 1 – alder peat, 2 – reed peat, 3 – tall sedge peat, 4 – sedge-moss peat, 5 – gyttja, 6 – sedge-moss peat with read.

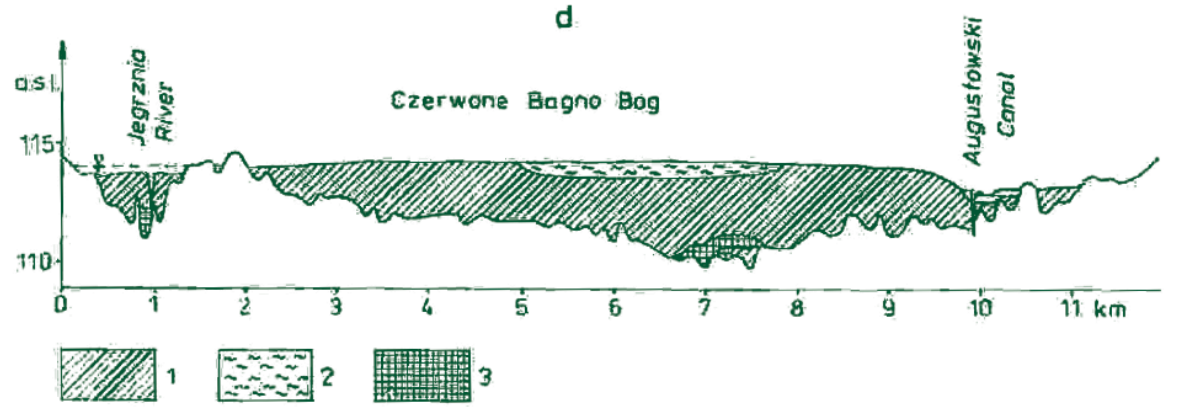

Figure 3. Schematic cross-section of the Red Bog mire in the Biebrza Middle Basin. 1 – sedge and sedge-moss peat; 2 – Sphagnum peat; 3 – gyttja.

Basin and form only 1 to 3 m thick beds. They are underlain by sands, with gravel series at the bottom of the northern part and silts and clays in the southern part. The valley contacts directly with the 10 to 14 m high slope of the morainic plateau in the east and southeast only. The plateau rises to 140 – 150 m a.s.l. The Middle Basin is distinguished by extensive sandy tracts transformed in many places by eolic processes to dunes partly submerged by peat.

The hydrology of the Middle basin has been considerably altered by the construction of drainage canals and ditches, which started in the 19th century. This has led to moderate drainage and cessation of peat-forming processes in the most of the basin, facilitating the meadow utilization by farmers.

Another interesting part of the Middle Basin is the Red Bog nature reserve. The Red Bog is one of the European oldest nature reserves, baring hardly any signs of direct human influence over the last 80 years. Over the last 3 years, a multidisciplinary research project has shed new light on the evolution and transformation of this mire. The peatland started to grow c. 10.000 years ago and for almost the entire time developed as a groundwater-fed rich fen to finally evolve into a forested poor fen with marked rain water feeding during the recent 300 – 400 years only. Dendrochronological and cartographical analyses excluded the hypothesis of an anthropogenic origin of the forest, suggesting rather its gradual increase since the early 17th century. However, an apparent layer of more degraded peat at shallow depths, overlain by recent *Sphagnum*-dominated peat, point at a significant impact of the regional hydrological alterations that occurred c. 200 years ago, which probably accelerated the process of acidification. The recent 50 years are characterized by quite distinct changes in vegetation and differentiated dynamics of the forest line. The area is a major refuge of the elk, which seems to have a large impact on vegetation character here, contributing to maintenance of large open vegetation patches and specific shrub communities with *Betula humilis*.

Lower Basin – large fens with well-preserved vegetation zonation

The Lower Basin is 30 km long and up to 12 – 15 km wide (Żurek 1984). The valley floor slopes down from 109 to 102,5 m a.s.l. at the confluence with the Narew. The peat is usually not more than 2 m thick and is underlain by thick sandy-gravel beds locally covered by loam and silt deposits. Small dunes form several meters high islands, submerged in the peat of the surrounding flat floodplain. Numerous oxbows are situated in a 1 to 2 km wide muddy zone along the river. The Lower Basin is separated from the downstream Wizna Basin by a fluvial cone stretching out along and deposited by the Narew River. To the west and east the valley is bordered by morainic plateaux. The plateau surface gradually rises to 135 – 160 m a.s.l. further from its edge (Wassen et al 1992).

In the Lower basin water resources are replenished from a vast area. The basin itself forms a reservoir closely dependent on the Biebrza, receiving discharges of its flood water (Byczkowski & Kiciński 1984). The floodplains are calcareous which is partly caused by flooding with calcium-rich river water but also partly by exchange of calcium from sedimentary loam (Wassen et al 1992, 1996). The rich fens along the moraines are in the Southern basin fed by upward flowing groundwater, just as in the Northern basin.

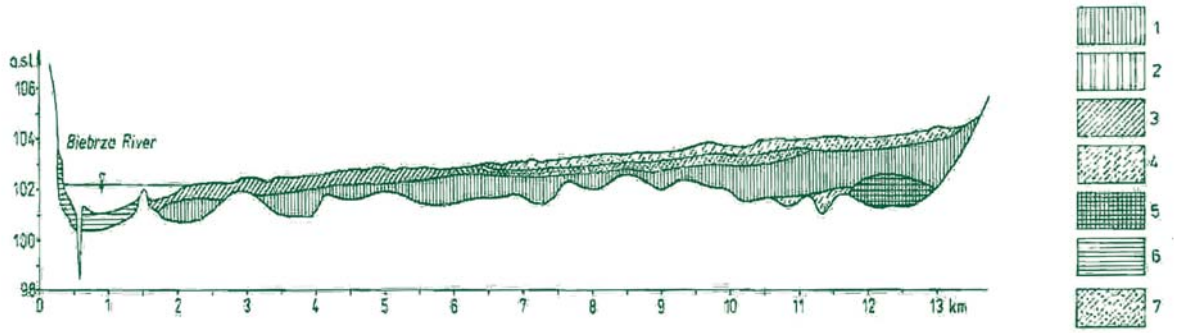

Figure 4. Cross-section of the Biebrza Lower Basin. 1 – alder peat; 2 – reed peat; 3 – tall sedge peat; 4 – sedge-moss peat; 5 – gyttja; 6 – mudd; 7 – mossy tall sedge peat.

FLORA AND FAUNA

The Biebrza valley has retained a typical pattern of vegetation zonation. Moving from the river channel outwards towards the valley margin the zones of vegetation are as follows: reed swamp communities, flooded continuously for the larger part of the year, featuring both the peat forming and silting processes; tall-sedge communities associated with annual flooding of several months' duration; sporadically flooded tall sedge-moss communities with prolonged water logging by phreatic groundwater; sedge-moss communities lying beyond the flooded zone; alder swamp or swampy spruce communities growing at the edge of the valley at locations with discharging groundwater. The transverse zonation is particularly well-defined in the southern part of the valley.

As a result of a diverse geomorphology (occurrence of upland elevations and mid-wetland sand dunes), differentiated water conditions and extensive management, the area shows a high diversity of plant communities: c. 30 forest communities and 40 peatland and meadow communities have been distinguished. Many plant communities occurring in Biebrza valley are listed on the *Annex I of the Habitat Directive*, e.g. alkaline fens (about 4360 ha, in this 2700 ha of *Caricetum diandrae*, 490 ha of *C. lasiocarpae*), *Molinion meadows* (c. 6120 ha), swamp forests of area 7490 ha or bog woodlands (*Sphagno girgensohnii-Piceetum* (70 ha), *Vaccinio uliginosi-Pinetum* (130 ha) etc.)).

In the Biebrza valley 921 species of vascular plants have been registered, including 10 listed in the Polish Red Book Data and 45 listed on the Red List of Threatened Plants in Poland. 5 species of vascular plants and one moss species are listed on the *Annex II of the Habitat Directive: Cypripedium calceolus, Liparis loeselii, Saxifraga hirculus, Pulsatilla patens, Thesium ebracteatum* and *Drepanocladus vernicosus*. Forests and sedge-moss communities include also a large diversity of moss species.

The Biebrza valley is a refuge for rich and varied wildlife, both resident and migrant. So far 271 bird (180 breeders), 48 mammal, 5 reptile, 12 amphibian, 36 fish, over 750 species of moths and butterflies, 500 species of battles, 450 spider species, 42 species of caddis-fly and 19 of leeches have been registered here. The long list of nesting birds includes such rare species as the aquatic warbler (having 75% of EU population in the Biebrza Valley), black grouse, black stork, corncrake, great snipe, white winged black tern and many more. Moreover Biebrza valley plays an outstanding role as feeding ground and stopover for migratory birds, especially during the spring migration. From the point of view of number of migrating flocks and diversity of bird species the Biebrza stands out among other Polish river valley. Biebrza wetlands also are an important breeding habitat in Europe for birds of prey like: *Aquila clanga, A. pomarina, Cyrcus pygargus, Haliaeetus albicilla*. 79 bird species that have been registered in Biebrza valley are on the *Annex I of the Bird Directive*.

None of 48 mammal species found in Biebrza valley are considered to be endangered. Elk (*Alces alces*), survived the war here and being protected spread its population almost in entire Poland. The population of the elk in the Biebrza valley account about 500 individuals. 12 wolf individuals and c.1000 individuals of beaver have been registered. Among species mentioned on the *Annex II of the Habitat Directive* 6 mammal species: *Barbastella barbastellus, Myosotis dasycneme, M. myosotis, Castor fiber, Lutra lutra, Lynx lynx*; 1 reptile species – *Lacerta agilis*, 2 amphibian species: *Bombina bombina, Triturus cristatus occur* in Biebrza valley, 7 fish species: *Cobitis taenia, Misgurnis fossilis, Aspius aspius, Salmo salar, Phoxinellus phoximus, Rhodeus sericeus, Cottus gobio* and *Eudontomyzon mariae* live in Biebrza river.

Upper basin

Near Lipsk, one can find such rare plant species as *Liparis loeseli, Saxifraga hirculus, Carex dioica, Baeothryon* (*Trichoforum*) *alpinum*. After abandonment of mowing, birch encroachment has been a major problem for maintaining the plant diversity here. In 2009, a significant part of the area has been cleared from shrubs by the national park in co-operation with a local NGO.
In the central part of the fen, on top of sedge-moss peat one can observe the process of gradual acidification (formation of rain water 'lenses'), with communities dominated by *Betula humilis* and *Pinus sylvestris* in the older stages.

Middle Basin – litter meadows and poor fens

Particularly interesting are the extensive meadows near the village of Woznawies, with vegetation related to the *Molinion* and *Cnidion* alliances. Late summer mowing without fertilizer application is still regularly applied here, contributing to the maintenance of unique combination of species, with high frequency of *Carex buxbaumii, C. lepidocarpa* and *C. panicea, Viola stagnina, Succisella inflexa, Cnidium dubium, Gentiana pneumonante, Iris sibirica*. Fertilization experiments carried out here, have revealed phosphorous-potassium co-limitation here, developed over 200 years of mowing in moderately drained conditions.

Lower Basin – large fens with well-preserved vegetation zonation

The largest mire complex of the lower basin is the so-called Lawki mire, developed in an 11 km – wide section of the valley. Ławki Fen belongs to the soligenous-topogenous type. Peat deposits are up to 2.5 m, but on average c. 1m deep, mainly of sedge-moss origin, underlain by tall-sedge and reed peat. The width of the fen zone, from the valley's margin to the Biebrza floodplain is c. 5 km. Most of the area has been mown until the 1950s – 1970s. No large-scale changes of the habitat occurred here. However, in historical times, shallow drainage ditches were built in the mires, to enhance hay production. This might have caused a relatively high degree of peat decomposition in the upper layer. The ditches are now mostly overgrown with vegetation and their draining role diminished. Plant communities of the sedge-moss zone are more productive compared to those in the Upper Basin, brown mosses and small sedges (*Carex diandra, C. lasiocarpa, C. flava*) are commonly accompanied by tall sedges *Carex elata* and *C. appropinquata*, which are gradually becoming dominant in many places due to abandonment of mowing. Also reed and birch encroachment have been considered as main threats to biodiversity here.

MANAGEMENT

Biebrza National Park owns its unique values to the natural character of the Biebrza River and extensive management of the valley for hay-making in the past. 42% of the park area is private property, in this above 37% - meadows, pastures and waste land (low classified meadows). During last decades agricultural use of Biebrza valley has been decreasing and recently is limited to the area where machinery can be used.
One of the main threats to Biebrza National Park nature values is the plant succession, caused mostly by the abandonment of its wetlands. About 15 000 ha is threatened by willow, birch and reed encroachment. According to the Draft Management Plan for BNP there is area of 30 444 ha that should be mowed and area of 8000 ha that bushes should be removed. A few projects are undertaken to restrain plant succession in BNP. They have covered area of about 2 500 ha until now. One of these areas where mowing has started again is the large Lawki mire in the lower basin, initially by the Park team and recently also by the Polish Bird Conservation Society (OTOP) and individual farmers receiving biodiversity-targeted agri-environmental subsidies.

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SIDRA SPRING FEN

Compiled by: Paweł Pawlikowski

The Sidra spring fen, situated in the upper basin of the Biebrza catchment, near the village of Makowlany, is considered to be the highest known spring fen cupola in Poland (Bitner, 1959, 1961). The cupola consists mainly of travertine (calcium carbonate) and reaches ca. 10 meters above the valley bottom (Fig. 1). The spring mire complex is relatively small and covers ca. 4 hectares. It is situated in morphologically diversified landscape with some young glacial features. It has developed at the margin of small river valley of the Makowlanka river, which is a tributary of the Sidra River. The cupola hill is a very prominent feature in the local landscape. The thickness of spring fen deposits exceeds 7 meters, including calcium carbonate-rich peat near the surface and more than 4 meters of pure travertine below. The water discharging in the spring system is rich in calcium, magnesium and iron.

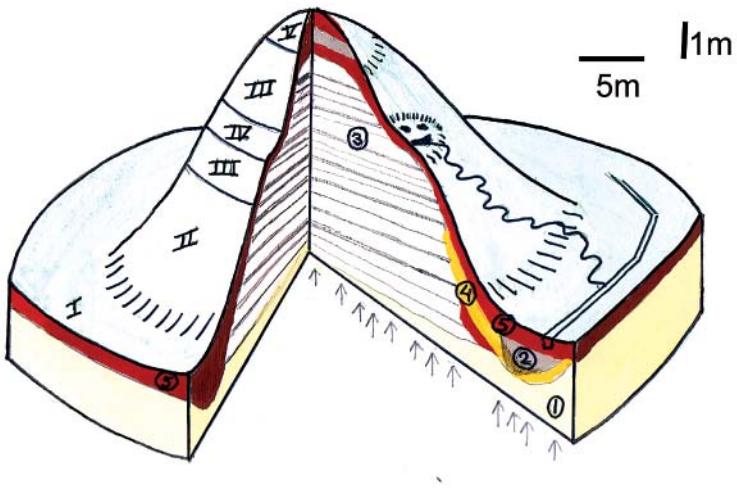

Figure 1. Spring cupula of Sidra showing banded deposition of travertine ($CaCO_3$) and peat. The travertine hill is covered by a thin layer of peat, which is degraded at the top of the hill due to escape of groundwater discharge tolower areas. 1 = sand, 2 = sedge peat, 3 = travertine with peat banding, 4 = brown moss peat, 5 = decomposed peat. The arrows indicate the position of the peat corings.

The vegetation of the cupola forms four main zones. On top a small forest of *Alnus glutinosa* is present (zone V), which has established itself probably during the 1960ties of the last century, when regional hydrological changes after intensive drainage activities prevented the groundwater to discharge at the top any longer. The second vegetation zone consists mainly of *Phragmites australis*, and it grows on the upper, steep slopes of the hill (zone III). The lower part of the slope is covered by a species-rich brown moss-sedge vegetation (zone II), which is surely a real fen vegetation. *Carex rostrata* is the most prominent species. It is accompanied by *Equisetum fluviatile, Festuca rubra* and *Typha latifolia*. Mosses that dominate the vegetation are *Tomentypnum* (*Homalothecium*) nitens and *Aulacomnium palustre*. In the past the very rare *Liparis loeselii* occurred here, but it has not been found recently. Possibly the species is still present. Other rare species present in this vegetation zone are *Epipactis palustris*, *Parnassia palustris, Carex dioica* and *Helodium blandowii*. The last zone (zone I) consists of the managed fen meadow with a nice aspect of *Cirsium rivulare*. This meadow is surrounding the hill and stretches out at the lower reaches of the system. Zone IV in figure 1 is part of the Phragmites zone, but here spring water is flowing out of the system. It is very wet and the vegetation is almost floating on the water.

The spring area is private-owned and has not been legally protected until very recently, since it has been proposed as a part of the Natura 2000 “Springs of the Sokółka Hills” area. Threats addressing the mire are:
– regional hydrological changes that diminish the groundwater supply to the spring system;
– digging drainage ditches around the cupola by the private owners of meadows;
– lack of management that accelerates secondary succession of willows, expansion of *Phragmites* etc.
Almost no information is available about the fauna of the Sidra spring area.

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ROSPUDA RIVER VALLEY – The last pristine, large percolation fen of temperate Europe

Compiled by: Paweł Pawlikowski and Ewa Jabłońska

The Rospuda is a small river in the young, postglacial landscape of north-eastern Poland (Fig. 1). In the lower course the river is called Netta, which is tributary to the Biebrza River in the Vistula River catchment. The climate of this area is under strong continental influence, with growing season of ca. 190 days. In the lower course of the Rospuda River, close to the town of Augustów, the river crosses the Augustów outwash plain, which is covered with coniferous forests. Here the large soligenous mire has developed. Since the late 80s plans have existed to make Rospuda Valley a nature reserve, but it has not been established yet. However, the mire is now a part of large Natura 2000 habitat protection and bird protection sites ("Augustowska Refuge" and "Augustowska Forest", respectively). The unique natural values of the lower Rospuda valley have been recognized quite recent, in the late 80s, by A.W. Sokołowski. Detailed botanical and eco-hydrological research has been implemented very recently by the group of S. Kłosowski of the University of Warsaw.

Figure 1. Location of the fens in the lower course of the Rospuda River (source: geoportal.gov.pl)

The area has become famous during the last decade due to government plans and, subsequently, building of the Augustów by-pass, which would be a part of the international Via Baltica Highway, through the lower Rospuda valley. The government plans to build a large bridge across the Rospuda valley was supported by most people of the local community, but fiercely opposed by environmental NGOs, scientists and a part of the Polish general public. The environmental groups gained much support of international organizations, including the IMCG and the SER (Society of Ecological Restoration). After involving the European Commission that demanded a proper environmental impact assessment procedure, the Polish government decided to abandon the plan to cross the river at the Rospuda mire site.

GEOLOGICAL LANDSCAPE SETTING

The lower Rospuda mire developed in a deep valley that once contained a chain of ribbon lakes. At present it is a groundwater fed percolation mire with a slightly sloping surface. There are two main basins in the mire: the northern (upper) basin, where gyttjas are hardly present (Fig. 2), and a southern (lower) basin, which is filled with lacustrine sediments (mainly clayey gyttjas) that can reach a depth of 16 meters (Fig. 3). In both basins brown moss-sedge peat dominates in the peat profiles. In the northern basin the peat thickness can reach almost 4 meters and sometimes much wood remnants can be found in peat. The entire peatland area is ca. 600 ha. Most of the peatland area is covered with fen forests, but almost half of it is covered with non-forest vegetation, including tall sedge and reed communities and sedge-moss vegetation. From a conservation point of view, the latter is the most valuable one. It can be found primarily in the southern basin, which is up to 1600 m wide. Pristine sedge-moss communities cover more than 100 hectares, while the zone that is regularly flooded by the river is very narrow here.

Figure 2. Upper (northern) basin of the Rospuda mire (photo: Kamila Brzezińska/CMok)

Figure 3. Lower (southern) basin of the Rospuda mire (photo: Kamila Brzezińska/CMok).

Figure 4. *Sphagnum teres* – dominated fen in the lower (southern) basin of the Rospuda mire (photo: Filip Jarzombkowski).

FLORA AND FAUNA

The vegetation forms several distinct zones in the valley (Fig. 2, 3). In the main (southern, lower) basin, five main zones are present:
1) regularly flooded alder forests and reed rushes, forming a narrow zone adjacent to the river;
2) tall sedge communities with *Carex acutiformis*, which is also flooded, and in which a moss layer is practically absent;
3) tall and medium sized sedge communities with a well developed moss layer, usually with *Carex appropinquata*, with participation of *Equisetum fluviatile, Phragmites australis, Carex rostrata, Carex lasiocarpa, Thelypteris palustris, Menyanthes trifoliata* and *Calliergonella cuspidata*, forming quite an extensive zone which is fed both by groundwater and surface water;
4) then the main zone of brown moss-small (and medium) sedge communities

forms the main vegetation zone of the southern mire basin (see below); within that zone, islands of Sphagnum-dominated vegetation with a.o. *Sphagnum teres, Oxycoccus palustris* and *Menyanthes trifoliata* developed (Fig. 4);
5) spring alder forests and spruce-birch-pine fen woodlands form a narrow (at places broader) zone along the margins of the peatland.

Figure 5. Brown moss-sedge fen in the lower (southern) basin of the Rospuda mire (photo: Paweł Pawlikowski)

Figure 6. Vast area of brown moss-sedge fen in the lower (southern) basin of the Rospuda mire (photo: Paweł Pawlikowski)

Figure 7. Pine-birch fen woodland in the upper (northern) basin of the Rospuda mire (photo: Paweł Pawlikowski).

Open brown-moss vegetation, that hosts majority of rare species of the Rospuda fen (including the most numerous Polish populations of *Saxifraga hirculus* and *Liparis loeselii*), is dominated by *Carex rostrata, Carex lasiocarpa, Carex diandra, Festuca rubra, Agrostis stolonifera, Menyanthes trifoliata*, *Thelypteris palustris* in the herb layer and *Calliergonella cuspidata, Tomentypnum* (*Homalothecium*) *nitens, Aulacomnium palustre, Hamatocaulis vernicosus, Plagiomnium ellipticum* and *Calliergon giganteum* in the moss layer.

In the northern Rospuda mire basin, with extensive forested areas, pine-birch fen woodland predominates (Fig. 7). Small non-forest vegetation patches persist within the forest zone there. In such open patches a number of rare species are present, among them *Herminium monorchis*. Close to the river, a broad zone of reed and tall sedges is present. The flora of the Rospuda mires is extraordinary rich. 17 species are listed in the Polish Red Data Book and 37 species occur on other Polish red lists of mosses and vascular plants. Among them, there are 16 species that are listed as endangered or critically endangered. The peatland area hosts populations of 17 orchid species, which is one-third of the Polish species belonging to the *Orchidaceae* family. UE Habitat Directive species include *Saxifraga hirculus* (Fig. 10), *Liparis loeselii* (Fig. 8), *Cypripedium calceolus* (Fig. 9) and the moss species *Hamatocaulis vernicosus* (Fig. 11). Thus, the mire in the lower Rospuda valley is a place of primary importance for the protection of endangered plant species in Poland.
Rare bird species that breed in Rospuda valley and in adjacent forests, are White-tailed Eagle *Heliaeetus albicilla*, Lesser Spotted Eagle *Aquila pomarina*, Honey Buzzard *Pernis apivorus*, the Tengmalm‘s

Species	Polish Red Data Book category	Polish „red list" category
Baeothryon (*Trichophorum*) *alpinum*	EN	V
Betula humilis	EN	V
Carex chordorrhiza	VU	V
Carex dioica	-	V
Carex limosa	LR	V
Carex loliacea	VU	V
Cinclidium stygium		E
Corallorhiza trifida	-	V
Cypripedium calceolus	VU	V
Dactylorhiza baltica		V
Dactylorhiza fuchsii	-	V
Dactylorhiza incarnata ssp. *ochroleuca*	EN	-
Drosera rotundifolia	-	V
Drosera anglica	-	E
Dryopteris cristata	-	V
Empetrum nigrum		V
Epipactis palustris	-	V
Eriophorum gracile	CR	-
Hamatocaulis (*Drepanocladus*) *vernicosus*		-
Hammarbya (*Malaxis*) *paludosa*	EN	E
Helodium blandowii (*H. lanatum*)		E
Herminium monorchis	CR	E
Huperzia (*Lycopodium*) *selago*	-	V
Lathyrus palustris	-	V
Liparis loeselii	VU	E
Listera cordata		V
Malaxis monophyllos	LR	V
Meesia triquetra		V
Paludella squarrosa		E
Pedicularis palustris	-	V
Polemonium coeruleum	VU	-
Pseudobryum cinclidioides		E
Ranunculus lingua	-	V
Saxifraga hirculus	EN	E
Scheuchzeria palustris	-	E
Sphagnum fuscum		V
Stellaria crassifolia	-	E
Tomentypnum (*Homalothecium*) *nitens*		V
Trisetum sibiricum	LR	-
Utricularia intermedia	-	V
Utricularia minor	-	V
Viola epipsila	CR	E

Table 1. Flora of the rare and threatened plant species of the peatlands in the lower Rospuda valley

Figure 8. *Liparis loeselii* (photo: Paweł Pawlikowski).

Figure 9. *Cypripedium calceolus* (photo: Paweł Pawlikowski).

Figure 10. *Saxifraga hirculus* (photo by Paweł Pawlikowski).

Owl *Aegolius funereus*, White-backed Woodpecker *Dendrocopos leucotos*, Spotted Crake *Porzana porzana,* Hazel Grouse *Bonasia bonasia* and others. Among UE Habitat Directive-protected dragonflies are White-faced Darter *Leucorrhinia pectoralis* and Green Club-tailed Dragonfly *Ophiogomphus cecilia*.

Figure 11. *Hamatocaulis* (*Drepanocladus*) *vernicosus* (photo: by Paweł Pawlikowski).

MANAGEMENT

The unique feature of the Rospuda mire is that it has never been reclaimed and no single ditch was dug there. It used to be extensively mown only, which ceased in the 70s.

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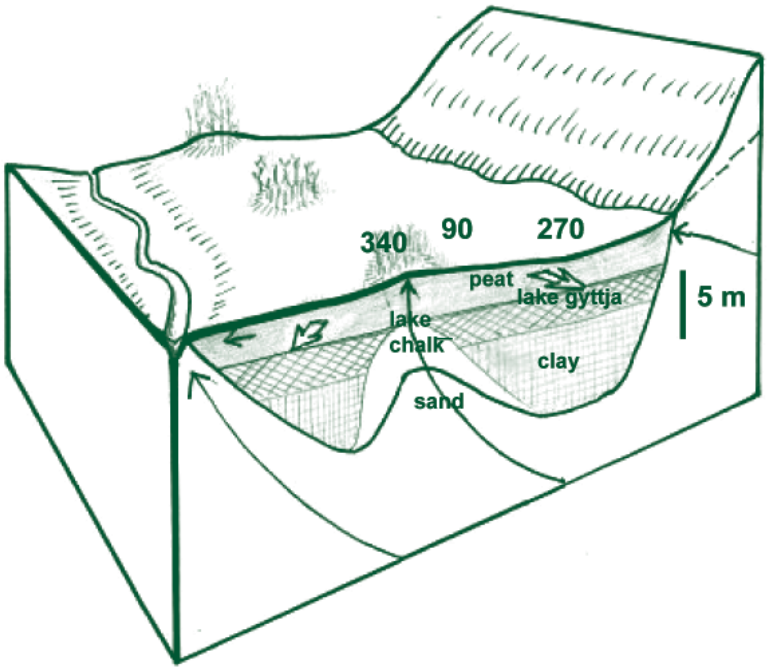
EVALUATION OF IMCG PARTICIPANTS

The IMCG participants acknowledged that Rospuda valley can be regarded as one of the best reference sites for percolation mires in Europe. The vegetation types were very well developed and expressed the dominant mesotrophic character of the environment. The group of Polish organisers were complimented with their success in saving Rospuda valley for future generations.
Two peat corings showed that the lower basin has indeed developed from a lake. The peat layer is exceptionally well preserved and thick clay layer underneath the valley bottom keeps the system completely saturated with ground and precipitation water. A peat coring in one of the “tree islands” showed that this island was actually a spring system where calcareous groundwater with a high EC (660 µS/cm) was discharging through a calcareous (white) gyttja layer. The spring was situated at a site where the sediments were rather thin. The discharging groundwater was mixed apperently with less calcareous groundwater from the upper layers, since at the surface the EC was only slightly higher then 300 µS/cm, which is still higher then in the surrounding mire, where values ranged between 90 and 270 µS/cm at the mire surface.

The lower basin of Rospuda that we visitit looked well protected, also from a hydrological point of view. Future threats could be changes in the groundwater regime of the river due to hydrological changes downstream. If the groundwater pressure in the system drops the spring systems in the central forest could become a source of groundwater loss to the River and drain the surrounding mire. Such changes would proceed very slowly, so monitoring of water levels and vegetation in and around such a spring system in the middle of the mire is highly recommended.



Simplified sketch of the peat development and possible groundwater flow in the lower basin of Rospuda valley. Values of the electrical conductivity (EC25) of the surface water are indicated above the peat layer.

ŁEMPIS NATURE RESERVE – Calcareous lakes and Sphagnum-mires

Compiled by: Paweł Pawlikowski

Łempis nature reserve (126.64 ha) was established in 1983, and protects well-preserved lakes, coniferous and mixed forests and mires within the Augustowska Forest. It is a part of large Natura 2000 habitat protection and bird protection sites ("Augustowska Refuge" and "Augustowska Forest").

GEOLOGICAL LANDSCAPE SETTING

The reserve lies in a deep, postglacial valley that crosses the Augustów outwash plain. The adjacent areas are also rich in kames and kettle-holes. The valley is filled with lacustrine sediments of a former ribbon lake. There are three small, shallow lakes remaining in the depression (Łempis, Stulpieniuk and Stulpień). The largest lake (Łempis Lake) does not exceed 12 hectares.
The lakes are calcareous and mainly filled with calcareous gyttjas. The mires around the lakes are mainly *Sphagnum-dominated*, and they are still growing. Locally also brown-moss dominated fens are present around the lakes. The majority of mires in the Łempis reserve are covered with woodlands. Peat deposits in the Łempis reserve vary a lot in peat thickness and composition and they have been poorly investigated. While marginal woodlands developed on thick peat layers, most of the *Cladium* and *Sphagnum*-fens have peat layers that do not exceed 1 meter. Under the peat, thick calcareous lake gyttjas are present.
The hydrology and stratigraphy of the mires in the Łempis nature reserve have been researched only superficially, and need further investigations.

FLORA AND FAUNA

The vegetation forms distinct zones. *Cladium mariscus* dominates a zone bordering the lakes. The lakes itself have few water plants (mainly *Potamogeton natans* and *Chara species*). The pH is alkaline to neutral. Both pure *Cladium* stands and brown moss-rich *Cladium* patches can be found, which contain many typical fen species. Further away from the lake sharp ecological gradients occur, in which *Sphagnum fuscum* forms small hummocks with dwarf pines and *Sphagnum fallax* forms lawns, together with the calcitolerant *Sphagnum teres*. Finally these *Sphagnum-mires* are usually flanked by a broad zone of

Species	Polish Red Data Book category	Polish „red list" category
Baeothryon (*Trichophorum*) *alpinum*	EN	V
Carex chordorrhiza	VU	V
Carex dioica	-	V
Carex limosa	LR	V
Carex loliacea	VU	V
Cinclidium stygium		E
Dactylorhiza fuchsii	-	V
Drosera anglica	-	E
Drosera rotundifolia	-	V
Dryopteris cristata	-	V
Epipactis palustris	-	V
Hammarbya (*Malaxis*) *paludosa*	EN	E
Huperzia (*Lycopodium*) *selago*	-	V
Listera cordata	-	V
Pseudocalliergon (*Calliergon*) *trifarium*		E
Ranunculus lingua	-	V
Scorpidium scorpioides		E
Sphagnum fuscum		V
Tomentypnum (*Homalothecium*) *nitens*		V
Utricularia intermedia	-	V
Utricularia minor	-	V

Table 1. Flora of the rare and threatened plant species of the peatlands in the Łempis nature reserve

pine, pine-birch and spruce fen woodlands.
The area covered by the *Cladium mariscus* around the largest lake (Łempis) has decreased significantly since the late ‘70 due to expansion of *Phragmites australis*. The reasons for this expansion is not yet well understood, but increased beaver activity (digging small channels, building dams etc causing higher water fluctuations and a change in surface water composition may be significant here.
The flora of the mires in the Łempis reserve is rich in rare plant species. Five of them are listed in the Polish Red Data Book and 21 moss and vascular plant species are listed in other Polish Red Lists. The most valuable among them are *Hammarbya paludosa, Baeothryon* (*Trichophorum*) *alpinum, Carex chordorrhiza, Carex loliacea* and the moss species *Pseudocalliergon* (*Calliergon*) *trifarium*. The fauna of the reserve consist of the typical forest species of the Augustowska Forest, including Eurasian Lynx *Lynx lynx*, Gray Wolf *Canis lupus*, European Elk *Alces alces*, Mountain Hare *Lepus timidus*, Tengmalm‘s Owl *Aegolius funereus*, Hazel Grouse *Bonasia bonasia* and numerous more common species.

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WIGRY NATIONAL PARK – Suchary dystrophic lakes and adjacent floating poor fens

Compiled by: Paweł Pawlikowski

Wigry National Park (150.86 km²) has been established in 1989 and protects Wigry Lake (21.7 km²) and the adjacent part of the Augustów Forest with numerous smaller lakes and mires (Fig 1). The strictly protected nature area Suchary ("suchar" is the local name for a small dystrophic lake) includes five lakes with adjacent peatlands and mixed/coniferous forests. The plant cover and hydrochemistry of these dystrophic lakes have been studied in detail by D. Sobotko, A.W. Sokołowski, A. Górniak and others.

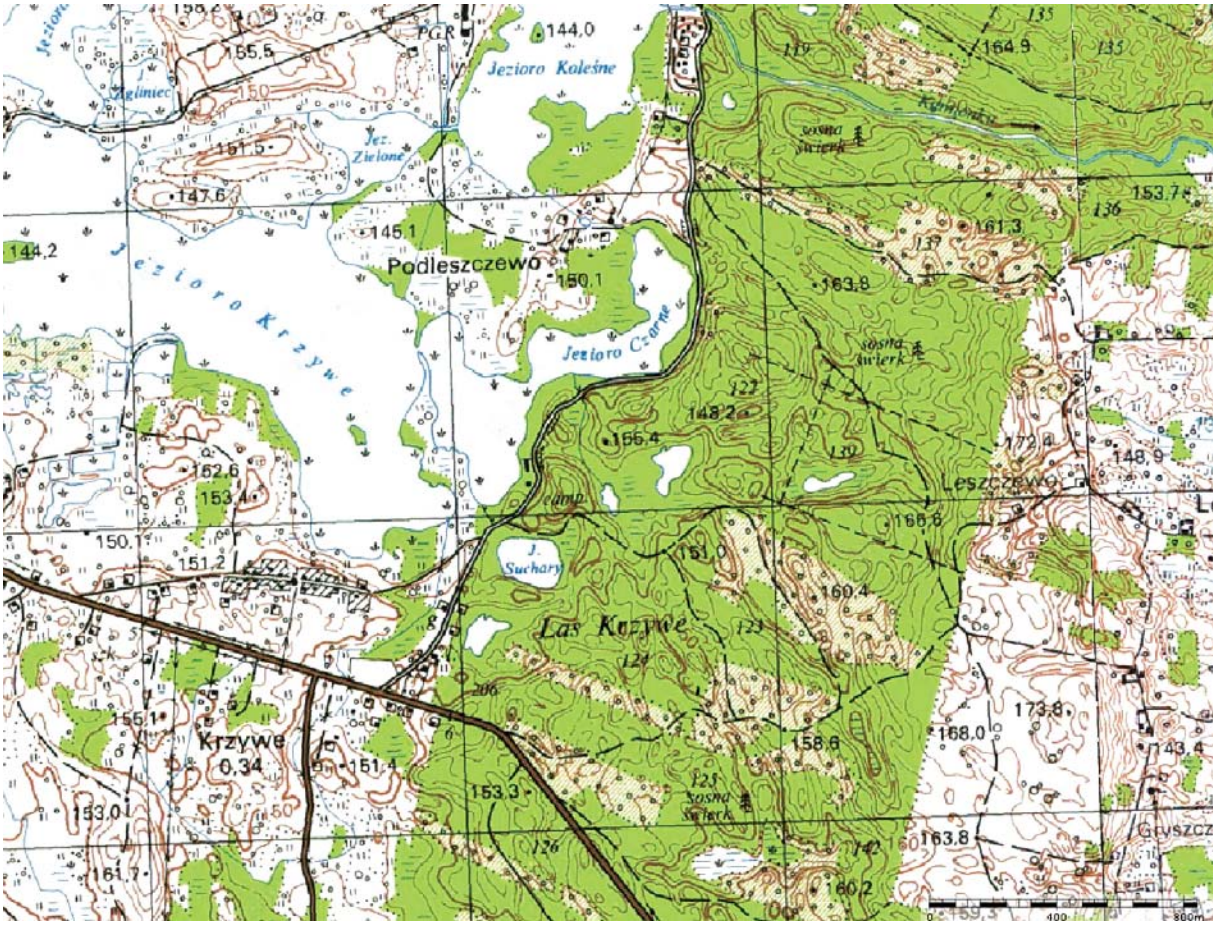

Figure 1. Topographical map showing the surroundings of Suchary Nature Reserve.

GEOLOGICAL LANDSCAPE SETTING

The majority of the park area is situated in an outwash plain and has numerous kettle holes with small dystrophic (polyhumic) lakes in it. Kettle holes have been formed by melting blocks of ice within the outwash plain leaving small water bodies afterwards. In total 17 of such lakes are still present within the borders of the Park. Their area rarely exceeds 2 ha, and the maximum depth varies between 2 and 10 meters. The lakes are surrounded by mires that have a bog-like vegetation and by pine bog woodlands. The mires can be classified as extremely poor fens. The lakes are acid and rich in humic acids. The thickness of the peat layer is diverse usually between 3 and 6 meters. Poorly decomposed *Sphagnum*-peat dominates, frequently with remnants of *Eriophorum, Scheuchzeria*, sedges, dwarf shrubs and pine trees. In most cases a thin layer of brown moss-sedge peat is present at the bottom of peat profiles,. Moreover, in some lakes typical lacustrine sediments can be found.

FLORA AND FAUNA

The vegetation is species-poor and forms distinct zones going from lake to the peatlands at the mineral margins. In the lakes themselves some *Potamogeton natans* and *Utricularia minor* is present. Around the lakes, floating mats with poor fen vegetation dominated by *Sphagnum fallax* lawns where *Rhynchospora alba, Carex limosa, Carex lasiocarpa, Eriophorum vaginatum, Scheuchzeria palustris, Oxycoccus palustris* and *Andromeda polifolia* occur. Pine bog woodland is present at the mineral margins bordering the peatlands. In the transition zone between floating poor fen vegetation and the forest, typical bog species like *Sphagnum magellanicum* and *Eriophorum vaginatum* appear, forming a bog-like vegetation type. This zone appears to be fairly isolated from discharging minerotrophic groundwater. More research on these hydrological mechanisms is needed.

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MECHACZ WIELKI NATURE RESERVE – the best preserved raised bog in north-eastern Poland

Compiled by: Paweł Pawlikowski

Mechacz Wielki nature reserve (146.74 ha) has been established in 1974 and protects a large mire (ca. 150 ha) situated in the Romincka Forest. The reserve is a part of a large Natura 2000 habitat protection site ("Romincka Forest") and is also a part of an existing Romincka Forest Landscape Park, which has a lower grade of protection. Most of the mire complex is formed by an ombrotrophic acidic raised bog, one of few surviving mires of this type in the north-eastern Poland. The bog has developed in a former large lake basin, which was situated in a depression within a moraine area. The thickness of peat is almost 4 meters, including 3 meters of *Sphagnum*-peat in the upper layers. Underneath the peat we find several meters of lacustrine deposits (mainly detrical gyttjas). These gyttja deposits are sometimes rich in fossil nuts of Trapa natans. Since *Trapa natans* is a southern, high temperature-demanding species, it suggests that the former lake was a shallow, warm water body and developed under warmer climatological conditions.

At the beginning of 20th century, the course of the adjacent Czarna River has been altered in order to drain the peatland. Two large drainage ditches have been dug across the mire during that time. It has resulted in expansion of pine trees on the previously almost treeless mire and caused the decline of the typical bog species, in particular those of bog hollows. At present the old ditches are mostly filled with organic sediments and consequently the drainage intensity has decreased. The two main ditches have been dammed three years ago as a conservation measure in order to raise the water level in the mire. In the past the Mechacz Wielki peatland has been studied both by German (who called it "Grosses Moosbruch") and Polish botanists, but the existing knowledge is still scarce.

The vegetation of the mire forms four distinct concentric zones. In the central part of the bog, an open *Sphagnum*-dominated vegetation persists. This part of the bog still shows a distinct hummocks and hollows pattern with associated plant assemblages. On the hummocks *Sphagnum magellanicum, Sph. fuscum, Sph. rubellum, Sph. fallax, Andromeda polifolia, Oxycoccus palustris, Ledum palustre, Calluna vulgaris, Empetrum nigrum, Drosera rotundifolia* and dwarf pines are growing. In the hollows *Sph. cuspidatum, Rhynchospora alba, Scheuchzeria palustris* and sometimes *Drosera anglica* and *Carex pauciflora* are found.

Species	Polish Red Data Book category	Polish „red list" category
Carex disperma (*tenella*)	VU	V
Carex limosa	LR	V
Carex loliacea	VU	V
Carex pauciflora	-	V
Corallorhiza trifida	-	V
Drosera anglica	-	E
Drosera rotundifolia	-	V
Empetrum nigrum	-	V
Glyceria lithuanica	-	-
Huperzia (*Lycopodium*) *selago*	-	V
Listera cordata	-	V
Ranunculus lingua	-	V
Rubus chamaemorus	EN	V
Scheuchzeria palustris	-	E
Sphagnum fuscum		V

Table 1. Flora of the rare and threatened plant species of the peatlands in the Mechacz Wielki nature reserve

Outside the real bog, pine tree of several meters high grow. This is where *Rubus chamaemorus* occurs. The marginal zone of the peatland is covered by forests - pine bog woodlands, spruce woodlands and alder woodlands. Marginal forests with spruce are particularly rich in rare plant species, such as *Glyceria lithuanica Carex disperma, C. loliacea, Listera cordata, Corallorhiza trifida* and *Huperzia selago*. The swampy forests of the reserve have primeval features, with many age classes, many fallen trees and decaying wood.

There are four plant species from the Polish Red Data Book and 14 species from other the Polish Red Lists growing in the reserve (Tab. 1). The most valuable species are *Carex pauciflora, C. disperma, Rubus chamaemorus* and *Glyceria lithuanica*. The latter species has been re-discovered in Poland just recently. Romincka Forest is the only area in the country where this boreal species occurs, and the population in the Mechacz Wielki reserve is the largest one known there.

Among animals, many ancient forest species occur, eg. Gray Wolf *Canis lupus*, European Elk *Alces alces*, European Beaver *Castor fiber*, Lesser Spotted Eagle *Aquila pomarina*, Black Stork *Ciconia nigra*, Eurasian Three-toed Woodpecker *Picoides tridactylus*, White-backed Woodpecker *Dendrocopos leucotos*, and Hazel Grouse *Bonasia bonasia*. Rare bog specialists among butterlfies and moths are also present, including Cranberry Fritillary *Boloria aquilonaris*.

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STRUGA ŻYTKIEJMSKA NATURE RESERVE – Active cupola spring fens

Compiled by: Paweł Pawlikowski

Struga Żytkiejmska nature reserve (467.07 ha) was established in 1982, and consists of a large area of forests in and around a swampy river valley at eastern part of the Romincka Forest (Fig. 1). The river Żytkiejmska Struga passes through a moraine area with numerous kame hills. Its valley is wide and filled with peat.

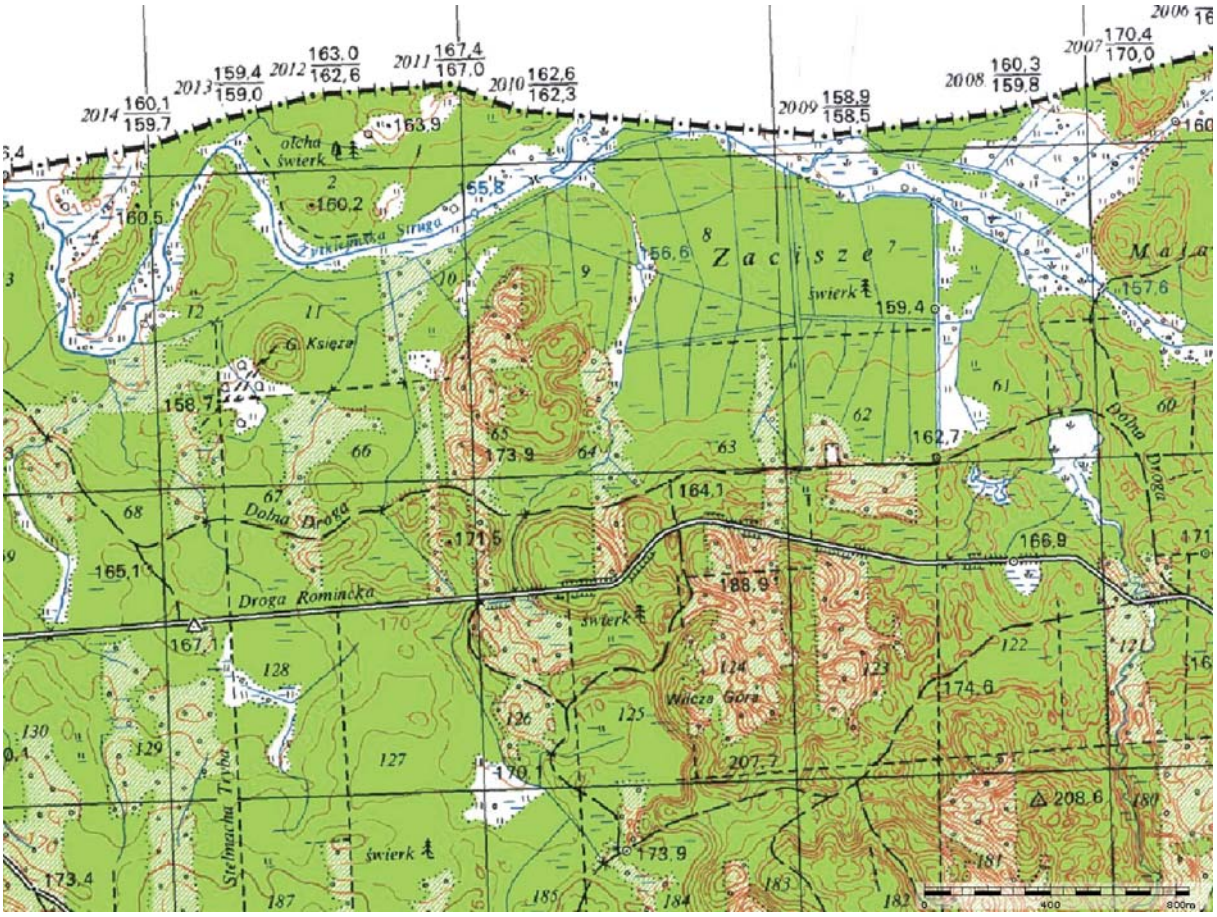

Figure 1. Location of the Struga Żytkiejmska Nature Reserve (source: geoportal.gov.pl)

GEOLOGICAL LANDSCAPE SETTING

Numerous springs occur on the valley margins and mineral islands within the valley. Some of them developed into spring fen cupolas. The total area of predominantly groundwater fed peatlands in the Żytkiejmska Struga valley exceeds 200 hectares. Near the valley margins the thickness of the peat deposits may reach almost 5 meters. On the spring cupolas it can be even more. The peat profile consist of rather well preserved sedge-brown moss peat that is often very rich in calcium carbonate, which is interspaced with various travertine layers (Fig. 2). Under the peat, 3 – 4 meters of calcareous and organo-calcareous gyttjas are present.

At the end of 19th and in the first half of 20th century, the river was regulated and the treeless fens were severely damaged by extensive drainage ditches, including double parallel ditches. Due to that reclamation, the majority of open fens turned into spruce and birch forests. Open fens survived in the cupola springs only, where the groundwater discharge was most intensive. The last couple of years some ditches have been dammed as a conservation measure to decrease the drainage of the system. Moreover, beaver activity raised the water level in some other parts of the mire, which resulted in the

death of many trees.

It is perhaps interesting to mention that the Żytkiejmska Struga mires were once a subject of a classical research by the German botanist H. Steffen (1922), which resulted in an important article (*'Zur weiteren Kenntnis der Quellmoore des Preussischen Landrückens mit hauptsächlicher Berücksichtigung ihrer Vegetation'*) about the stratigraphy, plant cover and hydro-ecology of the cupola spring fens in this area. Some other systems that he studied are now located in the Kaliningrad Province of Russia (Fig. 3). Steffen first distinguished the spring association *Hypneto-Caricetum* from here.

Figure 2. Peat profile with calcium carbonate layers (photo: Paweł Pawlikowski)

FLORA AND FAUNA

At present the plant cover of the peatlands around Żytkiejmska Struga River is dominated by disturbed spruce forests with tall herbs, including nitrophilous species. Natural spruce, birch-pine-spruce or alder forests only occur in some places. Here we sometimes find the rare

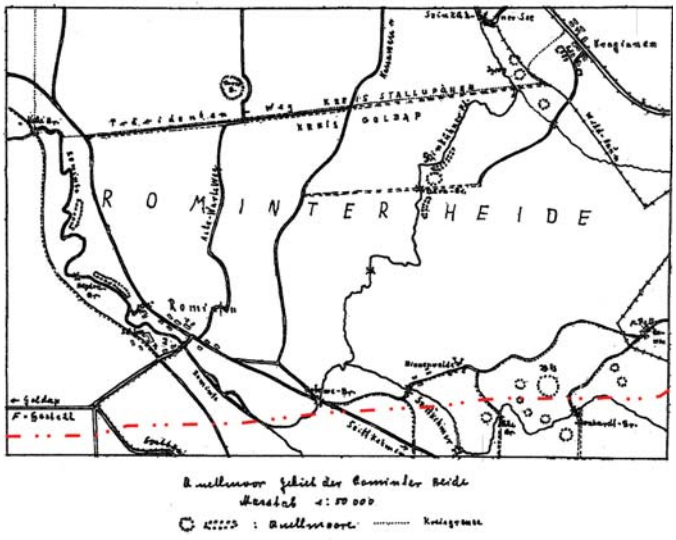

Figure 3. Distribution of spring cupolas in the Żytkiejmska Struga area (after Steffen 1922).
The red line indicates the present state border between Poland and the Kaliningrad Province of Russia.

Figure 4. Spruce-pine forest with a lot of decaying wood north of the Żytkiejmska Struga river (photo: Paweł Pawlikowski)

dwarf birch *Betula humilis*. Natural forests are rich in rare species, including orchids (e.g. *Listera cordata, Corallorhiza trifida (Fig. 6),* (*Malaxis monophyllos, Dactylorhiza fuchsii* and *Epipactis palustris*). Especially the old spruce stands have a nice natural appearance with numerous fallen or standing dead trees and decaying trunks (Fig. 4).

On several spring cupolas, non-forest vegetation still persists. They are covered with large tussocks of Carex paniculata, and much *Carex acutiformis* and sedge moss vegetation as well, which corresponds well to what

Figure 5. Active spring cupola with sedge-moss vegetation south of the Żytkiejmska Struga River (photo: Paweł Pawlikowski)

H. Steffen described as the *"Hypneto-Caricetum der Quellmoore"*. The latter association, however, one is usually dominated by sedges (*Carex rostrata, C. lasiocarpa*) and brown mosses (*Plagiomnium ellipticum, Aulacomnium palustre*), and also several grasses (*Festuca rubra* and *Agrostis stolonifera*).

In the best preserved spring cupola in the southern part of the nature (Fig. 5) reserve many threatened species have survived, despite the two drainage ditches crossing it.

Species belonging to this category are: *Saxifraga hirculus, Liparis loeselii, Stellaria crassifolia, Betula humilis, Trisetum sibiricum, Polemonium caeruleum* (Fig. 7), *Carex dioica, Epipactis palustris, Helodium blandowii, Paludella squarrosa, Tomentypnum* (*Homalothecium*) *nitens* and orchids of the genus *Dactylorhiza*. On top of some cupolas the discharge of groundwater is so strong that the vegetation forms a floating mat.

Figure 6. *Corallorhiza trifida* (photo: Paweł Pawlikowski)

Figure 7. *Polemonium caeruleum* (photo: Paweł Pawlikowski)

Only a few species are able to survive under such conditions. Examples are: *Carex rostrata, Agrostis stolonifera, Stellaria crassifolia, Epilobium palustre, Lemna minor* and *Plagiomnium ellipticum*. Eight plant species listed in Polish Red Data Book are growing in the mires and 16 other species listed on Polish Red Lists, were also found in the peatlands of the Struga Żytkiejmska Nature Reserve (Table 1).

Rare animals occurring here are: Eurasian Lynx (*Lynx lynx*), Gray Wolf (*Canis lupus*), European Elk (*Alces alces*), European Beaver (*Castor fiber*), Tengmalm's Owl (*Aegolius funereus*), Lesser Spotted Eagle (*Aquila pomarina*), Eurasian Three-toed Woodpecker (*Picoides tridactylus*), White-backed Woodpecker (*Dendrocopos leucotos*) and Hazel Grouse (*Bonasia bonasia*).

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Species	Polish Red Data Book category	Polish „red list" category
Betula humilis	EN	V
Carex atherodes	VU	V
Carex dioica	-	-
Carex loliacea	VU	V
Corallorhiza trifida	-	V
Dactylorhiza fuchsii	-	V
Dactylorhiza ruthei	EN	-
Drosera rotundifolia	-	V
Dryopteris cristata	-	V
Epipactis palustris	-	V
Helodium blandowii		E
Lycopodium selago	-	V
Liparis loeselii	VU	E
Listera cordata	-	V
Malaxis monophyllos	LR	V
Orobanche pallidiflora	-	R
Paludella squarrosa		E
Polemonium coeruleum	VU	-
Ranunculus lingua	-	V
Tomentypnum nitens		V
Saxifraga hirculus	EN	E
Stellaria crassifolia	-	E
Trisetum sibiricum	LR	-
Utricularia intermedia	-	V

Table 1. Flora of the rare and threatened plant species of the peatlands in the Struga Żytkiejmska nature reserve.

EVALUATION OF IMCG PARTICIPANTS

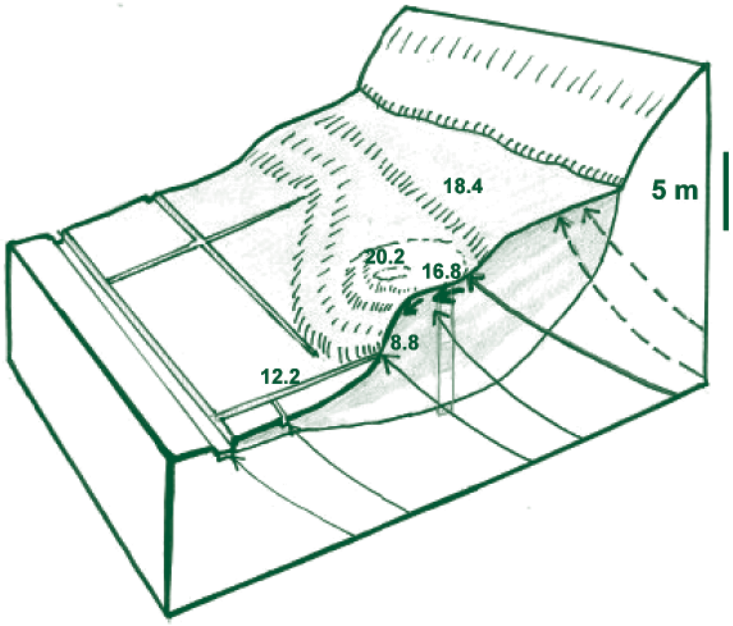
The spring system in the Struga Żytkiejmska Nature Reserve is indeed a part of a much larger system that spreads out along the slope of the hill and which is covered with trees for more then 80%. The spring cupola we visited is still of high ecological quality, but the system as a whole has been severely damaged by an intensive drainage system.

Upslope of the present active cupola we found remnants of an earlier spring cupola, which was quite dry and which is covered with trees. Further downslope we saw sign of regeneration of wetland vegetation. Extensive carpets of mineralotrophic Sphagnum species could be seen at places where the drainage ditches were not functioning very well

The treeless spring cupola at Struga Żytkiejmska Nature Reserve

Regenerating carpets of minerotrophic *Sphagna*

anymore. Filling up all the ditches would be the best practise in order to speed up the regeneration process, but this could be quite an expensive operation. We recommend filling in the main ditches, after a more detailed inventory of the ditch system and the peat thickness. Also removing trees from the spring system would help to store more groundwater in the system.



Location of the Struga Żytkiejmska Nature Reserve, showing the treeless wet cupola in the middle of a severely drained spring system. A net work of drainage ditches still transport the water to the Struga Żytkiejmska River. The groundwater that is escaping to the drainage ditches is rather cold (8-9 °C). The water that is discharging in the cupola itself is warmed up during the warm period (July 2010), indicating that the discharge of groundwater is not very strong anymore. Arrows with a dashed line indicate former flow patterns.

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