Herminium monorchis, Saxifraga hirculus, Liparis Loeselii, Juncus subnodulosus, Carex chordorrhiza, Carex dioica - these are rare species in Poland and threatened with extinction. Their common feature is the occurrence on alkaline fens - specific wetland ecosystems fed with clean, groundwater, waters rich in calcium and magnesium salts. They are characterized by an extraordinary richness of flora, especially bryophytes, and most of the plants found there are species described in the Red Books of species threatend with extinction. Unfortunately, alkaline fens are disapearing in an alarming pace. Over the last two centuries, we have destroyed over 90% of their original area. We can observe the best preserved and the largest fens only in the upper Biebrza valley and the Rospuda valley. Despite the outstanding natural values, distinguishing our country from the rest of the Europe, an extremely important role in shaping the country's water resources and marginal importance for the agriculture, alkaline fens are still exposed to degradation! This publication presents how, in the last few years we have tried to save these valuable ecosystems. We hope that the activities described here will not only be in the future continued, but also extended to other areas.

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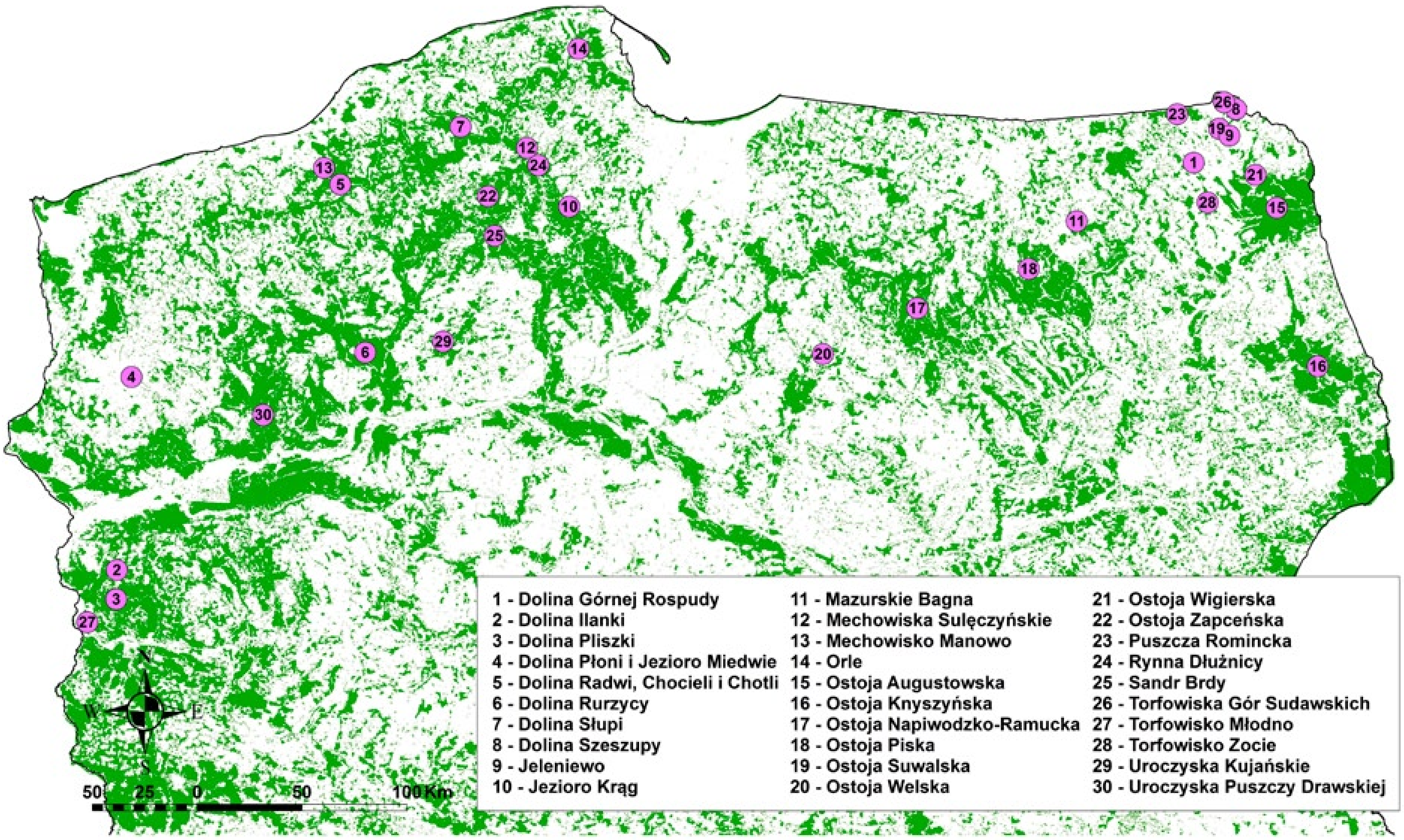
Layman's Report from realization of the projects
Conservation of alkaline fens (7230) in young-glacial landscape of northern Poland
(LIFE11 NAT/PL/423)
Conservation of alkaline fens (7230) in southern Poland
(LIFE13 NAT/PL/024)

VOLUME I

Conservation of alkaline fens (7230) in Poland

Localisation of Natura 2000 sites, where project activities were implemented



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VOLUME I

Robert Stańko, Lesław Wołejko, Magdalena Makowska, Dorota Horabik, Joanna Bloch-Orłowska, Elżbieta Cieślak, Katarzyna Żółkoś, Magdalena Kędra

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Authors (in alphabeltical order):
Bloch-Orłowska J., Cieślak E., Horabik D., Kędra M., Makowska M.,
Stańko R., Wołejko L., Żółkoś K.

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

Dorota Horabik, Magdalena Makowska, Robert Stańko
Klub Przyrodników, Świebodzin

Joanna Bloch-Orłowska
Leśny Ogród Botaniczny „Marszewo", Nadleśnictwo Gdańsk

Elżbieta Cieślak
Pracownia Analiz Molekularnych
Instytut Botaniki im. W. Szafera Polskiej Akademii Nauk, Kraków

Katarzyna Żółkoś
Stacja Biologiczna Uniwersytetu Gdańskiego, Gdańsk

Magdalena Kędra
Zakład Fizjologii i Biochemii Roślin
Wydział Biochemii, Biofizyki i Biotechnologii
Uniwersytet Jagielloński, Kraków

Photo on the front: Pliszka Valley upstream of Pliszka (town) - R. Stańko

Volume I

1. Introduction

Lesław Wołejko, Robert Stańko

1.1. General characteristics of alkaline fens

According to definition of the habitat provided by the Interpretation Manual of European Union Habitats (European Commission 2007), **alkaline fens are mires overgrown largely by sedge and moss communities capable of peat or tufa accumulation.** These wetlands show permanently high groundwater level with the water table oscillating around the ground level. They are supplied by ground waters, less often by waters flowing down or directly below the ground rich in alkali and often in calcium ions. Peat accumulation occurs below the groundwater level.

The flora, called calcified, in the process of evolution, as few have adapted to such conditions. At present, alkaline fens belong to the fastest declining ecosystems and the majority of related species to the most threatened of endangered species. Therefore, their protection is important both for Poland and the entire European Community.

In Poland they occur in lower parts of mountains, highlands and in lowlands – mainly in their northern part (Koczur 2011, Wołejko i in. 2012, Stańko i in. 2015).

1.2. Hydrology, development paths and typical vegetation of alkaline fens

Traditionally, habitat 7230 is identified principally based on vegetation. However, in the light of earlier experiences, this criterion is not sufficient to identify all alkaline fens existing in our country. A part of the typical syntaxa and species is common with other types of Natura 2000 habitats. For instance, characteristic species ie. sedges (like Davalla's, lesser tussock-sedge or flea sedge), orchids like inconspicuous Loesell's orchid colorful, i.e., purple swamp orchid or white marsh helleborine, but also a number of brown moss species - indicated as typical of alkaline fens (Herbichowa & Wołejko 2004, Koczur 2011) are also fundamental components of calcareous fens[1] (code 7210) and can be found in the flora of petrifying springs[2] (code 7220) and in purple moor-grass meadows (6410). On the other hand, species characteristic of different higher syntaxa of low sedge fens and transitional mires are constant components of vegetation of well-preserved alkaline fens, especially in northern Poland. Syntaxonomic position of these units in relation to the diverse vegetation of European low sedge fens is currently the subject of intensive discussion (cf. Peterka et al. 2017).

Due to succession, alkaline fens are transformed into transitional mires of bog moss type and raised bogs, tall sedge swamps, and forest swamps (change in the nature of supply waters from groundwater to surface waters and the degree of waterlogging towards more arid habitats). At present, fen complexes are dominated by meadow ecosystems with different land use type which, when abandoned quickly transform into tall herb communities, secondary reeds, and forests (Fig. 1).

1 It occurs on the banks of lakes in the littoral zone and on fens on the substrate rich in calcium carbonate (chalk, marl), overgrown with calciphic rush plants, mainly *Cladium mariscus* swards, as well as Buxbaum's sedge. In Poland, a very rare habitat, in dispersed positions only in lowland (continental region) (source: www.siedliska.gios.gov.pl).

2 springs and effusions within carbonate rocks and actively growing fens with precipitation of limestone sediments (travertines, other calcareous tars), overgrown mainly by communities of mosses, liverworts and algae, which actively participate in the formation of travertines fed with medium and high mineralization waters, pH from weakly to highly alkaline

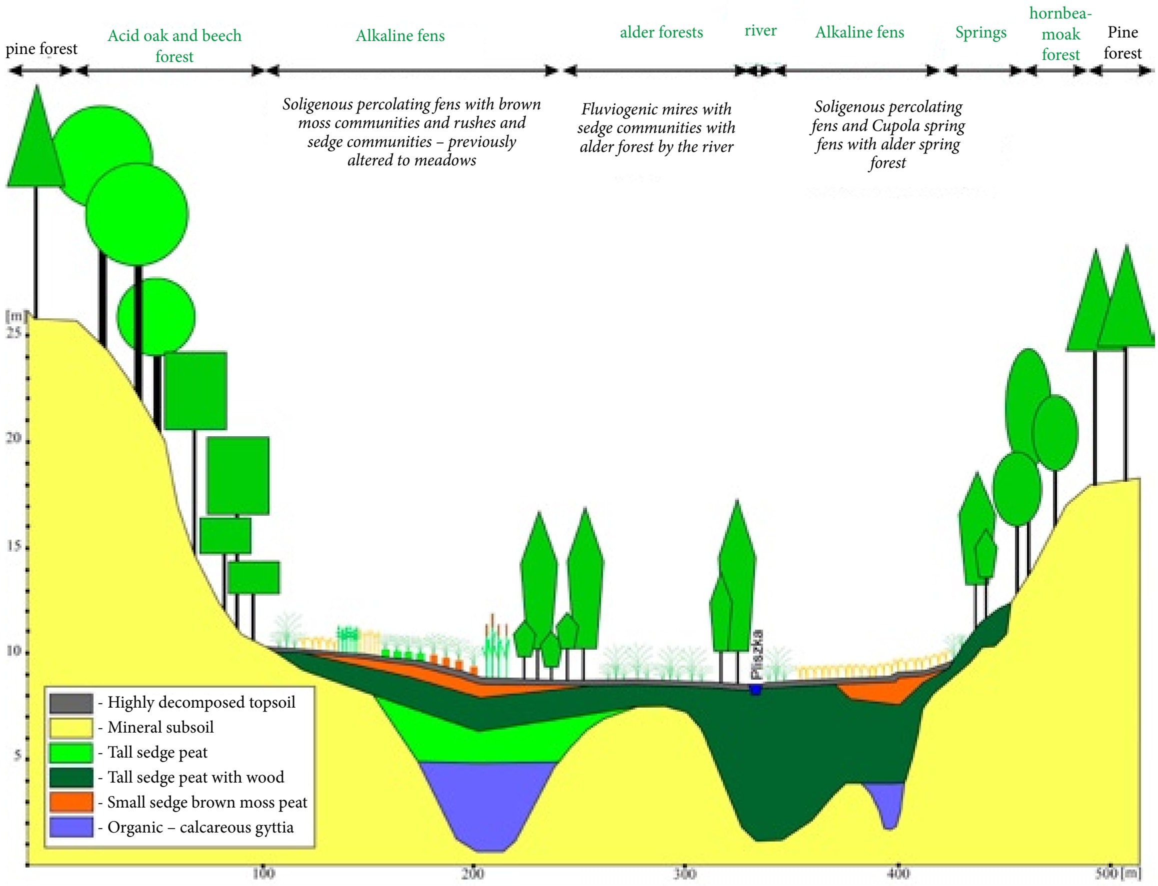

Fig. 1. A cross-section of fens situated in the upper Pliszka River valley

Compared with other mire ecosystems (e.g., transitional mires and raised bogs), alkaline fens are distinguished by an exceptional richness of valuable species with great conservation value and a narrow ecological amplitude (Wołejko et al. 2012). This natural habitat belongs to the most endangered with extinction. In several regions of Poland, this habitat is almost practically extinct and extremely endangered in the majority of locations (Stańko et al. 2015).

The size of an individual alkaline fen in Poland is very diverse, ranging from several ares to several tens—or in exceptional circumstances—several hundred hectares which depends on local topographical and hydrogeological conditions. However, a pattern can be noticed that in mountainous terrains these objects are abundant but of a small size and isolated, while their size increases northwards where vast valley and lake complexes are still preserved. They include the most famous Central European sedge-moss fens located in the Biebrza River (Pałczyński 1988, Wassen et al. 1990, 1996, Jarzombkowski 2010) and Rospuda River (Jabłońska et al. 2011, 2014) valleys, where no artificial drainages systems have been constructed.

In terms of water outflow intensity, location in landscape, type of accumulated substrates, and other diagnostic features, soligenous[3] wetlands can be divided into percolating fens and spring fens (cupola and hanging spring fens).

Flush fens are usually small wetlands with characteristics intermediate between hanging spring fens and open springs. In the strict crenological sense, flush fens are a type of spring characterized by surface, scattered seepage of groundwater. Since they are usually situated on slopes where there are not good conditions for the formation of a deeper peat layer, only shallow peat-gleyey soils are created. Flush fens are the most common type of fens in mountainous terrains (Photo 1).

3 Supplied by groundwater

Photo 1: A mountainous flush fen with broad-leaved cotton grass *Eriophorum latifolium* in the Gorce National Park (Photo R. Stańko).

<u>Spring fens</u> occur in different topographic situations that ensure long-standing, uniform groundwater supply usually driven by hydrostatic pressure. This water outflow is confined and spatially limited. Point outflow of a large amount of mineralized groundwater is often associated with tectonic fractures (as in the the Lubelszczyna region in the south-eastern part of Poland) or the so-called hydrological windows, i.e., more permeable patches in the midst of less permeable geological formations. These fens form cupolas or banks that developed as a result of alternate or concurrent accumulation of peat or calcareous sinters (travertines and tufaceous limestones) built, apart from calcium salts, of iron and magnesium compounds. Precipitation of mineral compounds out of the waters is termed "petrification".

<u>Soligenous percolating fens</u> are formed when water outflow from aquifers assumes a diffuse pattern. It can be observed on the margins of river valleys or lake basins. Percolating alkaline fens are formed most often in a varied landscape of glacial

Photo 2: A) Petrification of brown mosses. B) *Scorpidium scorpioides* (Photo A. Szafnagel-Wołejko).

Photo 3: Vegetation on travertines. Czarna Orawa (Photo R. Stańko).

origin. In contrast to flush fens or relatively small spring fens, percolating fens are usually characterized by peat beds of a considerable depth often underlain by aqueous sediments.

In growing fens, water percolates slowly under the peat surface from the mineral side towards the watercourse or lake. The fen surface is sloping, sometimes very markedly. In wide river valleys in old glacial terrains (e.g., in the Biebrza River valley) this sloping can be slight and difficult to detect without land surveying. With a slight slope and blocked drainage, the contribution of rainfall to the hydrological balance of the fen increases. It initiates a succession of peat-forming vegetation towards the poor fen vegetation and can be a cause of difficulties in the proper identification of the ecological character of the fen and natural habitat type.

1.3. Anthropogenic transformations of alkaline fens

Analysis of historical maps (see Chapter 2) indicates that the areas covered by fens, including alkaline fens, have been of great interest to humans for at least several hundred years. Compared with bogs, peat beds deposited in alkaline fens have not been so intensively exploited, probably due to their lower energy value and disadvantageous hydrological conditions (deeper excavation was not possible due to drainage difficulties). The situation is dramatically different when we look at it from the perspective of agricultural land use. In contrast to bogs, fens, including alkaline ones, have been under agricultural

Photo 4: Percolating fens in the lower Rospuda River. On the left, woodless open sedge-moss fens can be seen near slopes on the edge of the valley. The fen is supplied mostly by groundwater flowing from below the scarp, which then percolates through the peat bed towards the river (Photo K. Brzezińska).

pressure. For ages, even the least accessible fens have been used as a source of biomass, utilized mostly as litter for livestock. **In the past, human pressure in these terrains was insignificant because it was limited to sporadic mowing of already dead biomass—sometimes only in winter—from the frozen soil surface**. With economic development, a considerable part of the fens was converted into meadows and pastures that required a significant interference, not only in their hydrological conditions. In many regions, along with artificial drainage, the fen surface was covered by a dozen or so centimetre-thick layer of sand in order to allow for the use mechanical horse mowers. **Over time, when the human pressure constantly increased, a part of the fens—the most severely dried and located closest to the mineral edges—was transformed into arable land and irrecoverably lost**.

Since interest in using wetlands or fens declined at the end of 20th century (mostly for economic reasons), some of them have been undergoing spontaneous restoration. A significant area of fen-meadow complexes extensively used in the past, after cessation of exploitation, has been quickly transforming into scrubs and swamp forests, principally due to the disturbed hydrological conditions; some meadows and fens were also subjected to intentional afforestation.

While extensive use of alkaline fens consisting in occasional gathering of dry biomass from their frozen surface appears to be an insignificant human pressure (although significantly contributing to the preservation of the open character of the habitat), **the transformation of fens into typical meadows and pastures was associated with substantial interference with the hydrological conditions**. In spite of the abandoning of agricultural use of the fens, thousands of kilometers of drainage ditches were constantly maintained, thus fens are still strongly exposed to the negative impact of drainage infrastructure. A majority of fens is not only adversely affected by local drainage systems, but also by changes in the water supply to their groundwater catchments. In spite of a spontaneous improvement of water conditions in fens (related mostly with increased groundwater level) due to the overgrowing of drainage ditches and the blocking of water outflow by beavers, the parallel improvement of vegetation characteristic of habitat 7230 can be observed only in a few cases and on a small scale. **It appears that only the filling of the drainage ditches by organic sediments and their complete overgrowth will render their impact on the vegetation negligible.** Unfortunately, this process will need to continue for the next several decades. It seems unlikely that over this time the alkaline fens left for spontaneous restoration will preserve their open character. Based on studies conducted with the use of automatic monitoring systems (Pawlaczyk & Kujawa - Pawlaczyk 2017), the dynamic nature of these changes does not allow for drawing unequivocal conclusions regarding long-term trends.

In addition, the flow rate and chemical composition of the groundwater supplying the alkaline fens are important for their development. These factors have been undergoing modifications for centuries, first after the initiation of agricultural land use (the permanent deforestation of huge areas), and then forest management (large scale felling that also totally changes the conditions of rainfall infiltration) within the groundwater catchment areas. Characterizing anthropogenic changes in fens, the negative impact of mining and large agglomerations, for different purposes that exploit the groundwater resources for different purposes should also be mentioned. For these reasons, **currently in Poland there are probably no areas with undistorted hydrological conditions.**

It is difficult to estimate what was the overall extent of damage caused by the construction of dam reservoirs, connected with the excavation or flooding of the fens. Some alkaline fens were also lost due to the development of fish ponds.

In the near future, **global climate change may be another factor significantly affecting the conservation of alkaline fens**. It is difficult to determine how climate warming and related changes in the annual pattern of rainfall and temperature will influence hydrological conditions and consequently flora.

1.4. Conservation status of alkaline fens in Poland—reasons for undertaking the projects

Attempts to estimate the abundance and distribution of alkaline fens in Poland were undertaken several times in the last decade or so (e.g., Sefferova-Stanova et al. 2008, Wołejko 2012). In 2010, Poland's alkaline fen resource and conservation status were evaluated based on field inventory (Wołejko et al. 2012). The field studies carried out by the Naturalists' Club within the framework of the project "National Alkaline Fen Conservation Program

(7230)" indicated that at present the area covered by alkaline fens in our country amounts to ca. 15,000 hectares. Based on different data (e.g., GIS Wetlands), it can be assumed that this habitat originally covered from between 50,000 to 100,000 hectares. It means that the hectarage occupied by the fen habitat declined several times over the last ca. 100 years. More detailed analysis of the data acquired within the National Alkaline Fen Conservation Program (Wołejko et al. 2012) shows that currently the alkaline fen resource with preserved characteristic vegetation (which is a classification criterion for the habitat 7230) can be estimated at ca. 7,000—8,000 hectares.

Inventorizing the national alkaline fen resource involved the assessment of the conservation status of each site according to the parameters and indicators accepted by the Chief Inspectorate of Environmental Protection for monitoring of natural habitats and species. A global assessment was based on three parameters, i.e. "area of the habitat", "structure and function" [4], and "conservation prospects".

Countrywide, 9% of fens are in favorable status, 48% are in unfavorable-inadequate status, and 43% are in unfavorable-bad status. In terms of the number of objects, mountainous fens situated in the Carpathian Mountains are the best preserved; however, it should be mentioned that they cover a total area of only several tens of hectares (Wołejko et al. 2012). The results obtained for individual parameters unequivocally confirm a decline of the overall area of the habitat, and the inadequate and poor conservation status of a vast majority of alkaline fens in Poland (Wołejko et al. 2012).

Dramatic changes and a fast rate of extinction of this habitat to some extent reflect the results of the inventory of chosen plant species conducted under this project. For instance, the number of stands of yellow marsh saxifrage (ca. 25)—the species strongly associated with alkaline fens in good conservation status—represents only 10% of the historically known stands of this plant (Pawlikowski & Jarzombkowski, 2012)!

The role which alkaline fens play in the conservation of biodiversity of wetland ecosystems (a huge number of highly specialized rare, protected, and endangered species), and their services in the landscape (stabilization of water balance, carbon accumulation) in connection with their dramatic loss and deterioration, were the basic premises justifying realization of the project "Conservation of alkaline fens in young-glacial landscape of northern Poland" and its counterpart encompassing the remaining area of Poland.

1.5. Project LIFE11 NAT/PL/423 "Conservation of alkaline fens in young glacial landscape of northern Poland"—planned actions and actual results

Magdalena Makowska, Dorota Horabik

The project based on the assessment of conservation status of alkaline fens, described in the preceding chapter, was financially supported by the Financial Instrument for the Environment LIFE+ (50%), National Fund for Environmental Protection and Water Management (45%), and was realized by beneficiaries (5%): Naturalists' Club (leading) and Regional Directorates of Environmental Protection in Gdańsk and Olsztyn (partners) from September 2012 to June 2018. The aim of the project was to curb degradation of alkaline fens and to improve or preserve their conservational status at 30 Natura 2000 sites situated in northern Poland, as a habitat harbouring many rare, protected, and endangered with extinction plant species, especially those listed in Annex II of the Habitats Directive (yellow marsh saxifrage *Saxifraga hirculus*, yellow widelip orchid *Liparis loeselii*, and slender green feather moss *Hamatocaulis vernicosus*). Chosen areas include 89 of the most valuable and best preserved alkaline fens in the country, e.g., the Rurzyca River valley, Augustów Primeval Forest, Kaszuby Lake District, Słupia River valley, that are situated in 6 voivodeships: Lubuskie, West Pomeranian, Greater Poland, Pomeranian, Warmian-Masurian, and Podlaskie.

4 The parameter "structure and function" was evaluated basing on: occurrence of characteristic species, area and species structure of bryophytes, occurrence of alien invasive species, occurrence of expansive herbaceous plant species, appropriate water availability, structure of fen surface, peat excavation, drainage systems, presence of trees and shrubs

Detailed objectives of the project were as follows:

- to limit excessive water outflow and to increase the groundwater level in the chosen alkaline fens;
- to limit mineralization and eutrophication of the alkaline fen surface, resulting from excessive drying out;
- to halt reduction of biodiversity of alkaline fens caused by expansion of species characteristic of less humid habitats, e.g., grass, trees, shrubs;
- to purchase the most valuable and the most endangered fragments of alkaline fens in order to secure their long-term existence by establishing nature reserves;
- to popularize alkaline fen conservation methods based on good conservation and management plans supported by solid scientific evidence, with special consideration given to hydroecological aspects;
- to strengthen regional populations of extremely endangered with extinction species *Saxifraga hirculus* by its propagation and reintroduction into specific sites;
- to promote conservation of alkaline fens as areas capable of CO_2 accumulation which provide support to actions aimed at reducing the consequences of the greenhouse effect, and to assemble a group of people interested in alkaline fen conservation in the future, acting to make the project results sustainable.

Such a design of the project created an opportunity for preserving good conservation status or to improve the status of the most valuable areas where habitat 7230 can be found, which constitute 70% (on area basis) of alkaline fen resources occurring in northern Poland (30% of the country's resources), currently harboring characteristic sedge-moss vegetation. In addition, project realization contributed to strengthening and preservation of ca. 90% of yellow marsh saxifrage stands in Poland, ca. 50% of yellow widelip orchid and slender green feather moss stands, and ca. 50% of stands of other very rare plant species, e.g. fleshy starwort *Stellaria crassifolia* or bryophytes: *Meesia triquetra, Pseudocalliergon trifarium* and *Cinclidium stygium*.

1.5.1. Actions

The following actions were carried out within the framework of this project:

A1. Preparation of design and technical documentation and obtaining all necessary consents and administrative decisions authorizing construction of dam barriers and implementation of other non-technical measures aimed at improving water conditions in the fens. This action also included arrangements related to the purchase of land.

A2/A3. Preparation of draft conservation plans for existing and planned nature reserves along with plans of conservation measures for Natura 2000 areas within the boundaries of the project sites. This action was performed by the Partner, i.e. Regional Directorates of Environmental Protection in Gdańsk, or in close cooperation with it. This action also comprised of establishing new nature reserves and development of management plans for newly established but also existing reserves. Appropriate care was taken to ensure that the plans of conservation measures for Natura 2000 areas, where the project was realized, included appropriate recommendations for habitat 7230 to secure its proper conservation.

A4. Preparation of simplified documentation for habitat management plans, including plans of conservation measures for Natura 2000 areas within the boundaries of the project sites. Wherever management plans were not prepared (i.e., where fens were not situated within the boundaries of new or existing reserves), a "compendium of knowledge" about the habitat in a given area was developed. This documentation was prepared in order to assemble knowledge on the local habitat and to hand it to local (but not only) stakeholders so that they can use it in their work, e.g., in forest protection, issuing administrative decisions and changes in local law, including management plans. These documentations were prepared so as to encourage their use as the basis of application for inclusion of a given fen area into an agricultural-environmental-climatic scheme.

B1. Purchase of land for nature conservation. The aim of the land purchase was to prevent destruction of the most valuable patches of the habitat resulting from lack or incorrect conservation management by private owners, and incorporation of the purchased areas into nature reserve conservation system.

C1/C2. Construction of dam barriers. This action was executed together with the Partner, i.e., Regional Directorate of Environmental Protection in Olsztyn. The aim was to construct simple, small and maintenance-free wooden barriers in drainage ditches present in the fen. They were constructed in order to increase groundwater level and its stabilization at 10—15 cm below ground level. Owning to the improvement of water conditions, the encroachment of species preferring drier habitats was halted.

C3/C4. Preparatory mowing. This action was performed in cooperation with the Partner, i.e., Regional Directorate of Environmental Protection in Olsztyn. The aim was to restore extensive use of the areas of the project that were used for haymaking several decades ago, but this form of land use was then abandoned. In consequence, reeds, tree, and shrub species began to encroach on the dried fens, exacerbating the drying problem.

C6/C7. Removal of trees and shrubs. This action was performed in cooperation with the Partner, i.e., Regional Directorate of Environmental Protection in Olsztyn. As in the case of preparatory mowing, this action also aims to restore extensive land use. When traditional hand mowing was abandoned many years ago, to be able to restore it in many fens it is required first to remove tree and shrub undergrowth and then to perform first preparatory mowing.

C5. Optimization of water conditions disrupted by beavers. Conservation of habitat 7230 often clashes with the conservation of species (e.g., beaver) which oppose the habitat conservation measures. In an attempt to strike a fair balance between conservation of habitat 7230 which does not tolerate long-lasting flooding with surface waters, and conservation of the protected species, i.e., beaver *Castor fiber* L., perforated PVC tubing protected by a steel basket was installed in several beaver dams that permanently decreased water level (earlier impounded by the dam). It prevented permanent submersion of the habitat by surface waters without destruction of beaver lodges.

C8. Strengthening of the *Saxifraga hirculus* (yellow marsh saxifrage) population. This partly experimental action is described in detail in Chapter 3 of this Report. It aimed to develop a procedure for harvest, propagation, cultivation, and reintroduction of *Saxifraga hirculus* plants so as to strengthen the existing populations, or to reintroduce the population into areas were its stands were previously documented, but it withdrew due to negative habitat changes.

D1. Phytosociological and hydrological monitoring. In order to assess the impact of the implemented conservation measures and to provide basis for further actions, every conservation project requires monitoring of species composition and water conditions.

D2. Assessment of carbon accumulation potential of alkaline fens. This low-cost and narrow-scope action involved only an attempt to assess the significance of alkaline fens as a CO_2 store and to perform a cost estimation of this ecosystem service based on the literature data. Unfortunately, with a minimal budget it was only possible to perform a general comparison of literature reports and to draw conclusions about specificity of alkaline fens. More detail is available on the project website http://alkfens.kp.org.pl/pliki/ and in the Guidelines on Best Practice in Conservation of Habitat 7230 in Poland and Europe (Stańko et al. 2018), where the function of fens in the landscape is described more broadly.

E1/E2. Information and promotion actions. These included development of the project website (www.alkfens.kp.org.pl), preparation of promotional materials, organization of a series of training courses/seminars, and Guidelines on Best Practice in the Conservation of Alkaline Fens.

1.5.2. Results

During the 6 years of the project's implementation, the above tasks were successfully completed in the following areas:

Actions A2 / A3 - 12 conservation plans for nature reserves were prepared, of which 8 are newly established one during the project: in the Lubuskie Voievodship Mechowisko Kosobudki, Ratno, Ilanka II and in the Pomeranian Mechowiska Sulęczyńskie, Jezioro Krąg, Kruszynek, Mechowisko Radość and Gogolewko. Conservation plans for existing reserves have been developed for: Skotawskie Łąki, Mechowiska Czaple and Bukowskie Bagno. However, for the Manowo site, a full conservation measures plan for the entire Natura 2000 area (which is also a planned reserve Mechowisko Manowo) was developed.

Action A4 - 74 habitat management plans for remaining sites.

Action B1 - 61.5 hectares of land were purchased for purposes related strictly to nature conservation, including newly created reserves of Mechowiska Sulęczyńskie or Mechowisko Kosobudki, as well as in the Rospuda Valley and the planned Wierzchołek nature reserve in the Wielkopolskie voivodship.

Actions C1 / C2 - 130 dams, refractions and other facilities have been built to improve hydrological conditions.

Actions C3 / C4 and C6 / C7 - protective measures were carried out consisting in a one-off preparatory mowing on an area of 175 ha and removal of trees and shrubs from an area of 195 ha.

Action C5 - 8 devices were installed to stabilize water conditions disturbed by beavers.

Action C8 –plantations that strengthen existing populations of yellow marsh saxifrage was made or create new subpopulations in 13 places.

Three to six years have elapsed between planning and execution of the conservation actions. The plan often significantly differs from actual achievements. It is not a consequence of unrealistic planning but results from the fact that nature does not wait and has its own demands. Therefore, many conditions have significantly changed and the scope of the conservation measures had to be rethought. Other reasons include obstacles encountered during implementation of the project (lack of consents, lengthy procedures, etc.) or, on the contrary, unexpected opportunities (the initiative of owners or managers to sell land). Therefore, nature—like a living organism—should be approached with much flexibility and in a dynamic manner. We have tried to act in this way with a view to achieving the objectives set in the planning and implementation of this project. Unless we had met with the understanding of the institutions providing financial support to the project, we would not have been able to carry out many important, in our opinion, actions.

The monitoring of the results of the activities carried out as part of the project has generally confirmed the validity of both their type and scope, despite the fact that they sometimes required some modifications. The condition of the habitat has improved and in some cases you can even talk about "saving" the habitat from disappearing from the area. The nature of the habitat, and above all its transformations related to the activity of a human being, means that there are no effective, one-off methods ensuring its durability for many years. Full regeneration of mire ecosystems, especially those alkaline ones, usually requires the restoration of the natural hydrological regime and the restoration of the peat-forming process. Time in which it will be possible count in decades! We were aware of this for a long time before planning any conservation measures, which is why we considered the restoration of extensive use as one of the main goals of the project, which, combined with other protective measures, will improve the condition of the habitat and allow it to survive. Most of the activities must be continued (unfortunately, in the perspective of the next few decades - if it is possible at all) until the restoration of close to the natural hydrological conditions. The reader will find more in the so-called After-LIFE Plan - plan of actions to maintain the effects of the LIFE project, which should be taken after its completion.

The Naturalists' Club protects the most valuable habitats for over 35 years effectively obtaining appropriate funds for this purpose. Most of the protective measures taken nearly 30 years ago (protection of xerothermic grasslands in Owczary) have been continued so far. The protection of alkaline fens is one of the priorities of Club, therefore we intend to continue the activities described here in the future. Extensive mowing in most cases is ensured by CAP subidies. For the remaining part of the activities, i.e., monitoring the status of built-in dams, implementation of conservation plans or interventional activities, funds will be obtained from the Naturalists' Club budget, State Treasury resources in the RDEP budget or EU funding under other projects dedicated to the protection of alkaline fens carried out by the Club and other entities. Conservation prospects in the areas where the project was carried out are evaluated as good.

A detailed description of each action and the experiences acquired during their execution and results can be found in the full text of the Report (volume I). More detailed information about planned and realised activities Reader can find at the end of the book (Annex 1).

2. An example of the characteristics of alkaline fens protected by the project and the results of conservation measures and monitoring

Robert Stańko

2.1. Characteristics of Natura 2000 site „Dolina Pliszki"

A refuge with the surface area of more than 3,000 ha covering almost the entire valley of Pliszka River from its springs to its estuary, together with its edges and parts of forest complexes located on the hills and a part of its tributary – Konotop. The river is a tributary of Oder. The groundwater that feeds it mainly infiltrates areas of sandy sandurs. Surface and underground catchment areas of the river are covered with forests (a forest cover of ca. 85%), mainly pine forests. The natural values of the Pliszka River Valley are described in detail in numerous papers, including popular scientific publications, such as Wołejko and Stańko (1998). Until 1945, the mires in the Pliszka River Valley (except for small, wettest parts) were used as hay meadows after they had been drained. Agricultural use was gradually abandoned in the following years finally to cease completely in the 1990s. Since the abandonment of the agricultural use of the mires, the expansion of shrub and forest vegetation has been observed here.

Fig. 2. Historical map (ca. 1930) of the mires in the Kijewo site. The area is entirely used as meadows and strongly intersected by drainage ditches, which indicate high intensity of agricultural use and strong outflow of groundwater. At present, most ditches have completely disappeared. The process of abandoning agricultural use applies to all mires in the Pliszka River Valley and the neighbouring Ilanka River Valley.

Despite the above-average natural values described in documentation and applications for the establishment of a network of reserves to protect the most valuable parts of the valley, it was only in 2016 that two reserves were created at the request of the Naturalists' Club (within the LIFE project): "Mechowisko Kosobudki" (with a surface area of approx. 12.5 ha) and "Jezioro Ratno" (with a surface area of approx. 49 ha).

The mires of Pliszka River Valley are one of Lubuskie Province's best-preserved moss and spring mires with a through-flow of groundwater. They can be found here in interconnected complexes. The valley has the province's largest populations of species characteristic for habitat 7230, such as *Paludella squarosa, Helodium blandowii, Tomentypnum nitens*. Among vascular plants, still numerous populations comprise of blunt-flowered rush, fewflower spikerush and marsh helleborine. One of the biggest peculiarities of the valley is the active process of terrestrialization of the Ratno Lake due to the movement of a floating mat inhabited by a relatively large population of a fen orchid, estimated at about 60 specimen in 2016, which is covering more and more water surface.

Within the area, eight sites were identified for the purposes of the project – Konotop, Kosobudki I and II, Kijewo I and II, Pliszka, Wielicko and Ratno mires, which are either parts of larger mire complexes or independently functioning mires.

The active protection measures focused mainly on one-off mowing and removing small trees (C4 and C7 actions), limiting the negative effects of activities (C5 action) and improving hydrological conditions thanks to the construction of dams on drainage ditches (action C2). Within selected sites (Kosobudki II, Kijewo), hydrological monitoring was carried out by means of automatic water level recorders (so called divers) and phytosociological monitoring on designated areas (so-called transects). Based on information obtained during the project and previous studies, the effects of pro-

Fig. 3. Location of individual sites in the Dolina Pliszki area together with the distribution of research transects and hydrological monitoring points.

tective measures and changes that have occurred in the area over the past nearly 20 years have been assessed. The location of individual sites and selected monitoring elements (including research transects) is presented in Figure 3.

For details on the characteristics of each of the eight sites, please refer to the full version of the volume I of the Scientific Report. Below, one of the most interesting site is presented.

2.2. Characteristics of selected site

Reserve "Mechowisko Kosobudki" (Kosobudki II)

A compact mire complex of about 14 ha split apart by the Pliszka River. It is overgrown with alders to approx. 60%. The remaining part is covered by soligenous mires with a groundwater throughflow, which change locally into dome-like spring

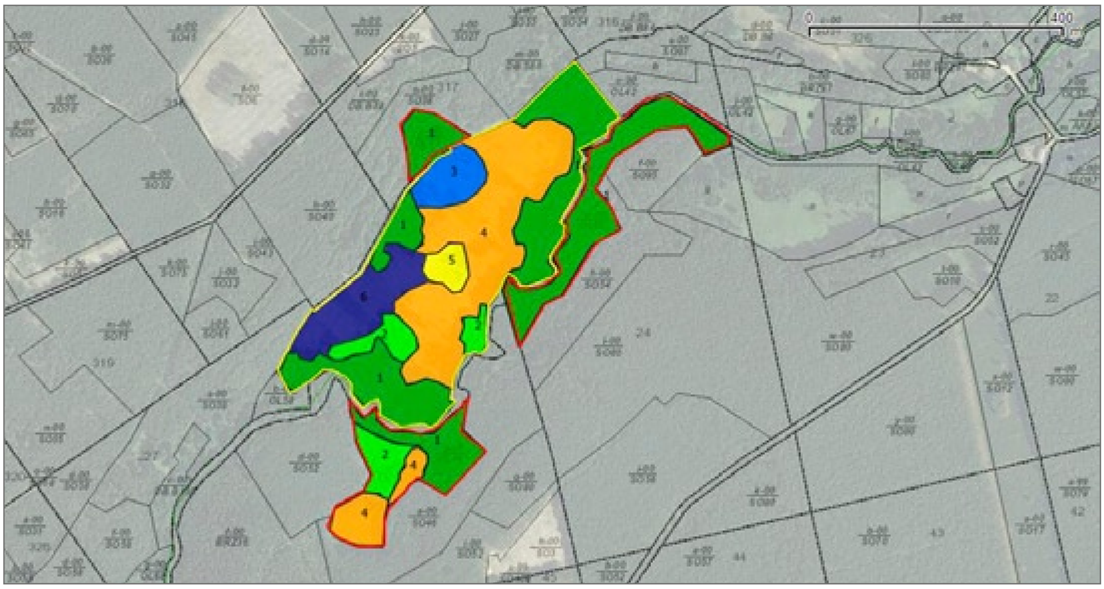

Fig. 4. Simplified map of actual vegetation. **Explanations:** 1 – ash alder forest (directly by the river) and spring alder forests entering sedge-moss communities, 2 – alder wildings on sedge-moss communities, 3 – mosaic of different tall sedge communities under the strong influence of the surface waters outflowing from the spring dome adjacent to the area, 4 – bogbean – Sphagnum vegetation partly with large participation of reed, 5 – meadow vegetation on mineral hill, 6 – mosaic of different tall sedge rushes, wetmeadow communities, patches of bogbean – Sphagnum vegetation developed in the hollows and along the ditches.

Photo 5: a, b. The value of the site is enhanced by other habitats occurring in the alkaline mire complex, i.e. a river covered with *Ranunculion fluitantis, Alnenion glutinoso-incanae* and dome spring mires (Photo R. Stańko).

Photo 6: A part of the mire bought by the Naturalists' Club as part of the project. There is a meteorological station installed in the far distance (Photo R. Stańko).

Photo 7: One of the gates built on a ditch draining the mire as part of the project (Photo R. Stańko).

mires (one of the best preserved in the region). Here, the patches of moss vegetation occupy the largest surface area in relation to the whole area of the Pliszka River Valley.

2.3. Actions undertaken, results and their monitoring

Active conservation measures within the project included: optimization of water conditions by building dams on drainage ditches (actions A1 and C2) and regulation of water level disturbed by beavers (action C5), trees removing (action C7) and mowing along with biomass removal (action C4). 'Kosobudki II' fen were covered by hydrological monitoring (action D1). In addition, on „Kosobudki II", a plot was purchased, which overlaps with newly established "Mechowisko Kosobudki" reserve (action B1), a conservation plan was developed for the site (action A3) and a meteorological station was installed (action D1). For other sites in the Pliszka Valley, detailed 7230 habitat management plans were also elaborated (action A4).

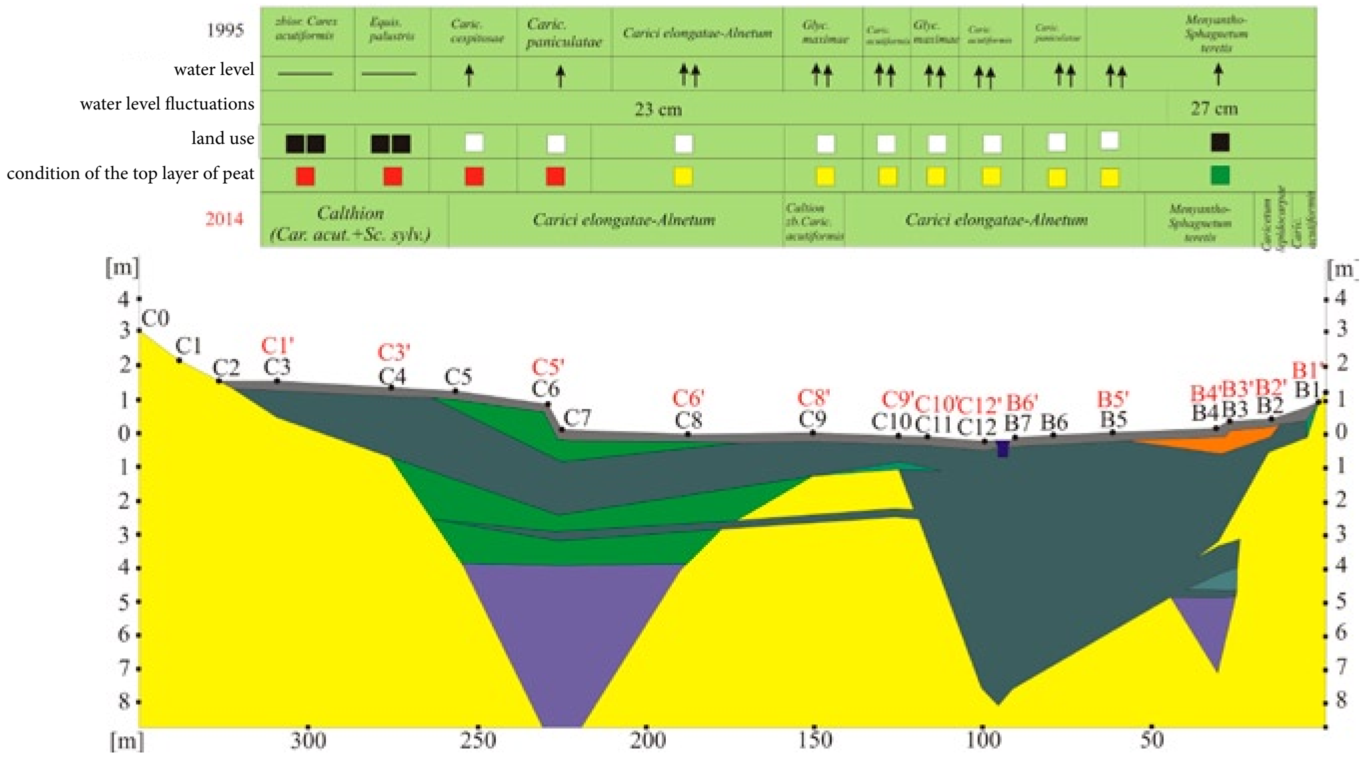

Fig. 5. Distribution of plant communities at the "B" and "C" transects between 1995 and 2014 in relation to water conditions, management measures, intensity of land use, and decomposition grade of peat in the proposed Mechowisko Kosobudki Nature Reserve.

Legend

Water conditions

- Stable conditions, small amplitudę of ground levels due to natural causes (precipitation)
- Small rise, systematic rising of ground water level during the observation period, within the range of 5 – 15 cm
- Strong rise, systematic rising of ground water level during the observation period, within range of 15 – 25 cm
- Very strong rise, systematic rising of ground water level during the observation period, above 25 cm
- Alternately strong rise and decrease of ground water level

Protection measures

- Lack of management and protection measures
- Extensive landuse of sporadic protection measures of no more than 1 – 2 times of mowing and/or 1 – 2 times of tree removal within 10 years period
- More intensive use by more than 2 Times of mowing and/or tree removal within 10 years period

Decomposition grade of Surface peat layer (von Post scale)

- Below 4
- 4-6
- 7-10

- highly decomposed topsoil
- strongly hydrated top layer of peat, overgrown with roots of plants
- mineral subsoil
- tall sedge peat
- tall sedge peat with sand
- tall sedge peat with wood
- tall sedge peat with wood and sand
- cladium peat
- small sedge brown moss peat
- shagnum sedge peat (transitional)
- organic gyttia
- calcareous gyttia
- organic – calcareous gyttia
- travertine
- loam – calcareous gyttia
- water

C6 - releve location

3. Strengthening of the population of a disappearing fen species – the yellow marsh saxifrage (*Saxifraga hirculus* L.)

Joanna Bloch-Orłowska, Elżbieta Cieślak, Katarzyna Żółkoś, Magdalena Kędra, Magdalena Makowska

The activity was carried out in 2013 – 2017 and was entirely entrusted to W. Szafer Foundation of Polish Botany in Krakow. The purpose of the task was to test in vitro breeding as a method of strengthening existing populations and reintroducing saxifrage in Poland.

3.1. Species characteristics

Saxifraga hirculus L. is linked to the open moss-sedge fens. It is encountered in sites with strong and stable water supply but never flooded. As a very low-competitive heliotropic plant, it grows in places with a low density of other vascular plants on moss patches made up of brown mosses (Łachacz 1995, Kosiński 2000, Bloch and Załuski 2001).

A species is not similar to other national representatives of the saxifrage genus. The flowering specimen are easy to find and identify. However, overlooking the species in its barren state is highly probable. The yellow marsh saxifrage blossoms from July to September.

Photo 8: Saxifrage in „Mechowisko Radość" reserve (Photo R. Stańko).

3.2. Methodology and applied measures

Initially, 12 sites (fens) located in Northern Poland were selected for the activities – Bagno Stawek, Dolina Kulawy, Torfowisko Radość, Jezioro Małe Długie, Sulęczyno, Jezioro Krąg, Sawonia Mostek, Poszeszupie, Żytkiejmska Struga, Bagno Parchacz, Torfowisko Kopaniarze i Orle. Sulęczyno, Dolina Kulawy, Bagno Parchacz i Orle were designated as yellow marsh saxifrage reintroduction sites, while the remaining ones were designated as sites to be reinforced with individuals bred as part of the project.

In 2014 from selected sites (where blooming/fuiting specimen were found) samples were taken for genetic analyses and in vitro breeding. The purpose of the genetic analyses was to test the genetic variability within and between populations of *Saxifraga hirculus* and determine the genetic relations between populations of *S. hirculus* from different areas of Poland (Pomerania, South Pomeranian Lake District, and Suwałki Lake District) – to find proper tactic in further implementation.

We found that there were no statistically significant differences in the level of genetic variability in populations. Molecular analyses also showed that the studied populations of *Saxifraga hirculus* in Poland are characterized by a relatively high level of genetic variability. Neither of the methods have shown a strong correlation between genetic diversity and geographical location. However, the results of PCO and cluster analyses clearly indicate a very even level of variability within the population and a high mutual similarity of individuals within the population. In the case of *Saxifraga hirculus*, it appears that the biology of the species – in particular the presence of vegetative and generative reproduction – has the main influence on the level and pattern of genetic diversity. Field observations show that most probably, in this species in Poland, there is a predominance of vegetative reproduction. In order to preserve the genetic structure of *Saxifraga* *hirculus*, although there is no close correlation between genetic and geographical distance, due to the observed differentiation between populations it was considered that individuals from a given population should first replenish the pools of the population from which they originate.

Obtained specimen of the yellow marsh saxifrage originated from 6 populations, including 3 from Pomerania (Bagno Stawek, Jezioro Krąg, and Mechowisko Radość) and 3 from north-eastern Poland (Sawonia-Mostek, Żytkiejmska Struga, and Torfowisko Kopaniarze). A small number of specimen obtained in the breeding process confirms the previous literature data on difficulties in breeding and multiplying the yellow marsh saxifrage.

Due to the small number of specimen of *Saxifraga hirculus* obtained from both seed growing and in vitro multiplication, as well as the fact that the obtained specimen originate from only a part of the population, it was considered appropriate to include only those populations from which progeny were derived, while disregarding the populations indicated in the project for reintroduction. The aim of this measure was to increase the chances of survival of the cultivated plants.

New plants were introduced in 2015 and 2017 in small clusters (usually 3 – 4 specimen) not far from the existing populations of yellow marsh saxifrage, in places with similar habitat conditions favorable for this species. It was done by hand. In addition, in the immediate vicinity (within a radius of approximately 20 cm) of their reintroduction, aboveground shoots of neighbouring vascular plants were cut and removed in order to restrict competition and improve access to light.

As a result of in vitro multiplication and partially of the growing from seeds, a **total of 143 specimen of yellow marsh saxifrage were finally obtained. As a result of their reintroduction, 13 species occurrence locations were created, i.e., 13 subpopulations located in 8 fens in northern Poland**. In most cases it was a contribution to the existing yellow marsh saxifrage populations, whereas in the Dolina Kulawy and Mechowiska Sulęczyńskie Reserves it was the introduction of a species which did not occur there at the time. The layout of the subpopulation's patches adopted at the time of planting was similar to the natural occurrence of the species.

During the period of full flowering of the species between 22 July and 14 August 2016, and also for selected populations at the end of the 2017 growing season the monitoring of success was carried out.

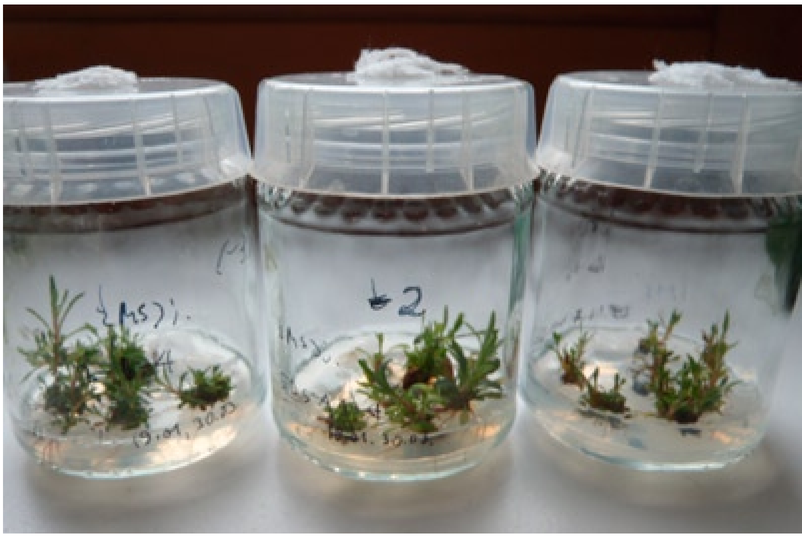

Photo 9: Multiplication of Saxifraga hirculus shoots (Photo M. Kędra).

Populations of *Saxifraga hirculus* were found at all the sites included in the study. At the same time, presence of specimen from cultivation or multiplication was confirmed at all sites of reintroduction, although their numbers varied between 20 – 100% (from 20 to 100% of specimen adopted and survived until the next growing season).

Photo 10: young seedlings planted on moss layer (Photo J. Bloch-Orłowska).

Annex 1. Planned vs actually implemented actions.

Name of LIFE project site	Name of the fen	Name and code of Natura 2000 site	Dams and other objects to improve hydrological conditions [pcs]		One-off mowing [ha]		Trees removal [ha]		Devices to optimalize water conditions disrupted by beavers [psc]		Conservation plans for nature reserves [pcs]		7230 habitat management plans [pcs]		Plots bought strictly for nature protection purposes [ha]		Metaplantation of *Saxifraga hirculus* [new subpopulations]		Newly established nature reserves/ proposed – not established
			P[1]	R[2]	P	R	P	R	P	R	P	R	P	R	P	R	P	R	
Dolina Pliszki	Konotop	Dolina Pliszki (PLH080011)							1	1			1	1					
	Kosobudki						0,70	0,93	0	1			1	1					
	Kosobudki 2			21		1,00	0,22				1	1				12,5			„Mechowisko Kosobudki”
	Kijewo 2						1,59	1,59					1	1					
	Kijewo					1,6	0,38	0,38					1	1					
	Torfowisko Pliszka					4,00	2,89	2			1								„Torfowisko Pliszka”
	Ratno						0,20				1	1	1	1					„Jezioro Ratno”
	Jezioro Wielicko					2,2	2,22	2,2					1	1					
Dolina Ilanki	Ilanka 3	Dolina Ilanki (PLH080009)											1	1					
	Ilanka 1						3,85	3,86					1	1					
	Ilanka 2							3,03					1	1					
	Ilanka 5												1	1	14,00				
	Ilanka 4				2,05	2,07	2,04	2,06	1				1	1					
	Ilanka 7				1,00	0,97	1,00	0,97	1				1	1					
	Ilanka 8												1	1					
	Ilanka 6										1	1			7,00				„Dolina Ilanki II”

Młodno	Młodno	Torfowisko Młodno (PLH080005)			5,58	5,67	4,13	4,21	1				1	1					
Wierzchołek	Wierzchołek	Uroczyska Kujańskie (PLH300052)			1,16	1,10	1,16	0,96	1	1			1	1	0,50	2,65			„Jezioro Wierzchołek”
Torfowiska Sandru Brdy	Bagno Stawek	Sandr Brdy (PLH220026)			6,13	5,77	5,00	7,06					1	1			1	2	
	Jezioro Głuche Małe 1						0,96	0,97					1	1					
	Jezioro Głuche Małe 2						0,20	0,20					1	1					
	Jezioro Głuche Małe 3						1,60	1,58					1	1				2	
	Zapceń 1						0,60						1	1	0,50		1		
	Zapceń 2		1	1		3,05							1	1			1		
Zapceńskie Mechowiska	Torfowisko Radość	Ostoja Zapceńska (PLH220057)			2,00	2,04	3,00	3,69			1	1			0,50		1	1	„Torfowisko Radość”
	Jezioro Kruszyńskie				1,50	1,69	1,00	1,35			1	1							„Kruszynek”
Jezioro Małe Długie	Jezioro Małe Długie	Rynna Dłużnicy (PLH220081)			2,00	1,10	1,00	0,25	3	4	1						1		„Jezioro Małe Długie”
Sulęczyno	Sulęczyno	Mechowiska Sulęczyńskie (PLH220017)			5,00	8,24	5,00	9,41			1	1			20,00	6,7	1	2	„Mechowiska Sulęczyńskie”
Jezioro Krąg	Jezioro Krąg	Jezioro Krąg (PLH220070)			1,30		1,30				1	1			5,00		1	3	„Mechowisko Krąg”
Manowo	Manowo	Mechowisko Manowo (PLH320057)		5	9,80	9,79	8,65	21,75			1	1*							„Mechowisko Manowo”
Torfowiska Radwi i Chocieli	Zgniła Struga	Dolina Radwi, Chocieli i Chotli (PLH320022)											1	1					
	Lubowo		1				2,00						1	1					
	Kwiecko						0,50				1								„Kwiecko”
	Drzewiany		3	8	3,00	2,35	1,00	0,78					1	1					
	Dolina Łęcznej		10		6,00	3,7							1	1					
Dolina Płoni - Żydowo	Dolina Płoni - Żydowo	Dolina Płoni i Jezioro Miedwie (PLH320006)	15	7	5,00	2,00	3,00						1	1	25,00				„Dolina Płoni”

Dolina Rurzycy	Diabli Skok	Dolina Rurzycy (PLH300017)			1,50	5,7	1,00	5,60					1	1					
	Wielkopolska Dolina Rurzycy				7,00	9,61	2,30	4,43					1	1					
	Smolary				0,80	2,15	0,50	1,30					1	1					
Uroczyska Puszczy Drawskiej	Mielęcin Bukowo	Uroczyska Puszczy Drawskiej (PLH320046)	5	6	2,13	2,13		2,13					1	1					
	Stara Korytnica		5	5									1	1					
	Nowa Studnica		10	10	0,13	0,12					1								„Nowa Studnica”
	Jez. Bukowo Długie i Małe								0	1	1	1							
	Nowa Korytnica 2				1,00	0,92							1	1					
	Nowa Korytnica 3		13	3									1	1					
Orle	Orle	Orle (PLH220019)	15		20,00		20,00				1								
Puszcza Knyszyńska	Stare Biele	Ostoja Knyszyńska (PLH200006)	3		6,98		5,85						1	1					
	Łosiniany				1,50	4,19	1,00	3,22					1	1					
Puszcza Augustowska	Augustów - ogródki	Ostoja Augustowska (PLH200005)			1,46	1,46	0,80	0,78					1	1					
	Kobyla Biel				8,00	4,45	5,00	4,45			1				8,00				„Kobyla Biel”
	Kalejty				0,20		0,10						1	1					
	Przewięź				0,60		0,40						1	1					
	Płaska				2,30		0,50						1	1					
	Jazy				0,40	0,68	0,40	0,68					1	1					
	Borsuki				4,50		3,50				1								„Borsuki”
	Perkuć				8,50	9,02	5,00	9,02					1	1					
	Sawonia - Mostek		3		1,60		0,50				1						1	1	„Sawonia-Mostek”
	Żyliny				1,50		0,60						1	1					
	Dolina Rospudy				3,00		3,00				1				5,00	36,22			„Dolina Rospudy”
	Sarnetki				5,00	22,06	2,00	19,42					1	1					

Wigry	Jez. Kruszyn	Ostoja Wigierska (PLH200004)	3	3	0,15		0,10						1	1					
Poszeszupie	Wingrany	Dolina Szeszupy (PLH200016)	1		1,00	1,89	1,00	1,27					1	1					
	Rudawki		10	18	5,00	18,00	4,00	14,53					1	1	7,00	3,53			
	Poszeszupie		1		2,00	2,11	1,10	1,64					1	1			1		
Rowelska Góra	Rowele	Torfowiska Gór Sudawskich (PLH200017)	5		1,00	1,05	1,00	1,03					1	1	1,00				
Jeleniewo	Dziabel	Jeleniewo (PLH200001)			0,40	0,32	0,40	0,32					1	1					
	Sumówek		1		0,30		0,30						1	1					
	Jez. Purwin	Ostoja Suwalska (PLH200003)			0,20	0,27	0,20	0,27					1	1					
Dolina Czarnej Hańczy	Hańcza	Ostoja Suwalska (PLH200003)	4		2,00	0,38	1,50	0,27					1	1					
	Linówek				0,50	0,32	0,40	0,32					1	1					
	Czarnkowizna	Jeleniewo (PLH200001)	1		2,00	1,47	1,20	1,23					1	1	2,50				
	Stara Wieś		1		1,80	1,07	1,80	0,94					1	1	1,80				
	Morgi				3,00	2,62	2,00						1	1	3,20				
	Rutka				3,00	3,41	1,00	1,67					1	1					
	Stara Pawłówka				3,00	3,42	2,80	3,42					1	1					
Żytkiejmska Struga	Żytkiejmska Struga N	Puszcza Romincka (PLH280005)			0,30		0,10						1	1					
	Żytkiejmska Struga S		15		0,50	0,78	0,20						1	1			1	1	
Bagno Parchacz	Bagno Parchacz	Dolina Górnej Rospudy (PLH200022)			3,00	1,62	2,30	1,36					1	1	3,00		1		
Zocie	Zocie	Torfowisko Zocie (PLH280037)	8		2,00	8,62	2,00	8,62					1	1	2,00				
Drozdowo	Drozdowo	Mazurskie Bagna (PLH280054)	4		2,00		0,80						1	1					
Głógno	Głógno	Ostoja Piska (PLH280048)			1,50	1,37	1,00	1,37					1	1	2,00				

Trępel	Trępel	Ostoja Napiwodzko-Ramucka (PLH280052)	3	2	3,00	3,10	1,50	2,47					1	1					
Kopaniarze	Kopaniarze	Ostoja Welska (PLH280014)	3	6	1,50	1,86	1,00	1,47					1	1			1	1	
Torfowiska Doliny Słupi	Gogolewko	Dolina Słupi (PLH220052)	16	18			35,00	32,53			1	1							„Gogolewko”
	Skotawskie Łąki		26	17							1	1							
	Mechowisko Czaple										1	1							
	TOTAL:		**186**	**130**	**169**	**175**	**170**	**195**	**8**	**8**	**21**	**12**	**66**	**66**	**32 ****	**61,5**	**12**	**13**	**8/11**

* - the conservation measures plan was elaborated for Natura 2000 site that overlaps with proposed reserve „Mechowisko Manowo”

1 Planned scope
2 Realised scope

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