Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XIV, 2025
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

RESTORATION ACTIVITIES AND BIODIVERSITY SURVEY OF WEST STUPINI MIRE IN THE BÂRSA DEPRESSION: BASELINE FOR NATURA 2000 CONSERVATION

Anca MANOLE[1], Ana-Maria MOROȘANU[1], Attila MÁTIS[2], Anna SZABÓ[2], Georgiana-Roxana NICOARĂ[1], Florența-Elena HELEPCIUC[1], Mihnea VLADIMIRESCU[1], Ioana Cătălina PAICA[1], Mihaela CIOBOTĂ[1], Daniela Elena MOGÎLDEA[1], Constantin-Ciprian BÎRSAN[1], Constanța-Mihaela ION[1], Tiberiu SAHLEAN[1], Sorin ȘTEFĂNUȚ[1]

[1]Institute of Biology Bucharest of the Romanian Academy,
296 Splaiul Independenței, District 6, 060031, Bucharest, Romania
[2]Babeș-Bolyai University, Faculty of Biology and Geology,
5-7 Clinicilor Street, 400006, Cluj-Napoca, Romania

Corresponding author email: anamaria.morosanu@ibiol.ro

Abstract

The Stupini mire, proposed as a new Natura 2000 site, is a wetland located in Romania's Bârsa Depression. The site hosts a diverse range of habitats, including alkaline fens (7230), calcareous fens (7210), Molinia meadows (6410), hygrophilous tall herb communities (6430), and alluvial forests (91E0*). This study highlights the ecological importance of the mire and evaluates the impact of recent restoration efforts. Vegetation surveys conducted between 2022 and 2024 confirmed the presence of rare and protected species, such as Swertia perennis and Primula farinose as well as the glacial relict Ligularia sibirica, a species protected under European legislation. However, the rare orchid Liparis loeselii was not detected, raising concerns about its possible local extinction due to drought and habitat degradation. To counteract these threats, restoration efforts focused on reestablishing the hydrological balance and removing invasive species. These measures resulted in a notable increase in the water table, with levels rising by up to 10 cm. The findings underscore the urgency of continued conservation efforts and formal designation of the site under Natura 2000 to prevent further biodiversity loss.*

Key words: *anthropic pressure, climate change, invasive species, rare species, biodiversity conservation.*

INTRODUCTION

At the United Nations Climate Change Conference held in Paris (COP21) the Intergovernmental Panel on Climate Change (IPCC) concluded the need for carbon neutrality by 2050, in order to prevent the rise of global temperatures beyond 2°C. In this respect, several nature-based solutions for climate change mitigation have been proposed, such as sustainable use of forest lands, croplands, wetlands, and grasslands to enhance their potential to store carbon (IPCC, 2021). The proposed solutions align with Aichi Target 15 from Convention on Biological Diversity, committed to restore at least 15% of degraded ecosystems by 2020 (CBD, 2013). They also correspond with the most recent Kunming-Montreal Global Biodiversity, Framework Target 2, which focuses on the restoration of degraded land to enhance biodiversity and ecosystem functions and services (CBD Secretariat, 2022). According to Bossio et al. (2020), soil carbon represents 25% of the potential of natural climate solutions (total potential, 23.8 Gt of CO_2-equivalent per year) and comprises 72% of the mitigation potential of wetlands. As part of the wetland category, peatlands cover only 3% of the global land area but store more carbon than that contained in the world's tropical rainforest biomass (Page & Baird, 2016). Unfortunately, through degradation, peatland carbon sinks are turned into carbon sources (Erkens et al., 2016).

During the past 150 years extensive peatland areas in the temperate and boreal zones have been drained mainly for agriculture. Over 70% of peatlands in Europe have been lost due to agricultural expansion, forestry, and urban development (Raeymaekers et al., 2000). It is estimated that peatland drainage contributes to 10% of global annual anthropogenic greenhouse gas emissions (Page & Baird, 2016). Thus, a reliable nature-based solution for climate change mitigation is the restoration of natural carbon sinks, such as degraded peatlands. Peatlands are strategic areas for climate change mitigation as their restoration results in safeguarding existing soil carbon stocks (Günther et al., 2020). Apart from their role in carbon storage and sequestration, peatlands deliver a range of ecosystem services, including water regulation, biodiversity protection, natural risk mitigation, food and fuel, and recreation opportunities (Page & Baird, 2016). Only 17% of peatlands are protected worldwide, according to Austin et al. (2025), which is much less than the percentage for many other high-value ecosystems. Thus, we consider it a pressing need to enhance the efforts made for this purpose, in Romania as well.

In order to restore peatland ecosystems services, the Institute of Biology Bucharest of Romanian Academy implemented a range of projects starting in 2015 (with *PeatRo* acronym), financed through the EEA Grants (https://www.ibiol.ro/). Within one of these projects entitled *Degraded mires and peatlands restoration of North-East 1 region of Romania (PeatRO2)* a series of restoration activities were performed in Stupini mire.

Currently, peatlands in Romania lack biodiversity assessment, habitat restoration strategies and a legal framework to protect these sensitive ecosystems. The present study aims to address these gaps for the Stupini mire. Assessment of the reference state of the site, showed an unfavorable conservation status, resulting from a significant decline in the water table, alterations of the characteristic vegetation with the presence of invasive species, and other anthropic pressures. As a result, a comprehensive restoration plan addressing all these factors was made.

In order to preserve in time and space the results of restoration activities, the Stupini mire was proposed as a Special Area of Conservation (SAC) under Natura 2000 Network. The current work first describes the study site and methods, then presents preliminary results on biodiversity and hydrological restoration and provides perspectives to strengthen conservation efforts of the site by including it in the Natura 2000 Network.

MATERIALS AND METHODS

Study site

The mire is situated in the Bârsa Depression, between the Bârsa and Ghimbășel valleys (45º42′3.04″N, 25º32′37.49″E), at an altitude of 560 m a.s.l. with a slight inclination to the north (Figure 1).

The site extends over 9.257 ha and hosts a meso-eutrophic marsh, being a complex formed by meso-eutrophic marshes, reedbeds and sedge communities, alluvial forests and wet meadows.

Vegetation monitoring and data collection

Between 2022 and 2024, botanical surveys were conducted in order to identify plant species, characterize the vegetation, and evaluate the site's conservation potential. For a comprehensive assessment of the site's ecological integrity and long-term vegetation trends, multiple field investigations were carried out throughout the vegetation seasons, providing complementary data on floristic composition and habitat conditions. Transects were made to capture the variability of all habitat types, with at least one transect established for each habitat type. The number and length of transects varied depending on the size and distribution of each habitat within the site.

In April 2022 we surveyed the springs in the floodplain and primarily the aestival aspect of vegetation, taking GPS coordinates and photo documentation at the springs and traces of previous drainage or other anthropic impact. In addition, we listed the flowering species. In July, homogeneous vegetation patches were delineated based on a preliminary map, which allowed us to determine the size of the habitat patches. We also completed the list of plant species.

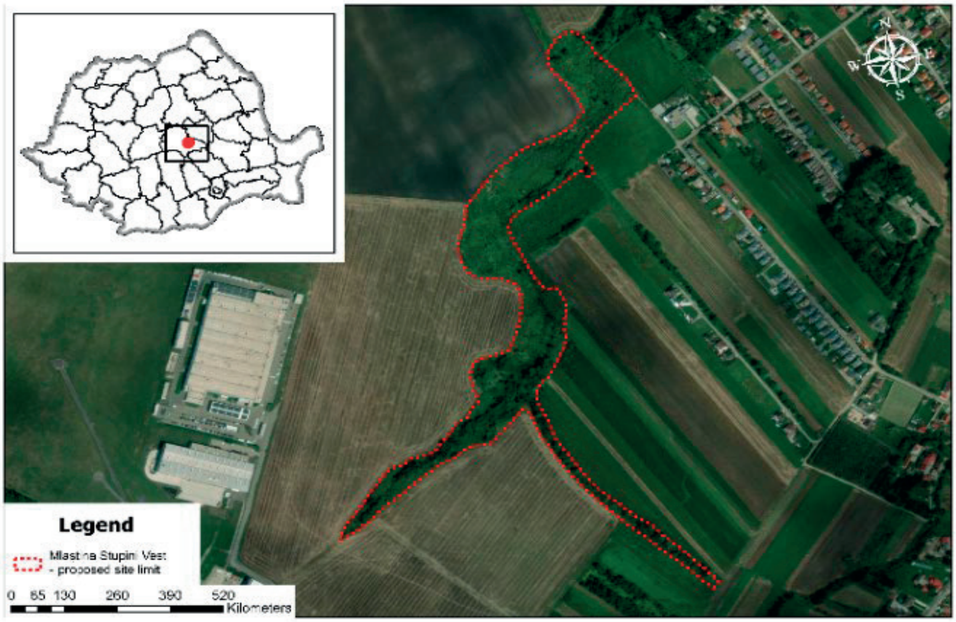

Figure 1. Satellite image of the proposed Stupini mire SAC

In July 2023 and April 2024, further field surveys were carried out to confirm the previously identified species.

Nomenclature for cormophyte taxa follows the Plants of the World Online (POWO) online database published by the Royal Botanic Gardens, Kew, while habitat types and plant associations are given according to Gafta and Mountford (2008).

Restoration Activities

The primary cause of degradation at Stupini mire is water loss due to artificial drainage, which has led to significant habitat alteration. To mitigate this, restoration activities focused on two main objectives: (1) reestablishing water balance and (2) controlling invasive species.

Hydrological restoration

In April 2024, a dam was constructed over the main drainage channel to reduce water loss and restore natural hydrological conditions (Figure 2). The channel, originally straightened and deepened for land drainage, significantly lowered groundwater levels. The dam was designed using a combination of wooden beams, soil, and plant material to mimic natural hydrological barriers. It measured 130 cm in length, 60 cm in width, and 50 cm in depth.

Figure 2. Dam over the main water drainage channel from Stupini mire
(photo by Ana-Maria Moroșanu, 08.04.2024)

Invasive species control

A secondary but equally critical restoration measure involved the removal of invasive species, particularly *Solidago canadensis*, which poses a major threat to native biodiversity. Invasive plants were manually uprooted along with their root systems to prevent recolonization.

In order to lay the groundwork for creating a legislative framework for the conservation and protection of the Stupini mire, the restoration efforts aimed to improve the site's hydric characteristics. Identification of important species and a continued and improved monitoring strategy will be essential for assessing the stability and effectiveness of long-term restoration initiatives.

Monitoring activities

To assess the effect of restoration activities special devices were placed on site, as follows:

- two Data Loggers (EasyLog EL-USB 2 type), to monitor temperature, relative humidity, and dew point, measured every 30 minutes;
- 5 piezometers (one central and 4 in peripheral position), measured in July 2023 and April 2024.

One of the two data loggers was lost, likely due to its proximity to an urban area, where increased human activity and recreational use make monitoring instruments more susceptible to disturbance. This contrasts with our Norwegian project partner's experience in remote regions of Norway, where such interference with peatland restoration and monitoring is significantly less.

RESULTS AND DISCUSSIONS

Site quality and importance

A vestigial part of the vast marshy areas that covered the Bârsa depression in the past (Pop, 1960), the Stupini mire, although occupying a small area, represents one of the few remaining areas that shelter plant communities of particular scientific importance.

Vegetation surveys revealed that the site hosts several habitats of community importance, included in Annex I of the Habitat Directive, and require special conservation area designation. These habitats are:

- 7230 Alkaline fens, with the plant associations *Orchido-Schoenetum nigricantis,* Oberdorfer 1957, *Caricetum davallianae,* Dutoit 1924 and *Seslerietum uliginosae* (Palongy 1915) Soó 1941 (Figure 3) with an area of 1.2 ha. Their ecological importance lies in their role in sustaining wetland hydrology and providing habitat for rare and specialized plant species and communities, adapted to nutrient-poor, base-rich wetland conditions and dependent upon a constant hydrological regime. These fens act as refuges for numerous orchids, sedges, and bryophytes, contributing to overall ecosystem stability and resilience (Šefferová et al., 2008).
- 7210* Calcareous fens with *Cladium mariscus* (L.) Pohl and species of *Caricion davallianae* Klika 1934 (Figure 4), present on an area of 0.2 ha, forming a rare wetland habitat that depends on stable groundwater levels (Frink et al., 2013).
- 6410 *Molinia* meadows on calcareous, peaty or clayey soils, with the *Molinietum coeruleae* Koch 1926 plant association, with an area of 1.5 ha. *Molinia* meadows are species-rich semi-natural grasslands that support a high diversity of plants; their conservation depends on traditional management, such as mowing or light grazing, to prevent shrub encroachment and maintain their biodiversity value (Ziaja, 2017).
- 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels with an area of 1.5 ha. This habitat is a species-rich, tall herb community that acts as a biodiversity hotspot along water bodies and offers essential resources for pollinators and wetland species (Joint Nature Conservation Committee, 2013).
- 91E0* Alluvial forests of *Alnus glutinosa* (L.) Gaertn. and *Fraxinus excelsior* L. (*Alno-Padion* ex Medwecka-Kornaś in W. Matuszkiewicz et Borowik 1957*, Alnion incanae,* Pawłowski et al. 1928, *Salicion albae* Soó 1951) with an area of 2 ha. This priority floodplain forest dominated by *Alnus glutinosa* plays a key role in flood regulation and soil stabilisation, and functions as an ecological corridor that supports habitat connectivity within riparian ecosystems (Danci, 2015).

The Stupini site is rich in rare and/or relict plant species such as felwort (*Swertia perennis* L.), the bird’s eye primrose (*Primula farinosa* L.), several species of sedge (*Carex davalliana* Sm., *Carex paniculata* L., *Carex lepidocarpa* Tausch, *Carex panicea* J.Carey, and *Carex hostiana* DC.), the black bog-rush (*Schoenus* *nigricans* Hoppe), and the brown bog-rush (*Schoenus ferrugineus* Huds.). Also, several species of orchids can be admired in June-July, such as the early marsh-orchid (*Dactylorhiza incarnata* (L.) Soó) (Figure 5), the marsh helleborine (*Epipactis palustris* (L.) Crantz) (Figure 6), and the marsh fragrant-orchid (*Gymnadenia densiflora* (Wahlenb.) A. Dietr.) (Figure 7).

Another important plant species identified in site is *Ligularia sibirica* (L.) Cass., a glacial relict protected under the Habitats Directive, Annex II (Figure 8).

The identified population is relatively small and consists of 15-20 well developed individuals, all in the flowering stage at the end of July. The presence of this glacial relict confirms that Stupini mire functions as a glacial refugia. Fed by cold springs, the site has created conditions for the perpetuation of glacial relict plant species.

During the period 11-14.07.2022, the rare and declining species *Liparis loeselii* (L.) Rich. (fen orchid or yellow widelip orchid, Natura 2000 species code: 1903 was reassessed). The species of community interest was previously identified by one of us at Stupini mire, in 2013 with a population of at least 15 flowering specimens.

Figure 3. Alkaline fen habitat (**7230**) in summer, showcasing characteristic species and hydrological conditions
(photo by Anna Szabó, 22.06.2022)

Figure 4. Habitat **7210*** with the characteristic swamp sawgrass (*Cladium mariscus*), a priority conservation habitat that persists on only 0.2 ha, making it highly vulnerable to groundwater decline, which threatens its long-term stability and biodiversity
(photo by Attila Mátis, 22.06.2022)

Figure 5. *Dactylorhiza incarnata*, a moisture-dependent orchid, now restricted to the few remaining wet areas as the fen habitat continues to degrade
(photo by Attila Mátis, 14.07.2022)

Figure 6. *Epipactis palustris*, a wetland orchid species that endures in isolated refuges where groundwater flow is still high, but where it faces increasing pressure due to drying habitat
(photo by Attila Mátis, 14.07.2022)

Figure 7. *Gymnadenia densiflora*, an orchid species that persists in the last patches where the groundwater level remains high, threatened by habitat desiccation. It occurs in the habitat 7230 Alkaline fens, within the plant association *Orchido-Schoenetum nigricantis*
(photo by Attila Mátis, 14.07.2022)

Figure 8. *Ligularia sibirica*
(photo by Anca Manole, 25.07.2023)

Unfortunately, not a single specimen of *Liparis loeselii* could be detected in any of the three small fragments of habitat 7230, represented mainly by the plant association *Orchido-Schoenetum nigricantis* Oberdorfer 1957. The absence of the species may be due to the exceptional drought of the year 2022, but there is a bleak possibility that the species completely disappeared because of the continuous drainage activities, and because of water capture from the Lauterbach tributary upstream of the mire.

Unfortunately, because of habitat degradation other rare plant species that require humidity, such as: *Drosera anglica* Huds., *Pinguicula vulgaris* L., *Menyanthes trifoliata* L. and *Saxifraga mutata* L. could not be reconfirmed in site.

During the survey, an expansion of the eutrophic species *Carex acutiformis* Brot. was observed consequently with a regression of the *Carex* species characteristic of type 7230 habitat. Thus, only a few bushes of *Carex davalliana* Sm. and *Carex paniculata* L. were detected. In alkaline marshes, the species *Carex lepidocarpa* Tausch and *Carex hostiana* DC. are often abundant, but in this area, they were suppressed by a hybrid between the two mentioned species, *Carex* x *leutzii* Kneuck., a taxon that has not been reported so far from the Romanian flora (Attila Mátis, Anna Szabó - personal communication, 22 June 2022). This sterile hybrid has pronounced vegetative reproduction, becoming the dominant sedge in the *Orchido-Schoenetum nigricantis* plant association.

Habitats of type 7230 and 7210* are also threatened by the expansion of reed (*Phragmites australis* (Cav.) Trin. ex Steud.), which, facilitated by the lowering of the water table, invades and shrinks habitats characterized by sedge species (Figure 9).

Drought, due to climate change, accentuates the negative impact of drainage channels, water captured from the Lauterbach tributary upstream of the Stupini mire, and the presence of invasive species. These are the main causes of lowering the water level in the substratum and ongoing habitat degradation. As a result, rare species that depend on a high water level in the substratum, such as *Liparis loeselii*, *Drosera anglica*, *Pinguicula vulgaris*, *Menyanthes trifoliata*, and *Saxifraga mutata*, are disappearing.

Figure 9. Habitat 7230 invaded by reed
(photo by Attila Mátis, 22.06.2022)

Although no extensive faunistic inventory was carried out, the house snake (*Natrix natrix* L.) was identified on site and should also be considered for conservation because the species was recently reclassified, according to the study carried out by Kindler et al. (2017). Thus, the range of the house snakes has suffered a significant reduction, and the impact of this change on the conservation of the species has not been assessed.

Preliminary effects of restoration activities

Even though the period between measurements was relatively short (between 20.09.2023, and 08.04.2024), the data from all five piezometers showed that the water table raised 1.5, 3.5, 4.5, 7.5, and 10 cm, respectively. Within the same interval, the maximum temperature value (31ºC) was recorded on 23.09.2023, and the minimum value (-17ºC) on 10.01.2024, with an average of 6.1ºC, during the measurement period. The air humidity recorded a maximum of 97% on 11.08.2023, and a minimum of 25%, on 21.07.2023, with an average of 75.8%. The dew point recorded a maximum of 18.4ºC on 1.08.2023, and a minimum of -18.8ºC, on 10.12.2023, with an average of 1.7ºC (Figure 10).

With implications for comprehending the impact of climatic conditions on water table oscillations and general ecosystem function, these data offer insightful information about the site's environmental dynamics. A warmer climate and altered precipitation patterns are driving changes in peatlands` vegetation, resulting in an increase in vascular plant cover, a decrease in peat moss abundance and an earlier onset of the growing season (Antala et al., 2022). Moreover, shifts in plant phenology result from climate change and can serve as indicators of environmental transformation and species adaptation to evolving conditions (Parmesan & Yohe, 2003; Visser and Both, 2005).

Restoring flooding is the first step in maintaining and conserving specific marsh species that depend on water levels. The importance of water levels is highlighted by Lou et al. (2020). In their survey, they found that over 40 years, water levels decreased, leading to a substantial decline in the abundance of species with higher optimal water levels.

The need for improved monitoring strategies is just as pressing even though Romania’s peatlands cover a significantly smaller area compared to those in Norway, for example, which have utilized more complex monitoring methodology. According to Kyrkjeeide et al. (2024), current monitoring efforts in Norway are limited in geographical and hydro morphological diversity hampering a thorough knowledge of restoration outcomes.

In a comparative study of eight national initiatives, Nordbeck & Hogl (2024) indicates that these strategies are making significant progress in raising awareness and building capacity. However, integrating policies across different sectors remains the main obstacle to effective implementation. The experiences of trailblazing nations provide important insights and a solid basis for developing their own effective, integrated approaches to peatland management and restoration for nations that have not yet established a national peatland policy.

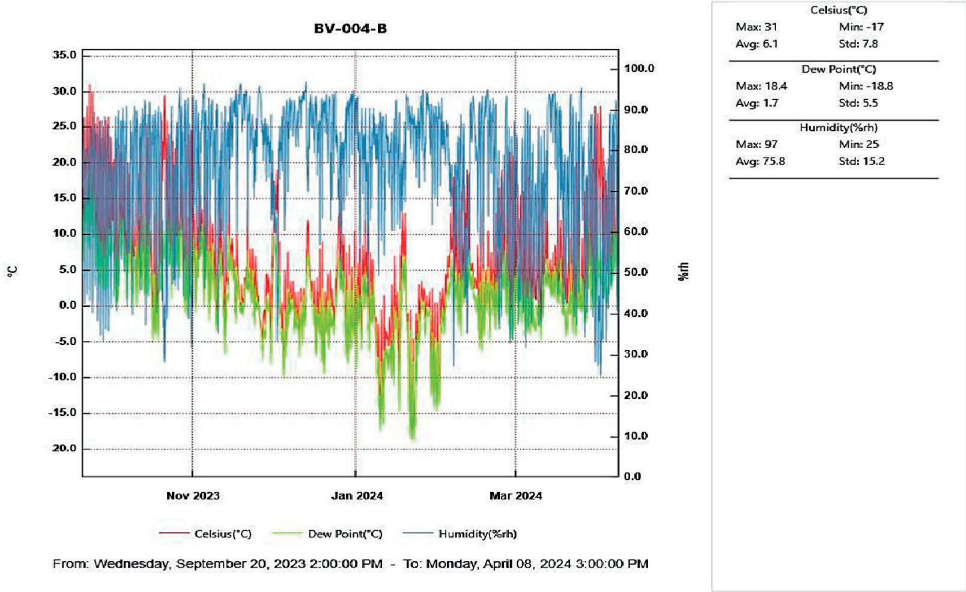

Figure 10. Abiotic parameters of the air recorded in Stupini mire. Most temperatures fall between 0.5°C (25th percentile) and 11.0°C (75th percentile), indicating a predominance of cooler conditions. Humidity values range from 25% to 97%, suggesting significant variation, though most values are above 67.5%. The interquartile range is -1.55°C to 5.3°C, showing that dew points are mostly positive but can drop significantly

CONCLUSIONS

The restoration measures undertaken have contributed to an increase of water table levels, but in order to preserve this result, the Stupini mire must be subjected to additional protection. Assessing the long-term success of the restoration process through continued monitoring of the water table, along with further vegetation surveys, will be essential. The success of future peatland conservation activities will be aided by developing a more comprehensive and varied monitoring strategy, which will guarantee more accurate data and allow future restoration projects to be conducted in an efficient manner.

Considering the species richness of the site, Stupini mire could be considered a biodiversity sink that requires specific conservation measures.

The Natura 2000 Network, composed of SACs designated under the Habitats Directive and the SPAs classified under the Birds Directive, is the central pillar of the Union's conservation policy. Because of their rarity and continuing decline, 13 mire habitat types are included in Annex I of the Habitats Directive. From these, 5 types of habitats were identified on Stupini mire. Also, the presence in Stupini mire of two plant species protected under EU Habitats Directive (*Liparis loeselii* and *Ligularia sibirica*) along with other rare species of the Romanian flora, gives the opportunity to designate this site as SAC under Natura 2000 Network, in order to assure complete legal protection.

ACKNOWLEDGEMENTS

This research work was carried out with the support of the Institute of Biology Bucharest of Romanian Academy and was financed from the Projects: PeatRO2 - EEA grant (RO-ENVIRONMENT-0004), RO1567-IBB06/2024 and RO1567-IBB03/2024.

REFERENCES

Antala M., Juszczak R., van der Tol C., Rastogi A. (2022). Impact of climate change-induced alterations in peatland vegetation phenology and composition on carbon balance, *Science of The Total Environment, 827,* 154294, ISSN 0048-9697. https://doi.org/10.1016/j.scitotenv.2022.154294.

Austin, K. G., Elsen, P. R., Coronado, E. N. H., DeGemmis, A., Gallego-Sala, A. V., Harris, L., Kretser, H. E., Melton, J. R., Murdiyarso, D., Sasmito, S. D., Swails, E., Wijaya, A., Winton, R. S. Zarin, D. (2025), Mismatch Between Global Importance of Peatlands and the Extent of Their Protection. *Conservation Letters, 18*, e13080. https://doi.org/10.1111/conl.13080

Bossio, D. A., Cook-Patton, S. C., Ellis, P. V., Fargione, J., Sanderman, J., Smith, P., Wood, S., Zomer, R. J., von Unger, M., Emmer, I. M., Griscom, B. W. (2020). The role of soil carbon in natural climate solutions. *Nature Sustainability*, *3*(5), 391–398. https://doi.org/10.1038/s41893-020-0491-z

CBD (2013). Quick guides to the Aichi Biodiversity Targets. Version 2 – February 2013. https://www.cbd.int/doc/strategic-plan/targets/compilation-quick-guide-en.pdf (Accessed on 05.02.2025)

CBD Secretariat (2022). Kunming-Montreal global biodiversity framework. 221222-CBD-PressRelease-COP15-Final.pdf (Accessed on 05.02.2025)

Danci, O. (2015). Management of alluvial forests included in Natura 2000 91E0* habitat type in Maramureș Nature Park. *Transylvanian Review of Systematical and Ecological Research, 17*(1), 163-176. https://doi.org/10.1515/trser-2015-0057

Erkens, G., Van Der Meulen, M. J., Middelkoop, H. (2016). Double trouble: subsidence and CO2 respiration due to 1,000 years of Dutch coastal peatlands cultivation. *Hydrogeology Journal*, 24, 551–568. https://doi.org/10.1007/s10040-016-1380-4

EUNIS, European Nature Information System https://eunis.eea.europa.eu/references/2324/habitats (Accessed on 07.03.2025)

Frink, J. P., Szabó, A., Attila, M. (2013). *Metodologiile de evaluare şi monitorizare a habitatelor de interes comunitar (tufărişuri, turbării şi mlaştini, stâncării şi grohotişuri, păduri) prezente în România*. Turbării şi mlaştini In: Institutul Naţional de Cercetare-Dezvoltare pentru Protecţia Mediului, Ghidul sintetic de monitorizare pentru habitatele de interes comunitar: tufărişuri, turbării şi mlaştini, stâncării, păduri. Universitas.

Gafta, D., Mountford, J.-O., eds. (2008). *Manual de interpretare a habitatelor Natura 2000 din România [Romanian Manual for Interpretation of EU Habitats].* 111, Cluj-Napoca: Risoprint

Günther, A., Barthelmes, A., Huth, V., Joosten, H., Jurasinski, G., Koebsch, F., Couwenberg, J. (2020). Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. – *Nature Communications, 11,* 1644. https://doi.org/10.1038/s41467-020-15499-z

IPCC (2021). Annex VII: Glossary. In J. B. R. Matthews, V. Möller, R.van Diemen, J. S. Fuglestvedt, V. Masson-Delmotte, C. Méndez, S. Semenov, A. Reisinger (Eds.), In climate change 2021: The physical science basis. Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change, pp. 2215–2256, Cambridge University Press.

Joint Nature Conservation Committee. Habitat: H6430: Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels. Peterborough, UK: JNCC. https://sac.jncc.gov.uk/habitat/H6430/

Kindler, C., Chèvre, M., Ursenbacher, S., Böhme, W., Hille, A., Jablonski, D., Vamberger, M., Fritz, U., (2017). Hybridization patterns in two contact zones of grass snakes reveal a new Central European snake species. *Scientific Reports, 7*, 7378. https://doi.org/10.1038/s41598-017-07847-9

Kyrkjeeide, M. O., Jokerud, M., Mehlhoop A. C., Linn Lunde, M. F., Fandrem M., Lyngstad A. (2024). Peatland restoration in Norway – evaluation of ongoing monitoring and identification of plant indicators of restoration success. *Nordic Journal of Botany, 4*, e03988. https://doi.org/10.1111/njb.03988

Lou, Y., Kapfer, J., Smith, P., Liu, Y., Jiang, M., Lu, X., & Ashcroft, M. (2020). Abundance changes of marsh plant species over 40 years are better explained by niche position water level than functional traits. *Ecological Indicators, 117*, 106639. https://doi.org/10.1016/j.ecolind.2020.106639

Nordbeck, R., Hogl, K. (2024). National peatland strategies in Europe: current status, key themes, and challenges. Regional Environmental Change, 24, 5. https://doi.org/10.1007/s10113-023-02166-4

Page, S. E., Baird, A. J. (2016). Peatlands and Global Change: Response and Resilience. *Annual Review of Environment and Resources*, 41, 35–57. https://doi.org/10.1146/annurev-environ-110615-085520

Parmesan, C., Yohe, G. (2003). A globally coherent fingerprint of climate change impacts across natural systems. *Nature, 421*, 37–42. https://doi.org/10.1038/nature01286

Plants of the World Online (POWO) online database published by the Royal Botanic Gardens, Kew. https://powo.science.kew.org/ (Accessed on 05.02.2025)

Pop, E. (1960). *Mlaştinile de turbă din Republica Populară Română* [In Romanian]. Bucureşti, RO: Editura Academiei.

Raeymaekers, G., Sundseth, K., Gazenbeek, A. (2000). *Conserving Mires in the European Union.* Office for official publications of the European communities. Bernan Associates [U.S. distributor].

Šefferová, S. V., Šeffer, J., Janák, M. (2008). Management of Natura 2000 habitats. 7230 Alkaline fens. DAPHNE-Institute of Applied Ecology, Slovakia.

Visser, M. E., Both C. (2005). Shifts in phenology due to global climate change: the need for a yardstick. Proceedings of the Royal Society B. *Biological Sciences, 272*, 2561–2569. https://doi.org/10.1098/rspb.2005.3356.

Ziaja, M., Wójcik, T., Wrzesień, M. (2017). Conservation status and trends in the transformation of Molinia meadows in the Laki w Komborni Natura 2000 site, SE Poland. *Acta Agrobotanica, 70*(3). 1718. https://doi.org/10.5586/aa.1718