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Abstracts

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Scree and rock vegetation in the western part of Turkey

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Mountain ecosystems of Turkey support many different vegetation types due to climatic zonation and marked changes within short distances. Rupicolous vegetation of mountains has a unique structure containing many endemics and species with narrow distribution. In this study, scree and rock vegetation of Western Anatolia was sampled. A total of 156 relevés (333 species) were stored in a Turboveg database, and classification was performed with Twinspan. As a result, 11 rupicolous vegetation communities were identified. *Draba brunifolia* dominated community on Uludağ mountain was classified in the alliance *Aubrietion olympicae* Quézel et Pamukçuğlu 1970, order *Silenetalia odontopetalae* Quézel 1973 and class *Asplenietea trichomanis* (Br.-Bl. in Meier et Bl.-Bl. 1934) Oberd. 1977. Other communities were classified in the alliance *Silenion odontopetalae* Quézel 1973 of the same order and class. However, rupicolous vegetation has a heterogeneous structure and varied floristic composition. Consequently, comprehensive surveys are needed for a consistent syntaxonomical classification.

The aggregation of preferential and probabilistic datasets to investigate Italian forests: A case-study through the LifeWatch infrastructure

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LifeWatch infrastructure mainly aims to aggregate and analyze big data in ecology, thus offering the public virtual services and tools to boost scientific research and dissemination (see https://www.lifewatch.eu). In this context, the inter-university centre PlantData began collecting and organising published and original datasets on plant diversity at the national level to obtain a standardized database from different sources. Different data collection methods were applied for different purposes. The evaluation of data bias is useful to improve data aggregation and thus to inform users of the big data infrastructure about methodological limitations. To this end, a target dataset derived from a heterogeneous collection of vegetation plots in the Italian forests is compared with a probabilistic reference dataset to evaluate its potential gaps and limitations.

We assembled a dataset composed of four regional databases, with about 18,000 vegetation plots from the whole of Italy, mainly following the preferential sampling. Our dataset was compared with the ICP-Forest dataset on plant diversity of Italian forests, composed of 201 vegetation plots, which followed a probabilistic sampling design. We compared the two datasets in terms of broad forest types and their occupied ranges, which resulted from a multivariate regression tree. We obtained three forest types comprising the warm temperate forest, the cool temperate forest, and the montane forest.

The preferential dataset was spatially representative for the forest types in the study area due to the great number of plots included. This last characteristic is also reflected in the taxonomical and ecological representativeness of the dataset through the occurrence of rare species. However, the preferential dataset showed an oversampling in the warm temperate area, suggesting a preferential accumulation of data for the (sub-)Mediterranean forests, while the coniferous forest of the Alps has been undersampled.

The LIFE Drylands project: Restoration of dry-acidic Continental grasslands and heathlands in Natura 2000 sites in Piemonte and Lombardia

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Open dry habitats, protected in Europe by the Habitat Directive (92/43/EEC), are increasingly rare and threatened throughout Europe. In the Po Plain, they are in a particularly critical situation: the high anthropic impact and the lack of management have led to their fragmentation and, in many cases, their disappearance. Here, these habitats (1) have a high phytogeographical value, being at the southern limit of their European distribution range, where central European, Atlantic, Mediterranean and steppe plant species mix, and (2) host communities rich in terricolous lichens, which at low altitudes are now exclusive to these habitats. The LIFE DRYLANDS project was proposed to conserve habitats 2330 ("Inland dunes with open *Corynephorus* and *Agrostis* grasslands"), 4030 ("European dry heaths") and 6210 ("Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)" acidophilous subtype) in eight Natura 2000 sites in the western Po Plain. The general objective of the project is the restoration of the dry-acidic Continental open habitats to favourable conservation status. The main means used to achieve such goals are: (1) Structural restoration of the target habitats (mowing and removing herbs; cutting native woody species; sod-cutting; topsoil inversion). (2) Removal/reduction of invasive woody species (cutting, removal of stumps, and stem injection with plant protection products). (3) Improvement of the floristic composition. (4) Creation of new patches of the target habitats using suitable propagation material. The sampling design was defined aimed at the ex-ante and ex-post monitoring of the vegetation in the intervention areas, included in 26 patches, where 99 circular plots of 3 m radius were analyzed (collecting data about vegetation structure and % cover of vascular plants, bryophytes and lichens). The comparison between them will allow assessing the success of the restoration actions.

Extremely rich fens in Latvia – re-surveyed after 17 years

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Extremely rich fens in Europe are declining and experiencing vegetation changes. I asked whether there were any vegetation changes in extremely rich fens in Latvia in the last decades. I re-surveyed the sample plots established in 2003 in *Schoenus ferrugineus* dominated plant communities in four Natura 2000 areas. The expansion of *Molinia caerulea* was observed at all sites. Concurrently, the cover of the target species *S. ferrugineus* increased at two sites but decreased at one site. In another site, its cover decreased close to the fen margin but increased in the fen expanse. In sites hosting *Myrica gale*, its cover remarkably increased. To conclude, the succession leads to the dominance of expansive species. The increase in *S. ferrugineus* cover at two sites cannot be seen as a positive trend either as the area of vegetation-free or only moss-covered patches decreases. I assume that the vegetation changes were caused by the combined effect of long-term drainage, abandonment, and climate change.

Functional analysis of the coal mine spoil heap vegetation along the thermal gradient

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The study was carried out on a thermally active waste heap of carboniferous waste rock in Upper Silesia (southern Poland). It aimed at examining the selection of species functional traits along the thermal gradient. Three thermal zones were distinguished on coal mine spoil heaps in reference to the average temperature detected (20, 35, 50 °C).

The RLQ analysis made it possible to distinguish three functional groups of species and showed an increase in the advancement of permanent vegetation cover with a decrease in substrate temperature, the proportion of skeletal parts, electrical conductivity, and an increase in the share of fine particles, pH, water holding capacity and $CaCO_3$ content.

The first group included 39 species, mainly perennial, taller, ruderal, meadow, and xerothermic, with a flowering period from June to August, with average specific leaf area (SLA), higher leaf dry matter content (LDMC), reproducing both vegetatively (high lateral spread) and generatively (transitional seed bank, light seeds, dispersed by epizoochory).

The second group included 25 species. These were mainly annuals, smaller plants; ruderal and segetal, rarer meadow plants, with a longer flowering period (May-October), with higher SLA but lower LDMC, reproducing generatively (short- and long-term seed bank, heavy seeds, dispersed by anemo- and hemerochory), less frequently vegetatively (lack of ability for lateral spread).

The third group included 18 species, perennial, intermediate in height, grassland and ruderal species, with lower SLA and LDMC, reproducing mainly by seeds, dispersed via epizoo-, endozoo- and anemochory, less frequently vegetatively (low lateral spread).

The thermally inactive part of the heap was statistically significantly richer in species and more species-rich than the thermally inactive part of the heap.

Drivers of community resistance under extreme climate events

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The stable delivery of ecosystem services depends on the temporal stability of biological communities, particularly of primary producers like plants. Plant communities' capacity of buffering (resistance) and recovering (resilience) following perturbations determines ecosystem responses to environmental changes. Extreme climate events induce considerable changes in plant productivity, with unpredictable effects on ecosystem functioning and services. As the frequency and magnitude of extreme climate events are expected to rise in the near future, understanding how plant communities react to climate anomalies is a timely task.

Relying on a 12-year time series of biomass data collected in 150 permanent plots in Germany, we investigated how anthropogenic and biotic factors influence grassland communities' resistance during extraordinary warm years. By exploring temporal trends of temperature anomalies, we detected 2018 as an anomalous year. For each plot, we derived two measures of biomass change: the log ratio of the biomass measured in 2018 and 2017; and the log ratio of the biomass measured in 2018 over the time-series biomass trend.

These were then related to land-use intensity, species richness, dominant functional strategy (summarized by the first two axes of a PCA performed on community weighted means of multiple traits) and functional diversity. Each log ratio was modelled as a function of the former variables using linear regression. Piecewise structural equation models were fitted to test networks of causal relationships.

We observed a unimodal effect of land use and functional diversity, indicating a decrease in resistance under strong land-use intensity or in communities with high functional diversity. Ruderal species appeared to benefit from extremely warm conditions. Piecewise SEMs evidenced an indirect effect of land use on biomass change, modulated by functional diversity and abundance of ruderal species, which in turn affected the log biomass ratio.

The plant community diversity at the sugar industry treatment facilities (Chernozem zone of Russia)

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For the first time, vegetation cover formed at the treatment facilities of sugar factories in the forest-steppe and steppe (Chernozem) zone of Russia were studied in the Kursk Region. Sugar production generates much wastewater discharged into extensive treatment facilities – networks of settling ponds separated by earth walls. Specific anthropogenic soils and vegetation types have been developing depending on the topography and activity of the settling ponds for decades. The variability of vegetation communities was described taking into account topography, soils and wetting or drying of the settling ponds.

On the bottoms of ponds, as drainage intensifies and lasts longer, various soils and associated plant communities are formed. Ass. *Lemnetum minoris* (all. *Lemnion minoris*, or. *Lemnetalia*, cl. *Lemnetea*) are found on Histic Gleysol (Alcalic Clayic) in the watering settling ponds. Ass. *Phragmitetum communis* (all. *Phragmition communis*, or. *Phragmitetalia communis*, cl. *Phragmito-Magnocaricetea*) grows in dried ponds on Histic Gleysol (Alcalic Loamic). Disturbed surfaces of periodically flooded settling ponds are covered with annual plant communities: ass. *Chenopodietum albi* on Histic Gleysol (Alcalic Loamic) or ass. *Cannabio-Atriplicetum nitentis* on Spolic Garbic Technosol (Alcalic Calcic Siltic Densic) (all. *Sisymbrion officinalis*, or. *Sisymbrietalia*, cl. *Bidentetea tripartitae*).

Thickets or park forests of the invasive *Acer negundo* mainly occupy inactive settling ponds and earth walls, forming communities of ass. *Aceretum negundo* (all. *Chelidonio-Acerion negundo*, or. *Chelidonio-Robinietalia*, cl. *Rhamno-Prunetea*) on the Eutric Cambisol (Loamic Protocalcic Oxyaquic).

Thus, on the territory of treatment facilities, specific landscapes were formed, the spatial structure of which is similar to the structure of wetlands – the alternation of wet areas and dry islands.

Secondary small-leaved forests of the Russian Plain: classification approaches, ecology, dynamics

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Most forests of birch and aspen on the Russian Plain are secondary. A high proportion of small-leaved forests has been characteristic for the hemiboreal zone of European Russia (which began to be massively reduced for arable land in the 11th-12th centuries) for a long time. Forests were repeatedly cut, and the main forest-forming species were birch and aspen. Subsequently, silviculture and the prohibition of cutting led to an increase in the proportion of coniferous and coniferous-deciduous forests. At present, birch and aspen forests make up about 40% of the forested area of the Moscow region, of which birch forests predominate. Their area continues to increase due to forest succession on abandoned agricultural land.

Birch and aspen forests were studied using the Braun-Blanquet method. Two subassociations of mesophytic small-leaved forests were identified, belonging to two associations of primary forests from the *Carpino-Fagetea* class: nemoral-herb spruce forests (ass. *Rhodobryo-Piceetum* Korotkov 1986) and broad-leaved forests (ass. *Querco-Tilietum* Laivinš 1983). Communities of waterlogged habitats (sphagnum and grass-marsh birch forests) were assigned to the association *Vaccinio uliginosi-Betuletum pubescentis* Libbert 1933 from the class *Vaccinio-Piceetea* and a so-far unresolved association from the class *Alnetea glutinosae*. The main ecological factor responsible for the differentiation of birch and aspen forests is soil moisture (according to Ellenberg indicator values). Spruce is most successfully renewed in the undergrowth of more boreal communities (up to 15% mean abundance). Pine undergrowth occurs only in sphagnum birch forests in the absence of competition and high insolation. Linden undergrowth is most noticeable in nemoral birch and aspen forests (up to 5% mean abundance). Rehabilitation of primary forests (spruce, spruce-broad-leaved and broad-leaved) occurs at different rates, depending on the renewal of undergrowth and ecological conditions.

Use of the UAV technology in post-fire monitoring

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A monitoring protocol for burned forest areas is described on the ground with phytosociological surveys and remotely with aerial photography in RGB with UAV. The study area, Monte Pisano in NW Tuscany, Italy (43°42′26″ N; 10° 31′ 30″), was hit by a large forest fire in September 2019. The forest matrix of the study area was historically represented by *Pinus pinaster* forests of anthropogenic origin containing species of *Quercion ilicis*, especially *Quercus suber, Quercus ilex, Arbutus unedo* and *Erica arborea*. The repetition of fires has led to the disappearance of the pine forest and its replacement mainly by *Q. suber* forest. The use of the UAV at a low altitude (25 m, 0.45 mm pixel resolution) in inaccessible areas has proved to be of great utility in monitoring vegetation recovery. The use of high-definition orthophotos made it possible to recognize and measure the main shrub and tree species. Moreover, aerial photo processing with dedicated software and the development of dense point clouds enabled the description of the physiognomy of the phytocoenoses (height of the surviving trees, development of the shrub layer, size of the foliage) without the need for ground measurements.

Ecosystem state assessment after more than 100 years since rehabilitation

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The assessment of the ecosystem state is fundamental to understand the success of ecological rehabilitation, especially in the long term. In this study, we aim to evaluate the rehabilitation success of a unique Mediterranean dune system site along the Tyrrhenian coast of Italy, which underwent a dune consolidation intervention and species planting at the beginning of the 20th century after the destruction of the natural ecosystem. We used three nearby non-rehabilitated protected coastal sites with different degrees of disturbance as reference sites encompassing different potential rehabilitation outcomes of the target site. To assess the overall result of the intervention, we used several plant characteristics and measured taxonomic and functional beta-diversity between all sites. We compared the proportions of typical and ruderal species of dune habitat types across sites. We further used the species-area relationship to examine if the number of observed species in our sites differed from the expected. Our analyses revealed that the rehabilitated site was taxonomically and functionally more similar to the least disturbed site. We suggest that plant characteristics arising from botanical inventories can be fruitfully used in rehabilitation assessment as they value the taxonomic and functional species diversity at the community scale. We conclude that plant characteristics compared across sites are useful tools in ecosystem state assessment if they reflect the ecological functions and conservation values of the natural ecosystems.

Classification and syntaxonomy of *Pinus nigra* forest vegetation

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Pine forest vegetation types dominated by *Pinus nigra* are naturally distributed in mountain regions of (sub-)Mediterranean Europe and Anatolia, and there are large plantations of this species in central Europe. Past classifications of *Pinus nigra* forests lack a formal, broad-scale approach, which hinders a better understanding of these communities. Our study investigates *Pinus nigra* forest vegetation of temperate and (sub-)Mediterranean Europe. The aim is to provide the first large-scale classification of these forests based on a comprehensive data set of vegetation plots. We obtained 13,689 vegetation plots from 38 EVA databases. Currently, the diversity of these forests is classified in the alliances *Berberido aetnensis-Pinion laricionis*, *Berberido creticae-Juniperion foetidissimae*, *Chamaecytiso hirsuti-Pinion pallasianae*, *Junipero sabinae-Pinion ibericae*, *Erico carneae-Pinion sylvestris*, *Erico-Fraxinion orni* and *Fraxino orni-Pinion nigrae*, while planted forests are disregarded. To study the species composition of these forests and *Pinus nigra* plantations and ascertain the main ecological patterns, we performed an unsupervised divisive classification using TWINSPAN. The preliminary results of TWINSPAN showed a clear distinction between planted and natural forests in the first division. Specifically, *Pinus nigra* plantations of temperate European lowlands outside the native distribution range of the species showed a different species composition from any previously described alliance of *Pinus nigra* forests. Furthermore, within the natural distribution range, species composition strongly reflected a west-east biogeographical division related to climatic differences. This study will provide a vegetation classification at the alliance level for *Pinus nigra* forests, enabling automatic classification using an expert system. The standardisation of the content of classifications will aid future vegetation and ecological studies, ensuring comparability and synthesis of findings across the geographical scope of this study.

Multifaced approach to analyse the effect of multi-year mowing on sub-Mediterranean invaded grasslands

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Traditional land-use abandonment of semi-natural grasslands is threatening biodiversity across Europe due to competitive tall-grasses spreading, which causes a drop in species diversity and the nutrient value of pastures. Finding an alternative and proper management practice to restore invaded grasslands is important for preserving their biodiversity and economic value.

In this research, we analysed the effects of recurrent mowing on different aspects of plant communities, i.e., floristic composition and taxonomic and functional diversity. We aimed to understand the ability of bi-annual mowing to restore grasslands invaded by *Brachypodium rupestre*, whose spread in the Italian Peninsula is fostered by traditional land-use abandonment.

The study site is close to "Montagna di Torricchio" Natural Reserve (central Italy). We fenced one area invaded by *B. rupestre,* which was mown twice a year from 2010 to 2020. Species cover was recorded in 30 plots, while for plant traits, we considered clonal propagation, leaf and flowering phenology, plant height and leaf traits.

We detected two main processes operating in the short and long term, respectively. In the short term, all weaker competitors previously outcompeted by *B. rupestre* were able to re-grow. The plant community in this phase was characterized by increasing taxonomic diversity and with plant composition of species belonging to *Festuco-Brometea* class sharing similar functional strategies (short size and leaf area, fast growth rates and different leaf phenologies). In the long term, taxonomic diversity reached a plateau. However, the plant community changed and showed adaptation to recurrent bi-annual mowing with an increase of mowing-adapted species (annual species, short-clonal propagation, short size) belonging to *Festuco-Brometea* and *Molinio-Arrhenatheretea* classes, consistent with mowed grasslands of the central Apennines.

Management optimization of Pannonian salt steppes and salt marshes in southern Slovakia based on remote sensing

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Pannonian salt steppes and salt marshes are Natura 2000 habitats and are undoubtedly one of the most endangered habitat types in Slovakia and Europe. They are highly influenced by higher temperatures and aridity in summer. There is characteristic zonation of halophytic vegetation, based on inland flooding regime, with dominant salt-tolerant grasses and herbs.

These habitats have been threatened by significant changes in land use and water regime. Halophytic vegetation is degraded by the absence of traditional land use, drainage, overgrowing and waste deposition. Regular monitoring is needed to ensure adequate protection. As conventional field approaches are challenging, remote sensing could play a key role. The NaturaSat software for segmentation of remotely sensed images was used in the salt-marsh revitalization project to test the feasibility of identifying individual habitat types and developing monitoring methods for halophytic vegetation. The time course of the waterlogged areas was recorded using Sentinel-2 satellite images from 2020. Zonation of vegetation was segmented using satellite, airborne, and UAV images and a digital terrain model. Based on the results, the areas with the best halophytic vegetation and areas with the potential for revitalization were evaluated and verified in the field.

One of the most challenging tasks is improving the water regime and restoring species diversity of these rare habitats. Although the revitalization of halophytes is financially demanding and requires a long time, the positive results suggest that this way of managing can help preserve them for the future. Continuous monitoring of water regime and vegetation zonation described in our study is crucial for assessing the success of revitalization activities permanently and could help with the planning of the future management for halophytic vegetation.

Project "LIFE PRIMED": a case of interdisciplinarity and ecosystem-based approach for restoring endangered Mediterranean forest ecosystems

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Transitional wetlands and coastal forests are among the most threatened ecosystems in Europe. This has resulted in many habitats and species in the Mediterranean coastal areas having 'unfavourable', 'vulnerable' or 'near threatened' conservation status according to the EU Habitats Directive (92/43/EEC). Actions to improve the conservation status of habitats are particularly needed in the 'Bosco di Palo Laziale' Natura 2000 site in Italy. It covers 50 ha and is largely composed of the habitat type 'Pannonian-Balkanic turkey oak-sessile oak forests' (91M0) and ephemeral habitat types particularly rich in biodiversity, such as the 'Mediterranean temporary ponds' (*3170). These habitats, and the associated wildlife (e.g. Hermann's tortoise or European pond turtle), face several serious threats, including shrub expansion, climate change impact and inappropriate forest and water management.

The EU-funded project LIFE PRIMED (LIFE17 NAT/GR/000511 – www.lifeprimed.eu) is implementing a combination of ecological restoration practices to improve the conservation status of the forest ecosystem of Palo Laziale, which was hit by a dieback phenomenon. The applied practices include selective trimming of encroaching shrub vegetation, remote-controlled irrigation system, origin-controlled and free-pathogen forestry nursery and ex-situ micro-propagation and in-situ reinforcement of keystone plant populations. The design and implementation of these restoration actions were based on an assessment and quantification of abiotic and biotic factors determining the decline of the ecosystem. For example, the silvicultural and afforestation practices were planned according to geo-morphological, climatic, pedological, and physiological parameters of the target forest habitat. Field monitoring activities are planned to verify the effectiveness of restoration actions and provide technical-scientific guidance for enabling the conservation of similar habitat types and threatened species elsewhere.

The experience of LIFE PRIMED outlines the crucial importance of the interdisciplinarity and the ecosystem-based approach in the practices of restoration ecology and conservation of biodiversity. The project is broadening this vision in the hope of a more systematic and regular application of its outcomes and solutions among practitioners and competent authorities.

The biogeography of alien plant invasions in the Mediterranean Basin

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Aims: Humans have deeply eroded biogeographic barriers, causing a rapid spread of alien species across biomes. The Mediterranean Basin is a biodiversity hotspot but is also a hub of alien plant invasions, particularly in its European part. Yet, a comprehensive inventory of alien species in the area is missing, and understanding the drivers of Mediterranean invasions is poor. Here, we aim to identify the main alien plant species in the European part of the Mediterranean Basin and quantify their invasion success to understand the plant species flows from other biomes of the world.

Methods: We analyzed 130,000 georeferenced vegetation plots from the European Vegetation Archive (EVA) and identified 299 extra-European alien plant species. We identified their biomes of origin and quantified the mean geographic distance, trade exchange and climatic similarity from each biome to the study area. After estimating the invasion success of each species in the study area, we tested which biomes have donated more alien species than expected by chance and which drivers best explain these non-random patterns.

Results: We found that other Mediterranean climatic regions, as well as temperate and xeric biomes of the world, are the main donors of successful alien species to Mediterranean Europe, beyond what would be expected by chance. Our results suggest that climatic matching, rather than geographic proximity or trade, has been the most important driver of invasion. However, climatic pre-adaptation alone also does not predict the invasion success of established species in the study area.

Phylogeny-informed evergreen forest vegetation classification in the Iberian peninsula

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Vegetation classification using similarity, based solely on the taxonomic composition of plots, may not express evolutionary relationships. The latter are assumed relevant, as actual vegetation is the result of both ecological and evolutionary processes. As a case study, we approach evergreen oak forest types in the Iberian Peninsula. A set of vegetation plots spanning types representative of Iberian biogeography and phylogeny of the flora in the plots is used for classification. Taxonomical composition-only and phylogenetic-informed similarity are both used in Isopam classification. The comparison of classifications highlights the importance of the palaeobiogeographic and evolutionary history of actual forests' classification. A less splitting forest classification of Iberian forests emerges as evolutionary relationships overarch fine taxonomical composition. A proposal of syntaxonomic expression of evolution at the alliance level in the *Quercetea ilicis* vegetation class is presented.

Restoration priorities arising from the Italian Red List of Ecosystems

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A Red List of Ecosystems (RLE) of Italy, complementing those for threatened species and habitats, has been recently commissioned to the Italian Botanical Society (SBI) by the Ministry of Ecological Transition. The RLE is based on the ecosystem typology and map defined by the same SBI group for the EU Biodiversity Strategy implementation. This common ground allowed knowledge on ecosystem extent, conditions and ecosystem service capacity to be combined with assessments of threats and risk of collapse. Therefore, awareness of the main pressures acting on biodiversity was improved, and sound information for prioritising restoration was made available.

Assessments were performed for all the 85 natural types represented in the map, both at the national and ecoregional level (Alpine, Po Plain, Apennine, Tyrrhenian and Adriatic Provinces). Thus, it was possible to complement national data with local knowledge provided by the many experts involved in the project and properly attune evaluation to the environmental and cultural heterogeneity of the country. Criteria for estimating risk were consistent with the IUCN guidelines, including distributional and functional symptoms of collapse. Namely, A) declining distribution, B) susceptibility because of restricted distribution, C) environmental degradation due to soil sealing, coastal erosion, intensive agriculture, water pollution and forest fires, and D) altered biotic interactions due to biological invasions, water quality and natural vegetation dynamics were considered, along with E) probability of collapse for the most endangered ecosystems. This presentation aims to show the main RLE results in terms of restoration priorities, including estimates of the number, extent, structural-physiognomic features and main threats for the ecosystems at risk in Italy and each ecoregional province. Potential operationalisation of results, as suggested in the last Report on the State of Natural Capital in Italy, will be highlighted as well.

Wet-meadow plant communities of the alliance *Trifolion pallidi* on the southeastern margin of the Pannonian Plain

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The presentation deals with wet meadow plant communities of the alliance *Trifolion pallidi* that appear on the periodically inundated or waterlogged sites on the riverside terraces or gentle slopes along watercourses. This vegetation type appears in the southeastern part of the Pannonian Plain, which is still under the influence of the Mediterranean climate. These plant communities are often endangered by inappropriate hydrological interventions or management practices. All available vegetation plots representing this vegetation type were collected, organized in a database and numerically elaborated. The numerical analysis identified four plant associations: *Trifolio pallidi-Alopecuretum pratensis, Ventenato dubiae-Trifolietum pallidi, Ranunculo strigulosi -Alopecuretum pratensis* and *Ornithogalo pyramidale-Trifolietum pallidi.* Each association is described in detail: diagnostic plant species, nomenclature, geographical distribution, climatic and ecological conditions and possible division into subassociations. Results are presented in a distribution map, figures resulting from numerical analysis and a synoptic table. The hydrological gradient was found as the most important factor shaping these plant communities. The article also brings new field data on this vegetation type, which has not been sampled for decades and is in the process of evaluation to be included as a special habitat type in the Habitats Directive.

Dynamics of herbaceous vegetation in the Central Forest Reserve (Russia) over seven years

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Large areas of meadows in the forest zone are overgrown with forest due to changes in land use. However, the rates and paths of these processes remain poorly understood. Meadows in the Central Forest Reserve (Tver' region, Russia) are a convenient object for studying successions since recent land-use history is known, including the time of abandonment. At the same time, managed meadows still exist in the transition area of the reserve under similar conditions, which enables us to compare them with the protected communities. In 2013, we investigated herbaceous communities in various environmental conditions and under different management regimes. We identified four community types: managed mesic meadows, abandoned mesic meadows, *Filipendula ulmaria* tall-herb communities and ruderal tall-herb communities.

The aim of this work is to assess the dynamic changes in the four types of herbaceous communities seven years after the first vegetation sampling. We made relevés of the four community types in 47 permanent vegetation plots in 2013 and 2019. We did DCA-ordination with successional vectors and compared the coordinates of the group centroids by T-test for dependent samples. We used Ellenberg's indicator values to characterize ecological conditions and Wilcoxon Matched Pairs Test to compare floristic richness.

The analysis revealed that in the space of the first two ordination axes, the position of the centroids over the years (according to the mean values of the coordinates) differed significantly only in abandoned mesic meadows (p=0.02). In the case of resumed haymaking, the difference was significant on the third ordination axis (p=0.01). The species richness (per 100 m^2) slightly but significantly increased in abandoned mesic meadows (from 44.5 to 47, p=0.02) and remained stable in other studied community types.

Spatio-temporal dynamic of coniferous and mixed forests in the Central Russian Plain (Moscow region)

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The Moscow region is located in the Central Russian Plain on the edge of the hemiboreal and broad-leaved zones. Felling is prohibited there, and mature coniferous forests can be found. The current proportion of spruce forests is 21.7% of the total forest area, according to our estimates. According to the Federal Forestry Agency (2019), the proportion of plantations in the Moscow region is about 20% of the total forest cover and 60-80% of the coniferous forests. The purpose of the study is to assess the current state and dynamics of coniferous and mixed forests in the Moscow region under the existing forest management regime. The composition of coniferous forests is complex (combinations of spruce with birch, aspen, pine and broad-leaved species) and is similar to the composition of the zonal primary coniferous-deciduous forests. The share of plantations is high (mainly monodominant spruce forests). The species composition of the herb-shrub and moss layers is represented by the full spectrum of transitions from boreal to nemoral types. Aspects of the development and composition of coniferous forests at different stages of reforestation are shown. It has been established that mature and overmature stands (over 80 years old) are similar in structure and species composition to natural forests.

Assessment of the spatial distribution of coniferous communities is based on field data and spatial modelling using remote sensing data – Landsat 8 mosaic for 2020. A simulation model of successive dynamics and a probabilistic forecast of the transformation of forests with the participation of spruce took into account the origin and landscape conditions. A set of features was identified that indicates risk factors for coniferous forests in the region. A further decrease of the spruce plantations and increase of the spruce-small-leaved and deciduous formations are expected in the study area.

Distribution maps of vegetation alliances in Europe

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The first comprehensive checklist of European phytosociological alliances, orders and classes (EuroVegChecklist) was published by Mucina et al. (2016, Applied Vegetation Science, 19, Suppl. 1, 3–264). However, this checklist did not contain detailed information on the distribution of individual vegetation types. Here we provide the first maps of all alliances in Europe, including Greenland, Canary Islands, Madeira, Azores, Caucasus countries and Cyprus. We collected data on the occurrence of vegetation alliances in European countries and regions from the literature and vegetation-plot databases. We interpreted and complemented these data using the expert knowledge of an international team and matched all the previously reported concepts of vegetation alliances to the concepts used in EuroVegChecklist. Then, we mapped the occurrence of the alliances as defined in EuroVegChecklist in 81 territorial units corresponding to countries, larger islands, archipelagos and peninsulas, and subdivisions of mainland parts of larger or biogeographically heterogeneous countries using the borders of European biogeographical regions or coastal areas. Specialized alliances occurring only in the coastal environments were mapped only for the coastal section within the territorial mapping units. Distribution maps were prepared for 1105 alliances of vegetation dominated by vascular plants reported in EuroVegChecklist. Three levels of occurrence probability were plotted for each region on the maps: (1) confirmed occurrence, (2) possible occurrence, (3) absence. The new map series represents the first attempt to characterize the distribution of all vegetation types across Europe. There are still many knowledge gaps, partly due to the lack of data for some regions, partly due to uncertainties about some alliance delimitations. The maps presented here provide a baseline for future research aimed at closing these gaps.

Predictive ecology with monitoring data: setting up local adaptive management plans for wet heathlands

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The importance of different abiotic and biotic drivers on wet heathland vegetation was modelled using a spatio-temporal structural equation model in a hierarchical Bayesian framework. It is demonstrated how such an empirical model may be used to make ecological predictions and set up local adaptive management plans.

The model was fitted using ecological data from 39 Danish sites, each with several wet heathland plots. The data were sampled in an eight-year period. Including resampling over the years, 1322 plots were sampled. Plant cover was measured using the pin-point method, and the joint distribution of the key plant species in the wet heathland ecosystem, *Erica tetralix, Calluna vulgaris, Molinia caerulea,* and an aggregate class of other higher plants was estimated assuming a Dirichlet-multinomial mixture distribution. The investigated drivers of wet heathland vegetation include nitrogen deposition, soil type, pH, precipitation and grazing.

The study demonstrated that important insight into ecosystem dynamics and regulation can be obtained by spatial and temporal structural equation modelling. Proper statistical modelling of the joint species abundance and the different sources of uncertainty is a key feature of such models. Furthermore, the advantages of partitioning different types of uncertainties become clear when the fitted structural equation model is used for predictive purposes.

Predicting environmental variables using vegetation composition

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In this study, the efficiency of the two nearest neighbor (KNN) and weighted average (WA) methods was evaluated for the indirect estimation of environmental variables in plant communities. For this purpose, vegetation composition data of 324 relevés with an area of 400 m^2 of the Hyrcanian yew forests database were used. Environmental variables (altitude, slope and slope direction, percentage of organic carbon, percentage of nitrogen, soil reaction rate and soil texture) in each relevé were indirectly estimated by using KNN and WA methods based on two kinds of vegetation data (incidence-based and abundance-based floristic data) as well as the original values of that environmental variables. The models were validated using the determination coefficient of linear regression analysis, which was done based on the initial values and followed by the estimated ones of each environmental variable as the predictor and response variables. Results showed that using the KNN method based on abundance data has priority compared to the other three algorithms, as it shows the highest determination coefficient value. The main reason for the differences between KNN and WA was influenced by different approaches of interpolation (KNN) and extrapolation (WA) in the point estimation of environmental variables. The better performance of the KNN compared with WA in the point estimation of environmental variables is due to using the environmental data of the only adjacent plot with the most similar floristically features to each point in the KNN, while the results of the WA are globally affected by the range of each environmental variable in the whole dataset.

Conservation value of ancient settlements of the Lower Dnipro for steppe vegetation

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In the past century, agricultural intensification resulted in a significant loss and fragmentation of steppe habitats in Ukraine, especially in the southern regions. In such a transformed landscape, the ancient settlements (or earthworks) have a high value for biodiversity conservation. In our previous publications, we proved the floristic value of 18 ancient settlements of the Lower Dnipro in an integrated manner by assessing the structure of their flora, level of synanthropization, and factors of their vascular plant diversity. In the present study, the conservation value of ancient settlements was estimated. The rare element of the settlements of the Lower Dnipro is represented by 31 vascular plant species (5.9% of the total number of species) included in the Red Book of Ukraine and regional Red Lists, six plant communities included in the Green Book of Ukraine, and three endangered natural habitat types of Resolution 4 of the Bern Convention. A comparative analysis of the floras of ancient settlements within steppe reserves (Biosphere Reserve `Askania-Nova`, Botanical Reserve `Lesovyi Canyon`, Botanical Reserve `Yakovlivskyi`, Projected Botanical Reserve `Starochvedskyi`) and kurgans showed their high representativeness in terms of the percentage of the steppe, native and non-synanthropic plants, rare species and habitats. The relationships between the flora of the ancient settlements and the analyzed objects, based on the different groups of vascular plant species, were analyzed in R software. The result indicates that the ancient settlements preserve the natural steppe diversity and can be considered nature conservation sites.

A survey of the Mediterranean broadleaved evergreen forests at the European scale

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Mediterranean evergreen broadleaved forests are characterized by the dominance of evergreen oaks (*Quercus ilex, Quercus suber*, *Quercus rotundifolia* and *Quercus coccifera*). These forests are species-poor and, therefore, difficult to classify. Several poorly differentiated associations have been identified and grouped in alliances belonging to the *Quercetalia ilicis* order, which are mainly defined based on ecological features but generally lack characteristic species.

In this study, we analysed the forests and maquis dominated by evergreen oaks occurring in Mediterranean Europe with a modelling classification approach that was already successfully applied to the forest vegetation of the Italian Peninsula. This approach was applied on a matrix of 10,446 vegetation plots and 3458 species from the EVA database. We obtained a divisive classification at two optimum levels: at the higher level, 11 clusters were identified that can be considered as suballiances; at the lower level, 46 clusters were considered corresponding to associations. The distinctiveness of these clusters varies: several clusters were very well floristically characterized, whereas others were characterized by a combination of ecological features and species composition. Syntaxonomic evaluation of the results was conducted based on the comparison with the currently accepted scheme for the European vegetation.

Alpine shrub encroachment in the central Apennines: current patterns and temporal trends

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Since World War II, European mountains have been increasingly abandoned, resulting in grazing declines and often in shrubs encroachment. Our study focuses on the Mediterranean alpine and subalpine belt (Central Apennine – Reatini, Duchessa and Ernici mountains) characterized by historical land use and summer water shortage that makes alpine vegetation particularly vulnerable to global changes.

In this context, we aimed to describe current patterns and encroachment trends of alpine dwarf shrubs: we obtained shrub distribution and encroachment in the last 60 years by mapping shrub patches using satellite images (2012) and historical aerial photos (1954). We then related shrub distribution and encroachment trends to the simultaneous influence of multiple environmental factors on a broad temporal scale (topography, productivity, grazing pressure, climate and snowmelt patterns).

Our results show a significant dwarf-shrub encroachment in the area, mainly by *Juniperus communis* var. *saxatilis*. Topographic heterogeneity, as well as variation in fine-scale productivity, strongly shape shrub distribution and encroachment patterns, with an important modulating role of productivity on climatic effects. In particular, spatial distribution and encroachment are mainly negatively related to productivity, spring snow cover and summer temperature. Contrarily, dwarf-shrub spread in unproductive and infertile areas is associated with high slope inclination and curvature and early snowmelt time. In this way, dwarf shrubs may benefit from open space. Surprisingly, our results suggest that variation in grazing pressure over the last few decades did not influence the current dwarf-shrub distribution and encroachment.

Our results are consistent with previous observations of alpine shrub encroachment worldwide. Moreover, we show that the alpine and subalpine environmental fine-scale matrix may strongly shape the overall distribution and temporal trends.

Success of de-eutrophication through topsoil removal depends on forest history

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We studied the effects of experimental clearcut and topsoil removal on vegetation, soil and microclimate of mixed oak forests (*Galio-Carpinetum*) in Bavaria (Germany). Mixed effect models revealed effects on radiation and Ellenberg light values as well as temperature amplitude and late frost duration, but no consistent effects on soil pH and Ellenberg nutrient values. One year after treatment, de-eutrophication of vegetation had not occurred on sites with a history of conifer plantations with topsoil acidification. As potential causes, we discuss confounding of Ellenberg reaction and nutrient values by acid forest floors. On rich geological substrates, neither coppicing nor topsoil removal warrant de-eutrophication and the creation of oligotrophic microhabitats for rare species.

Plant life forms in herbaceous communities: a case study from the Central Forest Reserve (NW Russia)

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The adaptation of plants to complex habitat conditions is reflected in their life forms. Thus, bio-morphological analysis can provide valuable insights into habitat assessment and monitoring. We studied the diversity of plant life forms in herbaceous communities of the Central Forest Nature Reserve (NW Russia). Among six Raunkiaer plant life forms identified, hemicryptophytes prevailed, which is a characteristic feature of the temperate climate zone. The spectra based on Serebryakov's system included 36 plant life forms with hypogeogenous long-rhizomatous herbaceous perennials prevailing. We compared the combined partial floras of the following vegetation types: managed mesic grasslands, abandoned mesic grasslands, tall-herb *Filipendula ulmaria* communities, and ruderal tall-herb communities, and revealed significant differences in their plant life-form composition. In the managed mesic grasslands, hypogeogenous long-rhizomatous and cespitose herbaceous perennials prevailed. The ruderal tall-herb communities were dominated by soboliferous herbaceous perennials. In the *Filipendula ulmaria* communities, the number of vegetative annuals was significantly higher, and the number of hypogeogenous long-rhizomatous, cespitose, and taproot herbaceous perennials, as well as the number of annuals, were significantly lower than in the other community types studied.

Syntaxonomical diversity of Dragoman municipality in Sofia district (Western Bulgaria)

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Overview: Dragoman municipality is located in the western part of Bulgaria and covers 323.9 km². The terrain is semi-mountainous, and the water resources are scarce, including the Nishava, Ezhovitsa and Gaberska rivers and the Dragoman marsh, one of the few karst marshes in Bulgaria. The syntaxonomical diversity of the area has been studied poorly, and this study aims to fill the knowledge gap revealing the syntaxonomical diversity of all vegetation types occurring there.

Materials and methods: There were only 42 relevés from the area available in the Balkan Vegetation Database (EU-00-013) and the Balkan Dry Grassland Database (EU-BG-001). During the growing season of 2019, we collected 170 relevés using the Braun-Blanquet approach. The plot size was 16 m^2 for grasslands, 64 m^2 for shrub communities and 225 m^2 for woodlands. Data for abiotic factors such as slope, altitude, bedrock, inclination and soil depth were collected too. All relevés were stored in the Balkan Vegetation Database. The nomenclature was standardised according to the Euro+Med PlantBase. Both the EuroVegChecklist Expert System and the PC-ORD functions of JUICE were used for class identification, and the lower syntaxa were determined by PC-ORD.

Results and conclusions: The syntaxonomical diversity of Dragoman municipality is represented by 16 classes (*Artemisietea vulgaris, Carpino-Fagetea sylvaticae, Crataego-Prunetea, Digitario sanguinalis-Eragrostietea minoris, Epilobietea angustifolii, Festuco-Brometea, Molinio-Arrhenatheretea, Papaveretea rhoeadis, Phragmito-Magnocaricetea, Polygono-Poetea annuae, Potamogetonetea, Quercetea pubescentis, Robinietea, Salicetea purpureae* and *Sisymbrietea*). The vegetation encompassed is classified into 20 orders, 20 alliances, 30 associations and 4 plant communities.

Distribution and ecology of *Lemna gibba* in Latvia

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Lemna gibba is widespread in temperate and southern Europe, reaching its northern limit in southern Scandinavia. It also occurs in W Asia, N, E and S Africa and N and S America, being most frequent in areas with the Mediterranean climate.

In Latvia, *L. gibba* is included in the Red Data Book. However, recent studies show that the species is widely distributed in the middle part of the country. The species frequently occurs in slow-flowing streams, canals and ditches, and sparsely in lakes and ponds. The data on the chemical composition of water are only available for the largest streams. The streams with abundant *L. gibba* are characterized by high nutrient levels and substantial anthropogenic and agricultural impacts. Several straightened streams and ditches are entirely covered by dense carpets of pure *L. gibba*, under which no other macrophytes can grow. *L. gibba* often forms communities with *L. minor, L. trisulca, Spirodela polyrhiza, Sagittaria sagittifolia, Elodea canadensis, Nuphar lutea* and *Chlorophyta*.

Considering that *L. gibba* is most frequent in the warm climate, it can be assumed that species occurrence in Latvia is already increasing and will increase in the future due to climate change. The wide distribution of *L. gibba* in eutrophic rivers also indicates that the species is not endangered. Estonian researchers suggest that *L. gibba* does not need any protection status, considering that anthropogenic eutrophication of water bodies is an unwanted process.

Vegetation Database of Turkey (NFVDT): current status and opportunities

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Vegetation databases are powerful tools for vegetation, plant ecology, and biodiversity studies across scales. In this study, I aimed to build up the Non-Forest Vegetation Database of Turkey – NFVDT. The database includes non-forest vegetation types across Anatolia, the European part of Turkey and the East Aegean Islands. I digitised information available from the literature using the TURBOVEG program.

Currently, the database contains 10,536 vegetation plots from published and unpublished studies, covering the period from 1971 to 2020. Vegetation types include grasslands (both natural and anthropogenic), coastal habitats, shrublands (including maquis, pseudomaquis, garrigue/phrygana), degraded forests, Mediterranean forest transitions, floodplain forests, post-fire, riparian, rocky vegetation and segetal communities. I digitised structural and environmental information in addition to locality, association and alliance information. I also digitised some performance measures, which might be useful for specific vegetation types. The elevational range of the data was from 0 to 3150 m a.s.l. The size of plots ranged from 0.5 m^2 to 1000 m^2. I georeferenced the plots and assigned precision values for coordinates.

NFVDT fills an important gap in continental and global vegetation-plot databases. Its content is already included in the European Vegetation Archive (EVA), and future updates are planned. NFVDT is expected to support future studies on vegetation classification, community ecology and biodiversity topics across open terrestrial habitats at both the national and international levels. The database is registered in the Global Index of Vegetation-Plot Databases (GIVD) under the ID 00-TR-003. NFVDT data are accessible via EVA or by asking the custodian.

Functional diversity of plant communities along urban river valleys as an aspect of their revitalization

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The Kłodnica river is one of the most anthropogenically transformed river valleys in southern Poland. This study aims to present the functional diversity of vegetation of the Kłodnica river valley in relation to its anthropogenic transformations. Along two study sections, semi-natural and anthropogenic, 100 phytosociological relevés of 25 m^2 were made. Data on functional traits of species and their environmental preferences were obtained from available databases (BiolFlor, LEDA). Moreover, some morphological and physiological traits (e.g. SLA, canopy height, chlorophyll fluorescence) of dominant species were measured directly in the field. DCA analysis was performed to determine vegetation diversity.

The distribution of communities is connected with a gradient related to light, productivity, soil reaction, substrate moisture and intensity of anthropogenic disturbances. Along the anthropogenic section in open areas, large aggregations of invasive species occur (*Aster novi-belgii, Helianthus tuberosus, Reynoutria japonica, Solidago canadensis, S. gigantea*) with a fast growth rate, large leaf area and considerable ability of regeneration and vegetative propagation. At shaded sites with more acidic substrate and more organic matter, small patches of nitrophilous fringe communities built by one- and two-year-old, generatively reproducing taxa, smaller and with higher SLA index (*Ballota nigra, Chelidonium majus, Galeopsis pubescens, Impatiens parviflora*) were recorded. In the semi-natural section of the river (in Katowice) in open areas, on substrates with higher pH, meadow and rush phytocoenoses dominated by perennial native species (*Calamagrostis epigejos, Carex rostrata, Deschampsia cespitosa, Phalaris arundinacea, Phragmites australis, Scirpus sylvaticus*) were recorded.

Revitalization of river valleys is a long-term and multi-faceted process in which knowledge about ecosystem functioning should be applied.

The dilemma of parallel understories under different canopies in Boreal forests

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In the boreal zone, similar understories can form under different dominant canopy tree species, which poses a challenge for forest vegetation classification. The Finnish (Cajanderian) forest typology has solved the problem by ignoring the canopy, while the Russian (Sukachev) forest typology has solved it by finely dividing the communities based on the dominant canopy tree. Both approaches have been proposed for the hierarchical Braun-Blanquet typology, and a consensus is yet to be reached.

In this presentation, I will demonstrate the issue using a large dataset of Northern European Boreal forest communities and provide examples of such parallel forest communities. With this presentation, I wish to open discussion and gain insight from the Braun-Blanquet classification community to this problem, which I am facing in my attempt at unifying the classification of Boreal forests in Northern Europe.

Agroecosystem species pools for greening olive groves

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Mediterranean olive groves are key ecosystems to balance crop production with biodiversity functions. In the current decade on Ecosystem Restoration, agroecological practices suggest moving towards the establishment of herbaceous ground covers. However, we still do not know which species are more suitable for vegetation recovery. Here, we present a comprehensive process for selecting regionally adapted species for restoration that also emphasizes considerations for seed production. Using olive groves as a target system, we found that research on ground covers for regenerative agriculture has largely overlooked native species at the expense of commercial and ill-suited varieties. Our assessment of native annuals showed that 85% of the evaluated grasses and forbs exhibit a suite of ecological and production traits that can be tailored to meet the requirements of farmers, seed producers and environmental agencies. These findings suggest that many native species are neglected in agronomic research, despite being potentially suitable for restoring semi-natural weed communities in the Mediterranean agroecosystems.

Restoration of pine forests of the Volga region after catastrophic fires under a protection regime

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Pinus sylvestris forests absolutely prevail in the Zavolzhie lowland – a vast sandy plain stretching along the right bank of the Volga. For the last 150 years, this territory has been subject to periodically recurring (every 30-40 years) forest fires. The reforestation work carried out, especially after the large forest fires of the 1970s, was not successful. As a result, by 2010, when the next major forest fire occurred, it was also quite significant. In particular, the fire affected more than half of the territory of the Kerzhensky Reserve, which was formed in 1993, including forest plantations. This event has created a unique opportunity for monitoring the processes of forest restoration – including the past anthropogenically transformed lands – under the conditions of the reserve regime.

The work began in 2011, when 30 permanent plots were established in the central part of the reserve, confined to places covered by various types of fires, as well as differing in their landscape position. The plots were confined to areas with both upland and lowland and subsurface fires of varying intensity; possible positions in the mesorelief and the probable initial communities were considered. Sampling was carried out once every 1-2 years (the first five years annually). Data from approximately 450 additional sample plots were also used to analyze the progress of reforestation.

In general, the composition and the rate of increase of understory cover depend to a larger extent on the type of fire and to a smaller extent on the type of mesorelief. In contrast, the increase in the cover and species richness of the herb-dwarf shrub layer in the first years after the fire depends more on the mesorelief than on the type of fire.

Turkey oak (*Quercus cerris*) forest vegetation in SW Turkey

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The Mediterranean vegetation in Turkey is mainly formed of broad-leaved and needle-leaved evergreen tree species like in the rest of the Mediterranean Basin. However, deciduous trees are also well represented. One of these deciduous trees is Turkey oak (*Quercus cerris*). In addition to its scattered distribution in the sclerophyllous and needle-leaved forests, it also constitutes locally dense forests. Due to the anthropogenic effects for centuries, these forests are mostly degraded. Therefore, they deserve special attention in terms of nature conservation and forest management. Some good examples of these forests occur in SW Turkey. This study aims to analyze the vegetation diversity of these forests under the ongoing degradation process. For this goal, 64 vegetation plots were sampled in SW Turkey following the Braun-Blanquet method. For the classification, we used the Jaccard dissimilarity index as a resemblance measure and Beta Flexible clustering (β = -0.25) using the PC-ORD program. Diagnostic species of each type were defined by calculating fidelity in the JUICE program. Detrended Correspondence Analysis was used as an ordination technique to understand the effects of ecological and geographical factors on vegetation diversity. As a result, four vegetation types were described: *Carex flacca–Quercus cerris* forest, *Medicago falcata–Quercus cerris* forest, *Arbutus andrachne–Quercus cerris* forest and *Festuca jeanpartii–Quercus cerris* forest. DCA showed clear ecological and geographical differences between vegetation types in addition to those in growth form and participation of different geoelements. The floristic composition and vegetation structure of Turkey oak forests in SW Turkey indicate a high level of degradation, requiring urgent restoration measures.

Canopy height model and topographic wetness index support field mapping of acidophilous spruce forests and bog woodlands

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The use of modern techniques in vegetation mapping is increasing. High-resolution LiDAR-derived data is handy for field mapping, in particular for vegetation types covering larger areas and with similar species composition (e.g. monodominant forest vegetation). We tested the adequacy of LiDAR-derived data, namely canopy height model (CHM) and topographic wetness index (TWI), during field mapping of various acidophilous spruce forests and bog woodlands in the Pohorje mountains (NE Slovenia). Several subtypes were distinguished based on phytosociological classification: *Pino mugo-Sphagnetum* s. lat., *Piceo-Sphagnetum flexuosi, Sphagno girgensohnii-Piceetum, Bazzanio-Piceetum, Rhytidiadelpho lorei-Piceetum* and *Luzulo sylvaticae-Piceetum*. Apart from differences in floristic composition (e.g. the representatives of bryophytes), these subtypes clearly differentiate in terms of site conditions, such as soil moisture, soil pH and site productivity. Some of them have high nature conservation importance and belong to the European priority habitat types (7110* Active raised bogs, 91D0* Bog woodland) within the Natura 2000 network. The most stressful environmental conditions (very acidic and nutrient-poor soils, high water-table) are found in areas covered by raised bog vegetation, where communities of peat-mosses (*Sphagnum* sp. div.), dwarf mountain pine (*Pinus mugo*) and small, shrubby spruce (*Picea abies*) prevail. A different spruce forest vegetation can be found near bogs with acidic mineral soils, where spruce trees grow up to 30 m or higher. Our preliminary results suggest a negative correlation between CHM and TWI as the wettest parts of the study area are normally characterized by lower productivity, tree heights or even absence of woody vegetation. The usefulness of CHM and TWI can be expanded to other vegetation types where ecological gradients (induced by soil characteristics and relief features) create a diverse mosaic of different vegetation subtypes.

Towards a consistent classification of the silicicolous epilithic lichen communities of the Ukrainian Crystalline Shield

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Our work aims to study silicicolous epilithic lichen communities of the Ukrainian Crystalline Shield and compare them with similar European syntaxa. Our questions were: (1) Which silicicolous epilithic lichen communities occur on the Ukrainian Crystalline Shield? (2) What ecological factors are influencing the community distribution? (3) Do the syntaxa of lichen communities fit into the current syntaxonomic scheme of Europe?

Analyses were performed in the JUICE software using agglomerative hierarchical cluster analysis in the integrated PC-Ord with pseudospecies cut levels 0-5-25, Jaccard dissimilarity measure and Ward group linkage method.

Lichen communities on siliceous rocks of the Ukrainian Crystalline Shield were assigned to the classes *Rhizocarpetea geographici, Leprarietea chlorinae* and *Collematetea cristati*. Two new alliances (*Aspicilion intermutantis* and *Staurothelion frustulentae*) and eight new associations were proposed as new for science. Species composition of silicicolous lichen communities of the Ukrainian Crystalline Shield differs from the known epilithic lichen associations from Central Europe. Their distribution depends mainly on the combination of nitrogen availability, pH-value, rain protection, substrate moisture (different inclinations of the surfaces) and dynamics (pioneer or climax communities).

The determination of spectral characteristics of artificially and naturally snowed ski slopes in Slovakia by Sentinel-2 data

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The production of artificial snow has become a fundamental part of the operation of ski resorts all over the world due to insufficient natural snow cover during the winter season. Satellite imagery can help better understand the processes vegetation on the ski slopes has to deal with under the long-lasting snow cover. The hypothesis of visible differences in spectral characteristics of biomass production between the artificially snowed ski slope and a slope that has not been artificially snowed can be proven through calculating the values of Sentinel-2 channels and indices, mainly B03 – Green, B05 – Vegetation classification, B09 – Water vapour and Normalized difference vegetation index (NDVI). A related question was if the differences would be visible only at the beginning of the growing season, or they would also be significant later. Eleven ski resorts in Slovakia were chosen for this study, while two polygons, one with artificial snow cover and the other with natural snow cover in each resort, were selected using ArcMap and the digital elevation model of Slovakia. The values of Sentinel-2 channels together with selected indices for each month from January until August 2020 were calculated using the NaturaSat software, while for the data processing, the t-test was run in the R software. The results have shown that statistically significant differences in the chosen channels and indices between the polygons (p-value < 0.05) were observed during the spring months, however, each of them was visible in a different month. Also, an evident contrast in multi-spectral characteristics between the surfaces of the studied areas had grown with fewer differences as the vegetation period was ending, meaning that the vegetation had almost restored to the same level as on the naturally snowed ski slope by the end of August 2020.

Biomorphs of plants in habitats of *Iris aphylla*

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Iris aphylla occurs in Russia in the forest-steppe zone, which is characterized by a mosaic vegetation cover. This study aims to identify vegetation types in the habitats of *I. aphylla* based on the prevalence of characteristic plant biomorphs (Serebryakov, 1962).

We sampled 47 plots of 100 m² in 13 localities of *I. aphylla* in the Russian Plain (51.5–54.5° N; 36.0–44.3° E). We recorded 244 plant species. We considered as conjugated with *I. aphylla* 43 species inhabiting 7–13 localities (> 50%) of *I. aphylla*. 65 species inhabiting 3–6 localities of *I. aphylla* are ordinary species. 136 species recorded in 1–2 localities of *I. aphylla* are occasional species. Among 17 biomorphs, the most numerous are taproot – 73 species, short-rhizome – 50, long-rhizome – 35, and monocarps – 25. Taproot herbs are the most numerous conjugated (13), ordinary (27) and occasional (33) species.

Cover of a dominant species varied in different plots from 12.5 % to 50 %. The biomorph of the dominant species was long-rhizome at 16 plots (in 12 plots it was a conjugated species; in 2 plots – an ordinary species, in 2 plots – an occasional species; see analogous data in the next brackets); dense cespitose – in 7 plots (7, 0, 0); short-rhizome – in 6 plots (5, 1, 0); loose cespitose – in 6 plots (0, 4, 2); shrub – in 5 plots (3, 0, 2); taproot – in 2 plots (0, 2, 0); monocarpic – in 1 plot (1, 0, 0).

Taken together, short-rhizome herbs dominate by their total cover in 19 plots, long-rhizome herbs – in 15 plots, taproot herbs – in 11 plots, loose cespitose herbs – in 1 plot, shrubs – in 1 plot. Together, long- and short-rhizome herbs dominate in 44 out of 47 plots. The ratio between the biomorphs, including the low cover of dense cespitose herbs, conforms to the definition of steppe meadows by Lavrenko (1980). This conclusion concerns the habitats of *I. aphylla* over the entire width of the forest-steppe belt, and not only in its northern part.

Syntaxonomy of steppe depressions (*pody*) vegetation of Ukraine

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Steppe depressions or *pody* are large drainless depressions periodically flooded by meltwater and characterized by peculiar ephemeral mesic to wet grassland phytocoenoses. In 2018, these depressions in the steppe zone of Ukraine were included as a complex type X36 to the Resolution 4 of Bern Convention and to the EUNIS classification, which requires a comprehensive study and protection of this habitat type.

Our aim was to revise the syntaxonomy of the steppe depressions (*pody*) vegetation, in particular (1) to identify the associations and to reveal their environmental, structural and compositional peculiarities; (2) to assign the associations to higher syntaxa; and (3) to correct nomenclatural aspects according to ICPN.

The data for the study were 1897 relevés made in depressions (*pody*) of the steppe zone of Ukraine from 1967 to 2019 and stored in the Ukrainian Grassland Database. We removed all the relevés with values of 7 or less of soil moisture on the Didukh ecological scales (DES) from the dataset and with a cover of shrubs more than 15%; 641 relevés were included in the final analysis in the PC-Ord program operated through the Juice software.

The analysis resulted in nine clusters, which were interpreted within *Festuco-Brometea* (two units), *Molinio-Arrhenatheretea* (three units), *Isoëto-Nanojuncetea* (three units) and one derivate community of the *Festuco-Puccinellietea* class. DCA ordination suggested that the leading factors of syntaxon differentiation are soil moisture and fluctuating water level.

The previously described syntaxa at the rank of alliance (*Myosuro-Beckmannion eruciformis*), suballiance (*Galio ruthenici-Caricenion praecocis*), and six associations were validated. Two associations and two subassociations were described as new to science.

Temporary ponds (*Isoëto-Nanojuncetea*) in Palo Laziale near Rome: unexpected aspects of an endangered Mediterranean vegetation

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Mediterranean temporary ponds are diverse vegetation, both from the floristic and ecological points of view. They are widespread in the Mediterranean. The main ecological feature of this vegetation is the alternation of periods of flooding and drought, which occurs in many shallow water bodies in the Mediterranean climate. Nonetheless, since the habitat can be present in many different forms, it is important for management 1) not to confuse the habitat with similar ones with more permanent water, 2) to appreciate different aspects in which this vegetation can occur.

Our study focuses on the temporary ponds of Palo Laziale along the coast near Rome, where a Life project has been undertaken. The characteristic vegetation of this formation in Palo contains terrestrial *Isoëtes* spp. together with several other characteristic species. This floristic pool occurs in a variety of habitats. In the Italian Peninsula, it is widespread in shallow ponds and on the shoreline of concave basin ponds that dry up in summer. In Palo, nonetheless, this aspect is absent. The shallow lakes are occupied by marsh or inundated woody vegetation without species of *Isoëto-Nanojuncetea* on the shores. These species are instead present with abundant populations in abandoned farmlands. These farmlands are inundated in winter when shallow marshes develop but are completely dry in summer when they resemble annual dry grassland. It is possible to observe a fine mosaic in these habitats: *Isoëtes* spp. are very abundant in depressions where waterlogging is longer, whereas *Avena sterilis* and *Carex flacca* occur together with many species of steppic Mediterranean grasslands on slight elevations. The two aspects, the grassland and the ponds, alternate, therefore both in time and space. This ecotone could be referred to the habitat 3120, but the floristic composition is different.

The muddy journey continues… Further developments of the project WetVegEurope

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The project WetVegEurope began in 2013, intending to review the existing literature and produce a consistent and unequivocal phytosociological classification of the European marsh and aquatic vegetation at the association level. In 2020, a paper was published with a hierarchical formalized classification of the European marsh vegetation into 92 associations, 11 alliances and 6 orders of the class *Phragmito-Magnocaricetea*. It was mainly focused on the methodological and conceptual background of the classification. In 2021, the 4th edition of the International Code of Phytosociological Nomenclature was published. Therefore, an update of the syntaxonomic nomenclature of our classification units was needed. Along with this update, we produced an extensive monograph of *Phragmito-Magnocaricetea* in Europe with a revised syntaxonomic nomenclature (according to the new Code) and descriptions and distribution maps of the associations. The work is still in progress, involving several experts who are writing descriptions of individual units. The distribution maps were created using the same data as used for the classification, literature information and knowledge of the experts involved in the project. The nomenclature part has been revised by some authors with the help of the members of the Steering Committee of the IAVS Group for Phytosociological Nomenclature (GPN).

Classification of inland salt-marsh vegetation reflects local environmental conditions across Europe

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Inland salt-marsh vegetation has been recognized as unique at a European scale, and according to the Council of Europe Directive 92/43/EEC, it is legally protected through the Natura 2000 network. There is currently a gap in the classification of inland salt marshes under temperate climates, which leads to differences in the nomenclature used by scientists in different countries. Studies on inland salt-marsh vegetation at large spatial scales and resulting information-based conservation strategies require a unified syntaxonomical system based on data gathered across Europe. Therefore, the aim of our research was to identify units of inland salt-marsh vegetation and to relate them to environmental drivers. Based on the data from the Polish Vegetation Database and an extensive literature survey, we built a database with more than 1000 phytosociological relevés from six countries: Czech Republic, France, Germany, United Kingdom, Luxembourg and Poland. We used the Cocktail method to segregate individual syntaxonomical units and then classified the phytosociological relevés into nine classes, including two typical for salt-marsh vegetation: *Therosalicornietea* and *Festuco-Puccinellietea*. We proposed to classify a part of the relevés in the *Festuco-Puccinellietea* class, which is a new concept in the classification of temperate inland salt marshes. Within these two classes, we distinguished two alliances and a total of five associations. Data were finally subjected to ordination analyses (DCA, CCA) to reveal the importance of local environmental factors (assessed by Ellenberg indicator values of species and reported soil parameters whenever possible). The most driving factors were salinity, humidity and light. We will further use these results to create a unified classification system for vegetation of European inland salt marshes based on the functional traits of plant species.

Diversity patterns of plant and gastropod communities along the urban-rural gradient in a fragmented woodland

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Urban areas cover only 3% of the world's land surface, but they have an enormous impact on climate, biodiversity, and land use. Land structure changes produce alterations in plant and animal species richness and evenness, in both negative and positive directions, but the urbanization process is mostly responsible for decreasing diversity and abundance. In this study, we investigate the effects of forest fragmentation on plant and land gastropod communities by examining plant and mollusc diversity and community composition in isolated urban forests and continuous forest stands along urban-rural gradients. We conducted our study within Bratislava, Slovakia, and the southern part of the Small Carpathians Mts. Twenty paired plots (forested "peninsulas" and controls), seminatural and ten isolated urban forest patches (islands) were selected to compare fragmentation effects while controlling for variation in species distributions. We measured fragmentation indices (area, perimeter, shape index, and distance to the nearest forest), using NaturaSat software, stand structural characteristics (the cover of the individual vegetation layers and the cover and thickness of the litter layer, bare ground, leaf litter, rock, coarse woody debris, aspect, and slope) and environmental variables (Ellenberg indicator values). The results indicate that the highest number of plant and gastropod species is represented by island plots. Regarding gastropods, forest islands are characterized by higher soil pH, higher content of coarse woody debris and litter. These environmental parameters are crucial for their occurrence. However, the plant species richness is caused by the presence of neophytes and archaeophytes, while for gastropods, forest islands are diversity hotspots even for indigenous species and specialists.

Species-level disturbance indicator values of European plants

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Disturbance is a key determinant of vegetation structure and functional differentiation of plants. Although some general disturbance indicator classifications have been proposed at a regional level, there is still the need for a broader classification at the European level, including important land-use specific disturbance indicators such as grazing and mowing tolerance.

We identified species-specific disturbance indicators for a large pool of species using an expert-based characterization of disturbance regimes of European vegetation plots classified to habitat types. To this aim, we first assigned expert-based disturbance regime values to each EUNIS habitat class and, based on such values, to 672,823 plots of the European Vegetation Archive (EVA). Our analysis focused on four disturbance indicator values based on the expert-based assessment of disturbance regimes: 1) Disturbance Frequency Index and 2) Disturbance Severity Index, as general indices capturing strength and frequency of disturbance events, respectively; and, 3) Grazing Tolerance Index and 4) Mowing Tolerance Index as land-use specific disturbance indices. Species disturbance indices were calculated as the average of the expert-based values in all the EUNIS habitat types in which that species occurs, weighted by the number of plots where the species is present within individual habitat types. For forest vegetation, we calculated separate values for the whole community and a subset of understorey species. Finally, we explored how disturbance indicators are related to plant traits focusing on specific leaf area, plant height, seed mass (L-H-S scheme), as well as lifespan and clonality, to test whether our indicators captured plant strategy trade-offs with respect to disturbance. Implementing such so-far missing disturbance indicator values for the European flora will allow for more detailed analyses of vegetation.

High-rank syntaxa of vegetation of Dolna Banya and Kostenets municipalities in Sofia district, West Bulgaria

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Overview: The territory of Dolna Banya and Kostenets municipalities is situated in the south-eastern part of Sofia district and covers 369 km^2. The relief is semi-mountainous and mountainous. The water resources are represented by the Maritsa river and its tributaries. The territory falls into the Continental and Mountain climatic zones. It is characterized by a great variety of soil types. There is a high diversity in vegetation habitats because of the broad altitudinal range from 400 to 2650 m a.s.l.

Materials and methods: Till now, syntaxonomical diversity was studied mainly in the southern parts of the territory, while the northern and central parts were poorly studied. This study aims to reveal the syntaxonomical diversity of all vegetation types in the study area. During May–September of 2019 and 2020, 374 new relevés were collected applying the Braun-Blanquet approach. The plot size was 16 m^2 for grasslands, 64 m^2 for scrub and 225 m^2 for woodlands, as recommended in the literature for each vegetation type.

Results and discussion: The syntaxonomical diversity on Dolna Banya and Kostenets municipalities is represented by 26 classes (*Alno glutinosae-Populetea albae, Artemisietea vulgaris, Bidentetea tripartiti, Carpino-Fagetea sylvaticae, Chenopodietea, Crataego-Prunetea, Digitario sanguinalis-Eragrostietea minoris, Epilobietea angustifolii, Festuco-Brometea, Juncetea trifidi, Lemnetea, Loiseleurio procumbentis-Vaccinietea, Molinio-Arrhenatheretea, Mulgedio-Aconitetea, Papaveretea rhoeadis, Phragmito-Magnocaricetea, Polygono-Poetea annuae, Potamogetonetea, Quercetea pubescentis, Robinietea, Roso pendulinae-Pinetea mugo, Salicetea purpureae, Scheuchzerio palustris-Caricetea fuscae, Sedo-Scleranthetea, Sisymbrietea, Trifolio-Geranietea sanguinei* and *Vaccinio-Piceetea*). A total of 34 orders and 44 alliances were identified.

Farming for the future: lowland grassland management for biodiversity

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Grassland is Ireland's most extensive habitat type covering >75% of the country but is also under serious threat of agricultural intensification or land abandonment. For example, 38% of semi-natural grassland sites surveyed in the 1970s have been lost by the mid-90s. While the decline in Irish grassland biodiversity has been recognised, there is a paucity of research into the restoration of lowland nutrient-rich grassland. Most of Ireland's grasslands are privately farmed mainly for pasture, therefore, appropriate agricultural management regimes for biodiversity restoration are vital. The purpose of this research was to first classify the grassland vegetation in the Killarney National Park, Co. Kerry in the west of Ireland (~244 ha), and then to investigate selected management regimes that are the most effective for spontaneous regeneration of lowland grassland vegetation diversity.

A baseline study of the grassland vegetation communities of the park has been completed. A total of 209 relevés were carried out over 29 lowland fields. These data were classified using the online classification tool ERICA. The predominant communities found were *Holcus lanatus–Lolium perenne* within the group *Agrostis–Trifolium repens*. This classification can be somewhat compared to a hybridisation between the phytosociological alliances *Arrhenatherion elatioris* and *Cynosurion cristati.*

Three management regimes (mowing, extensive grazing, and mob grazing) are currently in place across the grasslands. Preliminary findings indicate that the fields with moderate grazing or traditional hay regimes have the highest species diversity compared to those with little to no grazing and silage regimes.

We predict that with the regimes in place, the species richness of previously intensively managed fields will increase, the cover of previously sown commercial species will slowly decrease, and the communities will begin to resemble *Arrhenatherion elatioris* more closely.

Demutation processes of vegetation in Chernobyl Exclusion Zone

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The resettlement of people and strict attendance controls after the Chernobyl accident contributed to the natural succession in the Chernobyl Exclusion Zone. To study such changes in vegetation, six eco-coenotic profiles representing abandoned fields, settlements and natural vegetation of various landscape elements were established in 1992, and similar studies were conducted in 2021. During that time, *Acer negundo* and *Robinia pseudoacacia* grew intensively in the settlements, now forming stable, dense shady trees and scrub (*Robinietea*). In 1996, communities dominated by *Elytrigia repen*s were formed in the main areas of the fallows, which allowed to predict the overgrowth of these areas by *Betula pendula* and *Populus tremula* by 2000, and later the formation of typical *Dicrano-Pinion* zonal forests, as well as flooded alder forest. Although the development directions are sustained, the timeline stages stand behind significantly, and grasslands in the Chernobyl zone occupy more than 25% of the territory. Moreover, *Elytrigia repen*s lost dominance, being replaced by *Calamagrostis epigeios, Agrostis gigantea* and *Arrhenatherum elatius* due to the reduction of soil nitrogen. Tree species cannot form a closed canopy, probably due to the allelopathic properties of the soil, which was previously underestimated by phytocoenologists. At the site of large-scale fires in various types of forests from moist (*Alnetea glutinosae*), wet (*Molinio-Pinetum, Betulion pubescentis*) to dry (*Dicrano-Pinion*), it was found that dry forests (*Cladonio-Pinetum*) with a predominance of *Corynephorus canescens* were the least affected. In typical pine forests, *Epilobion angustifolii* species (including aliens) are common, and in some places, the grass cover has not been restored. In humid forests, due to the enrichment of the soil with carbon and nitrogen compounds, powerful thickets of *Rubus* spp*., Pteridium aquilinum* and grasses are formed.

Baltic Sea salt-affected grasslands – from large-scale studies to nature conservation

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The study of broad-scale vegetation plot data significantly contributes to a better understanding of vegetation types, which is important for decision-making in European nature conservation.

We studied semi-natural, saline and brackish grasslands of the Baltic Sea coast, which occur on sediment flats at the transition between land and sea. This diverse vegetation is dependent on low-intensity grazing and thus is especially threatened by land-use changes causing a decrease in quality and quantity. We classified a comprehensive plot-based dataset and described Baltic Sea salt-affected vegetation in relation to its ecology, littoral placement, geographic patterns, phytogeography and assignment to North-west European salt grasslands. We also examined Natura 2000 habitat type descriptions. We contributed to nature conservation by analyzing characteristic species of salt-affected grasslands in relation to cover-abundance of *Elytrigia repens* using a data subset from the southern Baltic Sea coast. We elaborated a quality assessment scheme for coastal grassland vegetation.

Results show that abiotic factors such as soil salinity, moisture and nutrient availability strongly relate to the micro- to meso-scale differentiation of the salt-affected Baltic Sea grasslands, whereas the distribution of vegetation types relates to phytogeographical patterns, sea-water salinity, tidal range, and climatic conditions. The communities found there are either most similar to North-west European or Arctic communities or are unique. Our findings contribute to an improved transnational perspective on the Baltic Sea coastal grasslands and Natura 2000 habitat type descriptions. We revealed that a high cover of *Elytrigia repens* significantly relates to differences in abiotic factors and a low presence of species characteristic of the target vegetation. We developed a monitoring method, which may contribute to improved decision making concerning grazing management and may be transferred to regions beyond the studied area.

Species and functional diversity dynamics of hay and pasture meadows in protected areas

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The assessment of the long-term dynamics of meadow communities of the Volga-Kama Nature Biosphere Reserve and its buffer zone was carried out, focusing on their species richness and functional diversity. The historical species pool concept was applied using data from the Vegetation Database of Tatarstan (GIVD ID: EU-RU-011), including geobotanical relevés from a period of more than one hundred years. The species abundance probability in the target community was considered. The plant functional traits such as leaf area (LA), leaf dry mass (LDM) and specific leaf area (SLA) were used. A general pattern of changes in the composition of vascular plant species under the influence of haymaking and grazing has been established for the periods: before the creation of the reserve, the use of meadows in the reserve, the termination of haymaking. The maximum species diversity was observed in the second period, with the dominance of graminoids. The maximum biomass is characteristic of overgrown post-hay meadows with a decrease in the species composition of the meadow community and an increase in the participation of forest plant species. With a decrease in the abundance of meadow species (*Alchemilla* sp.) in the post-haymaking community, the functional traits of LA, LDM, SLA increased, the LA and LDM of *Dactylis glomerata* decreased, but the SLA increased. In communities of pasture meadows, compared with hayfields, LA and LDM of *Plantago media* decreased, and SLA also increased. According to the analysis of the structural and functional flora indicators, it is concluded that the historical species pool concept can be used as a reliable tool for assessing the long-term vegetation dynamics. The loss and reduction of rare species and the emergence of ruderal and invasive species indicate the direction of anthropogenic changes. Plant functional traits can be used in assessing the succession dynamics of vegetation.

Tall herb-rich steppe in the peri-Carpathian region

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Vegetation mosaics of steppe grasslands in Western Ukraine and Eastern Romania include tall herb-rich vegetation consisting of a mixture of forest-steppe and mesophilous species. Such vegetation is confined to the most productive places, usually situated on the northern slopes of steppe sites. Most often, it is dominated by *Laserpitium latifolium* and *Clematis recta,* and the frequent species (e.g. *Brachypodium pinnatum, Geranium sanguineum, Pulmonaria mollis, Primula veris, Tanacetum corymbosum*) suggest its classification within thermophilous fringe communities of the *Geranion sanguinei* alliance. However, a regular admixture of mesophilous and montane species (e.g. *Aconitum* spp*., Aegopodium podagraria, Dactylis glomerata, Galium mollugo* agg., *Lilium martagon, Sanguisorba officinalis, Trollius europaeus*) suggests its relationship also to mesophilous fringe communities of the *Trifolion medii* alliance and even to montane tall herb-rich communities of the *Mulgedio-Aconitetea* class. Similar communities are also known from Romanian Transylvania, continental parts of the Alps or northern Balkans. Forest meadows of *Carici macrourae-Crepidetalia sibiricae* order distributed east of the Ural Mts are also similar. The presence of (sub)continental elements such as *Actaea europaea, Adenophora liliifolia, Crepis sibirica, Ligularia glauca* and *Veratrum nigrum* underlines this link. Possible drivers of these patterns and challenges for consistent syntaxonomical treatment will be discussed.

Floristic and ecological differentiation of fir forest communities in the mountains of south-central Greece

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Fir (*Abies* spp.) forests are a widespread landscape feature in the mountains of southern and central Greece, with high ecological and economic importance. Nonetheless, a good understanding of their floristic and ecological differentiation is lacking. This study aims at describing the fir forest vegetation of south-central Greece and determining the environmental factors affecting their floristic composition and differentiation.

Vegetation relevés were classified based on the floristic composition and species cover values. A hierarchical agglomerative cluster analysis based on Bray-Curtis distance was performed. To determine diagnostic taxa for the vegetation units, fidelity values for the species were calculated using a modification of the Φ index. To reveal the expected vegetation gradients, Non-Metric Multidimensional Scaling (NMDS) was performed, with Bray-Curtis distance. Recursive partitioning was used to derive classification trees for the response variables (plant communities) in order to reveal the most important factors for the discrimination of the main plant communities and to determine the threshold between them.

Two plant communities that reflect the differentiation of the fir forests in south-central Greece into xerophytic and mesophytic forest communities were described. Among several climatic variables, aridity best discriminated between the two forest communities. The quantification of the aridity threshold between the two fir forest communities was used to predict their potential distribution in the study area.

Effects of forest growth on the fragmentation of Mediterranean mid-mountain grasslands

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Mountain grasslands in Europe suffer from the abandonment of livestock grazing and are colonized by scrub and forest in the process of natural succession. Grassland fragmentation has been widely studied in agricultural models, but mid-mountain grasslands are often embedded in a forest matrix. There are no studies that have tested the effects of the forest matrix on pasture fragmentation.

Our objective is to verify the effect of grassland fragmentation on the composition and richness of grassland communities within the area of a natural 'melojo' (*Quercus pyrenaica*) forest developed in an area in the Sierra de Guadarrama (Community of Madrid, Spain) belonging to the supra-Mediterranean thermotype (1200-1250 m a.s.l).

Sampling was carried out in 30 grassland fragments within the forest that varied in size and distance from each other. Herbaceous plant communities were counted in each fragment within plots of 2x2 m. The number per fragment ranged from 1 to 10 plots, depending on the size of the fragment. The plots were classified into phytosociological categories according to the natural dynamics in the habitat. Measures of spatial fragmentation of the area, border and connectivity were calculated for each fragment. GLMM and multivariate analysis were carried out to test the effect of these fragmentation variables on the richness and composition of the plant communities.

The results show that the edge effect favoured the richness and composition of the herbaceous plant community while the area or connectivity had a weak effect on these variables. The reduction in size or the lack of connectivity in the grassland are not problems at a local scale. However, edges favoured the development of forest plant communities. We conclude that there are fragmentation effects on grassland communities, and their composition changes are affected by the surrounding forest.

Succession complexes of coniferous-deciduous forests on the southern border of the forest zone in European Russia: issues of conservation and restoration

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The negative effects of coniferous-deciduous forest fragmentation associated with intensive exploitation have been studied. Plant communities with populations of *Picea ×fennica* and *Abies sibirica* are especially valuable. A comparative analysis of species and ecosystem diversity based on modern studies and historical data was carried out. A 90-year period was considered. Two model areas were selected: a forest plot in a national park and a plot in a commercial forestry plantation. The general indicators of the forest mosaic (area, perimeter, coefficient of variation, entropy measure of the complexity of the pattern, etc.) and individual indicators of the contours of communities (Shape index, Compactness, FRACT) were calculated. The dynamics of the general indicators of the forestry plot show a continuously increasing fragmentation, entropy and the length of ecotones. Reforestation is possible only by cultivating plantations regulated by man. In this case, the restoration of fully developed populations of spruce and fir is impossible and does not ensure the maintenance of community biological diversity. In the national park, the forest fragmentation slows down, but the boreal plant species are replaced by nemoral ones. Fragments of natural coniferous-broad-leaved communities isolated in small areas are also unable to ensure their own reproduction. An important role in this is played by the loss of the ground moss cover, which usually, by stabilizing the water balance in the litter and in the surface layers of the soil, ensures the germination of coniferous species seeds. Understory nemoral species of the community create unfavourable conditions for the development of ground mosses and prevent the emergence of coniferous undergrowth. The task of preserving boreal complexes in the national park cannot be solved without removing the undergrowth of deciduous species and measures for the implantation of moss cover.

Grasslands of the Buzkyi Gard National Nature Park (Ukraine): inventory, mapping, and management

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The Buzkyi Gard National Nature Park is located in the northwestern part of the Steppe zone of Ukraine. There are 32 habitat types listed for the territory, based on the EUNIS Habitat Classification.

Habitat mapping of the grassland habitats was carried out using GIS software (NextGIS Mobile; QGIS) in the field and remotely, with a total mapped area of 1305 ha (21% of the territory of the National Park). 105 relevés containing 538 plant species were sampled across all grassland types and classified using the modified TWINSPAN method in the JUICE 7.0 program.

Dry grassland habitats (*Festuco-Brometea*, 1240 ha) are represented by true forb-bunch-grass steppes (R1B, *Stipo lessingianae-Salvion nutantis*), xero-mesic meadow steppes (R1A, C*irsio-Brachypodion pinnati*) and petrophytic steppe communities (R12, *Poo bulbosae-Stipion graniticolae*).

Mesic and wet grassland habitats (*Molinio-Arrhenatheretea*, 65 ha) are represented by mesic hay meadows (R22, *Arrhenatherion elatioris*), wet eutrophic and mesotrophic hay meadows (R35, *Deschampsion cespitosae*), wet pastures (R36, *Potentillion anserinae*), and small areas of moist tall-herb grasslands (R55, *Veronico longifoliae-Lysimachion vulgaris*).

An appropriate management regime should be grazing optimization, regular mowing in some areas, and removing shrubs and juvenile trees, especially invasive species.

Revitalization of the Danube inland delta – are we revealing a turning point in the ongoing invasion pattern?

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Riparian vegetation – floodplain forests and alluvial meadows – are among the most threatened habitats in Slovakia due to river regulation, changes in water regime, and the enormous pressure of invasive species. A considerable part of these habitats in the Danube inland delta is degraded, and their quality is still decreasing. However, several LIFE projects were implemented in the area to improve this status. The main revitalization activities were restoration and improvement of the water regime by reconnecting river branches, eliminating non-native tree plantations, and proper mowing in meadow localities. The influence of management activities and their effect on the species composition and vegetation structure were evaluated before and after management actions. The study is based on the data from the forest and meadow habitats (7 and 6 localities). Permanent plots were established, and phytosociological relevés were sampled by methods of the Zürich-Montpellier school at each locality in 2018–2020. For each relevé, the cover of vegetation layers, number and percentage cover values of neophytes and diagnostic species for the corresponding syntaxa were calculated. The observed variables were compared using ANOVA and time-series analyses. The main message is that the species spectrum changed significantly after the management activities. An apparent shift from a high cover of neophytes and ruderal species to the higher presence of hydrophilous species was observed in forest habitats. After revitalizing river branches and renewing the water regime in the meadow plots, a gradually decreasing cover of neophytes was observed. The effect of the management activities seems to be positive for maintaining natural riparian habitats and their original species composition. However, the results are still variable, and continuous further research is needed.

Lower Dnieper old cemeteries in steppe flora of southern Ukraine

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Changes in natural landscapes lead to the loss of a large proportion of the steppes. Especially significant changes occurred in the steppe zone in southern Ukraine. Recent studies (2008–2017) have demonstrated the high importance of cultural heritage sites of anthropogenic origin, such as old cemeteries. The size of the old cemeteries of the Lower Dnieper varies from 0.43 ha to 6.79 ha. The size of cemeteries affects the richness and composition of the local flora.

The purpose of our study was to show the role of ancient cemeteries in the preservation of steppe flora in southern Ukraine. The characteristic features of the natural conditions of the Lower Dnieper region are determined by its geographical location within the proper steppe zone of the Eastern European Plain.

The list of vascular plants from 10 cemeteries of the Lower Dnieper region includes 389 species belonging to 226 genera, 62 families, 3 classes and 2 divisions.

The flora of old cemeteries in the south of Ukraine shows these features:

a) The proportion of native flora is approx. 2/3 of the total flora.

b) The dominant share of therophytes, both native and alien, in the flora of old cemeteries indicates instability of habitats.

c) The share of woody species (phanerophytes) is small, about 9.2%. This reflects the location in the forestless zone (steppe).

d) Typical for cemeteries is the relatively large share of species escaping from cultivation (over 11%), both native and alien. Most of them are ornamental plants.

e) Old Ukrainian cemeteries should be subject to special protection as monuments and because they become habitats for steppe species. 22 species of legally protected vascular plants were found in old cemeteries.

The results obtained emphasize the floristic specificity and value of old cemeteries. They could play an important role in steppe phytodiversity conservation and give perspective for future steppe restoration actions.

Grazing project of meadow restoration in Tula region of Russia

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A grazing project is under implementation since 2015 in the Tula region, near the Gurovsky quarry of HeidelbergCement Rus LLC. The project aims to restore a meadow in an abandoned arable field intended for limestone mining in 2025. The soil from this meadow will be used for the remediation of the quarry, which is being developed now. The restoration of biodiversity should strengthen the ecological functions of the natural meadow community. This will increase soil fertility, which will be used to restore the currently developed quarry.

In 2015, the main part of the experimental plot was ploughed up and then grassed. We applied several methods of meadow restoration:

- year-round grazing by livestock (10 Shetland ponies per 10 hectares of a 10-year-old poor meadow and 20 Kazakh white-headed cows per 42 hectares of sown grasses) and feeding it with hay collected from the natural meadow,

- extended over time mosaic mowing of grass in hayfields (30 ha),

- sowing hay from natural meadows on parts of hayfields (1 ha),

- planting target species and sowing them in hayfields.

The number of plant species increased in the pony pasture from 69 to 103 species, in the cow pasture from 109 to 136 species, and in the hayfield from 104 to 137 species.

The average aboveground plant biomass was 3.7 t/ha in the parts of the hayfield sown with hay from the natural meadow, 2.0 t/ha in the rest of the hayfield and 3.0 t/ha in the cow pasture. For comparison, it was 3.2 t/ha in a natural meadow. The average hay yield in the Tula region in 2016 was 2.1 t/ha.

The fastest restoration is in the plot mown for hay, sowed with the seed mixture from the natural meadows. The invasive species *Solidago canadensis* and *Erigeron annuus* damage the meadows under restoration. The vegetation of the experimental plot belongs now to the basal and derivate communities of the *Molinio-Arrhenatheretea* class.

Drivers of temporal changes in Mediterranean coastal dune habitats

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Coastal dunes are fragile ecosystems of outstanding conservation value. Beyond hosting a rare and unique flora, they provide essential ecosystem services, including coastal defence, groundwater storage and climate mitigation. Nevertheless, they appear among the most endangered ecosystems on Earth and especially in the Mediterranean, where several habitats have been recently classified as 'threatened'. In the last two decades, the Mediterranean coastal dune vegetation of Central Italy experienced major taxonomic shifts consisting of species loss, high turnover and community simplification. Using data from a resurvey study, we investigated the drivers of recent (10–15 years) changes in 334 vegetation plots belonging to herbaceous dune habitats. We identified four metrics of vegetation change: i) plot status (plot vegetated at the time of the resurvey or not); ii) Jaccard's dissimilarity index and iii) its loss component; iv) absolute change in focal species richness. Using linear regression, we tested the influence of a set of potential drivers summarizing natural and historical anthropogenic disturbances, as well as changes in landscape configuration. Species richness, functional diversity and alien species richness at the time of the original survey were also included in the models to account for biotic mechanisms. Though with differences among models, our results indicate coastal erosion and landscape dissimilarity (i.e. change in the composition of land-cover classes over time) as the most important drivers of temporal change, followed by the amount of artificial land-cover historically present in the plot surroundings. Interestingly, functionally diverse communities located in areas experiencing an increase in psammophilous vegetation over time were able to mitigate the loss of the focal species. Our analysis suggests that recent temporal changes in Mediterranean coastal dunes are driven by multiple processes acting at different spatial scales.

Vegetation Database of Bosnia and Herzegovina – finally completed

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Vegetation Database of Bosnia and Herzegovina (GIVD ID: EU-BA-001) is a national database for Bosnia and Herzegovina, which was established back in 2014 to support the research of thermophilous deciduous forests in the country. Since then, the database has grown to include relevés from all vegetation types, and the digitization of relevés from references was completed at the beginning of 2021. A portion of relevés from Bosnia and Herzegovina can be found in several other databases; however, this one is the first that brings together all relevés from all the available literature. At present, the database contains 8141 relevés, including all the published relevés (4217 from 127 references) and relevés from the grey literature (theses, reports and manuscripts) that were available to us (1874), complemented by 2050 unpublished authors' relevés. The majority of relevés (62%) belong to forest vegetation, with six classes of forest vegetation sharing almost 60% of the total number of relevés. Another six classes of various grasslands take another 25%, while the rest belong to different types of non-forest vegetation. Relevés were recorded from 1931 to 2020. All relevés were georeferenced. The plot size is available for 83% of the relevés. The data are stored in the TURBOVEG format and can be used for phytosociological studies, various interdisciplinary research, as well as for studies in forestry, agronomy, nature management and biodiversity conservation.

Annual variability of the species composition of meadows in the Valday National Park (Novgorod region, Russia)

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The vegetation of the Valdai National Park was studied with particular attention to the meadows of the class *Molinio-Arrhenatheretea*. These ancient meadows have formed due to centuries of agrarian use of the forest lands in the region.

According to the methodology of the EDDG group, permanent sample plots of the grassland communities of the association *Anthoxantho-Agrostietum* (alliance *Cynosurion cristati,* order *Arrhenatheretalia*) were established in 2017. The species composition monitoring was carried out in these plots annually.

It was revealed that each year, the communities are characterized by high values of the total cover and the height of the herb layer (respectively, 75-100% and 80-120 cm). Due to the absence of haymaking and grazing, all plots are characterized by a thick litter layer. The number of species in the plots varies from 75 to 22. A tendency for decreasing species diversity was observed over the years. The group of constant species for every year on the plot is relatively small (from 8 to 30%). The maximum values are reached by a group of episodically occurring species that appear or disappear in different years or single species, found only in one of the four years of observation.

This high species turnover maintains a high level of biological diversity of post-forest meadows in the region. In addition, on all plots, expansion of trees and shrubs, as well as invasive species, is very rare, which indicates that owing to long-term anthropogenic evolution, meadows of the National Park retain their own succession status. They are conservative with respect to the introduction of new species (including alien ones) and can withstand forest overgrowth after the end of land use (haymaking and grazing). Thus, it is necessary to note the high importance of meadows for conserving natural biodiversity and cultural heritage in the Novgorod region.

Vegetation diversity in a rapidly changing landscape: investigating the effects of land abandonment on habitat conservation

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One of the most important drivers of landscape and thus vegetation change in our era is land abandonment, especially in mountainous areas. Land abandonment has dual effects on biodiversity. It may comprise a pressure or threat for the conservation and persistence of semi-natural habitats, but it may also constitute an indirect way for the (re-)establishment or the expansion of other habitats such as forests. Here, we studied the diversity of vegetation units in a (sub-) mountainous area of northwestern Greece (northern Pindus), in which the landscape has been changing rapidly during the last decades due to land abandonment. The study was based on vegetation sampling of three vegetation types, defined by their physiognomy, and representing the main stages of natural succession: grasslands, scrub, and forests. We mapped the distribution of these vegetation types, together with farmlands, for the years 1945, 1970, 1996 and 2015. The sampled vegetation data were analyzed by exploratory techniques, such as classification and ordination, to identify different vegetation units and describe and interpret their floristic differentiation. For the interpretation, we employed classical ecological explanatory variables (e.g. altitude, ground inclination, geological substrate, air temperature and precipitation), but we also tested some additional less common variables, such as land history at each sampling locality, as well as livestock and population density. Based on the vegetation mapping, we estimated the historical trends of the vegetation units, most of which represent certain habitat types according to the Habitats Directive. Finally, we discuss the effects of land abandonment on the conservation status of habitat types.

Comparison of habitat maps along the Ipoly valley (Hungary)

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Nowadays, it is increasingly important to have up-to-date data on the condition and changes of vegetation. Using satellite images, areas that were difficult to access during field recording also became easily observable.

The Ipoly valley is extremely mosaic-like, mainly because of its linear nature, and exposed to invasive species due to the global environmental change. The present study compares two different vegetation aspects of habitat maps based on satellite imageries in the Ipoly floodplain in the Dejtár area in Hungary, which contain variable habitats such as dry grasslands, forests and urban arable fields.

Spring aspects from 2019 and 2020 were compared. Field sampling was performed using the General National Habitat Classification System (Á-NÉR). We grouped different habitats and compared them with the satellite images of Sentinel-2A to look for possible correlations. NDVI (Normalized Difference Vegetation Index) data were generated for numerical evaluation and monitoring of the current state of vegetation.

The results showed that some habitats were well separated from each other. Significant differences were found mainly in urban and natural areas. Natural habitats showed a more uniform picture, with drier areas well separated from other habitat categories. Arable land and dry grassland were well separated from woody vegetation.

The impact of livestock grazing on dry dune vegetation in Meijendel, The Netherlands, based on permanent plot analysis

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The vegetation of coastal sand dunes is characterized by high species diversity and comprises some of the most valuable vegetation types in Europe. Especially dune grasslands include species-rich plant communities and are a priority habitat under the Natura 2000 legislation. In the 1950s, 41 permanent plots were set up to study vegetation succession in the dry dunes of Meijendel, the Netherlands. This long-term research was installed to evaluate the impact of artificial recharge for drinking water production and the development of grasslands and forests in the area. The plots were sampled in approximately four-year intervals. Progressive and regressive shifts in vegetation have occurred. In 1990, livestock was introduced to change the monotony of the vegetation by counteracting grass and shrub encroachment and stimulating bare sand cover (through supposed disturbance due to the weight of the animals). The changes found in the permanent plots will be discussed. Suggestions are presented on possible factors driving the changes, other than the introduction of livestock, including the role of rabbits.

Ecological bionics: restoration of plant communities taking into account the needs of invertebrates

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Environmental restoration requires methods of maintaining a community of producers, consumers, and decomposers. Regulatory mowing of an entire grassland plot causes the death of insect consumers. In the 1980s, we developed a method of incomplete mosaic mowing for regional meadow-steppe reserves in the Moscow region. In 2007, according to our proposal, the possibility of incomplete mowing of lawns was provided in the Rules for the creation and maintenance of green spaces in the city of Moscow.

Incomplete summer mowing is necessary so that anthophilous and chortophilic insects can continue to feed and develop, as well as to preserve the biotope of other insects. Incomplete autumn mowing is necessary to preserve wintering sites. Mosaic mowing prevents accidental complete mowing of microhabitats. The proportion and width of mowed areas are established, taking into account the limited ability of slowly moving species.

For cities, there are three options for biodiversity-saving open grass cover ("lawns") made from local plants:

1. The multi-species forb lawn allows anthophilic and chortophilic insects to survive, as well as insects in which the resting stages are associated with plant stems. Mosaic and time-stretched mowing is carried out in half or a third of the area of the plot once per season (in late summer-early autumn or late June-early July) with an annual shift by the width of the mowing strip.

2. Low-grass strip 0.5-1.0 m wide from creeping and rosette plants along the edge of the lawn. Five mows per season, that is, once a month, starting in May.

3. Tall grass – plants blooming in early July. Optimally one incomplete mowing in the fall, from 1/3 to 1/2 of the area. Tall grass can displace other plants, and therefore it must be limited and restrained seeding.

The use of three types of multi-species grass cover enhances the habitat mosaic, its biodiversity-saving capacity and community stability.

What is an alliance?

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I explored the original association concept of Braun-Blanquet, which was based on absolute character species. I found that this concept is more or less identical with the units that we now call alliances. Incorporating the concept of central syntaxa, I propose the following definition: "An alliance is a moderately broad vegetation unit that either has one or several absolute character taxa or that can be interpreted as the central alliance of an order." The one-to-one relationship between character taxa and vegetation units gives the latter a clear biogeographical and evolutionary meaning. Restrictions to the validity of character taxa – either to certain geographical areas or to physiognomic types – cause theoretical and practical problems and should be avoided. Possible exceptions are species with similar frequency in two formations or species introduced to other continents. The application of this definition will be discussed using examples from European temperate forests and grasslands.

Factors affecting the occurrence and demographical parameters of *Pulsatilla patens* in Latvia

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Eastern pasqueflower, *Pulsatilla patens*, is a rare and endangered plant species in Europe as well as in Latvia. The number of localities and vitality of the species is decreasing due to different reasons. The research aimed to identify interactions among occurrence and demographical parameters of *Pulsatilla patens* and environmental factors – species composition in the habitat, vegetation cover, plant litter, dead plants, and bare soil area. Collected data were analysed along with soil chemical and morphological parameters. To obtain data, 43 sample plots (100 m²) were surveyed twice per season in 2019 and 2020. Our research shows that the demographic parameters correlate negatively with increasing tree cover, especially the cover of conifers typical of boreal forest habitats. Shading from trees negatively affects both *Pulsatilla patens* and its accompanying plants such as shrubs, small understorey trees and herbaceous plants. Some herbaceous plants, for example, the expansive *Convallaria majalis*, negatively influence *Pulsatilla patens*, but no negative interaction was found with the dwarf shrub *Calluna vulgaris.* The dense cover of *Hylocomium splendens* moss affects more negatively *Pulsatilla patens* occurrence and demographic parameters than the cover of other moss species. The assumption of a negative correlation between demographical parameters of *Pulsatilla patens* and dead plants, as well as plant litter, was not confirmed. Investigated open-soil areas are too small to affect *Pulsatilla patens*. These small areas are rapidly overgrown by surrounding vegetation, and the chance for *Pulsatilla patens* to occupy them is small. Forest management focused on slowing down the succession is essential to protect *Pulsatilla patens* and provide conditions for the species occurrence and the improvement of its demographical parameters.

The study was conducted during the project "Investigation of *Pulsatilla patens* localities, data updating and monitoring of the management".

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