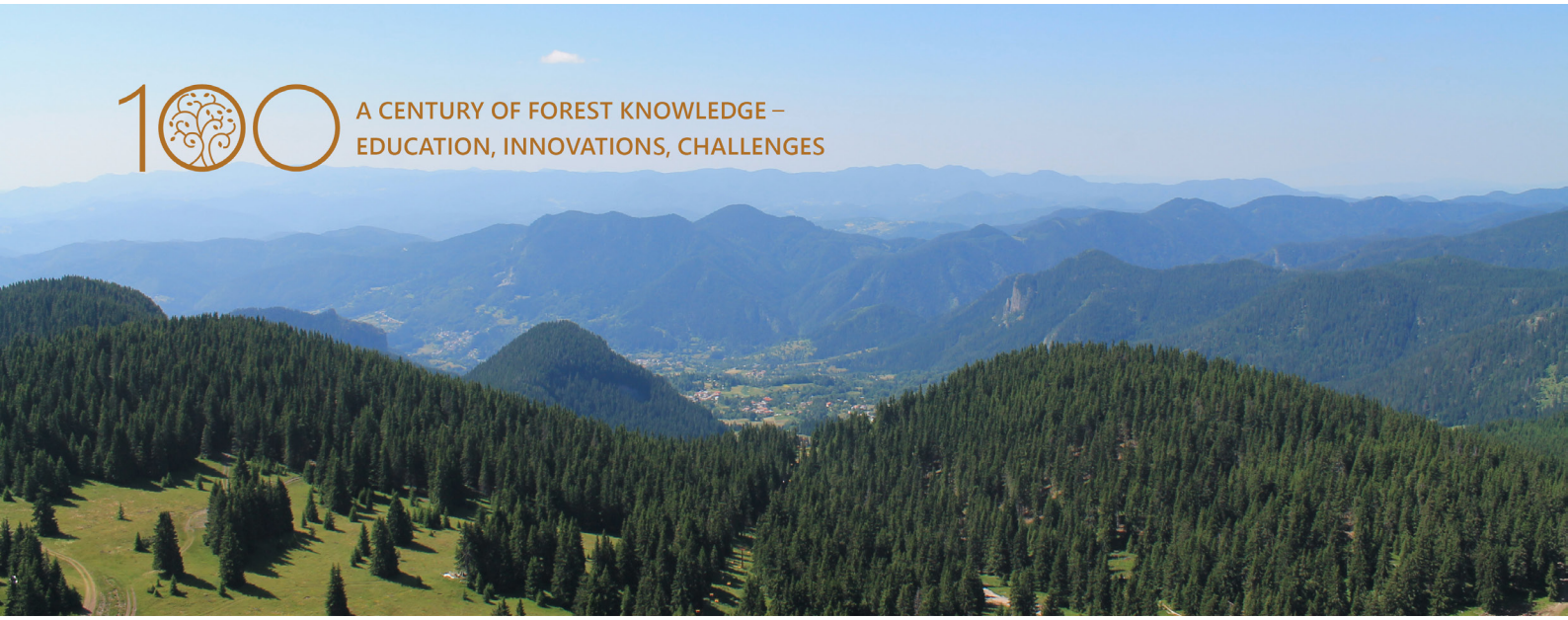

Conference

“A century of forest knowledge – education, innovations, challenges (CENFORKNOW 2025)”

dedicated to the 100th anniversary of Higher Forestry Education in Bulgaria

SOFIA, 08–09 May 2025, park-hotel Moskva,
Nezabravka Str. 25

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Sofia
2025

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Dear Participants and Guests,

On behalf of the Organizing Committee, it is my distinct honour to welcome you to the international scientific conference "A Century of Forest Knowledge: Education, Innovations, Challenges", marking 100 years of Higher Forestry Education in Bulgaria.

The expanding international reach and academic scope of this event reflects its growing significance in addressing global environmental concerns. This year's conference brings together 116 scholarly contributions from 433 co-authors across 13 countries, representing more than 30 academic and research institutions. We are also pleased to welcome representatives from scientific organizations, Bulgarian government agencies, and non-governmental organizations.

In the face of complex global challenges – climate change, prolonged droughts, extreme weather, natural disasters, and increasing forest fires – modern forestry is more crucial than ever. Our shared objective is the sustainable management and natural regeneration of forest ecosystems, the preservation of biodiversity, and the protection of old-growth forests and their essential ecological, hydrological, and recreational roles. Forests support countless rare and endangered species and provide vital environmental and social functions.

This conference provides an important platform for the exchange of knowledge, the development of innovative approaches, and the strengthening of scientific collaboration. The insights and ideas shared here will undoubtedly contribute to advancing our collective efforts in the forest and natural resource stewardship. By coming together, sharing research, and exchanging ideas, we can help develop real, science-based solutions.

Dear Colleagues,

I beleive that the coming days will offer meaningful professional engagement, fruitful discussions, and memorable experiences. May this event inspire us all as we continue the noble and challenging mission of advancing science in service of forest and environmental conservation.

Welcome, and best wishes for a successful conference.

Stoyan Stoyanov

Chair of Organizing Committee

Conference "A century of forest knowledge – education, innovations, challenges (CENFORKNOW 20250)",

dedicated to the 100th anniversary of Higher Forestry Education in Bulgaria.

Organized by:

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CONFERENCE PROGRAMME

Thursday, 08 May 2025

8:00-9:30	**Registration, Hanging of Posters & Morning Coffee**

9:30	**CONFERENCE OPENING**
	„Moskva“ Hall
9:30-10:15	**Greetings**
10:15-10:45	**Invited Speaker Prof. Tsvetan Zlatanov – Distribution and structural diversity of old-growth forests in Bulgaria**

10:45-12:00	**Climate Change** Session **Hall „Evropa“**

12:00-13:00	**LUNCH BREAK**

13-14:15	**Ecosystem biodiversity, conservation and environmental restoration** /Part 1/ **Hall „Evropa“**	**Agriculture in mountainous and semi-mountainous regions** Session **Hall „Conference 5“**

14:15-14:30	**COFFEE BREAK**

14:30-15:45	**POSTER SESSION 1 – Foaier and „Conference 1“ Hall**

16:00-17:30	**Ecosystem biodiversity, conservation and environmental restoration** /Part 2/ **Hall „Evropa“**	**Silviculture, forest management and ecosystem services** Session **Hall „Conference 5“**

17:30-20:00	**Ice Breaker, „Moskva“ Restaurant**

FRIDAY, 09 May 2025

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8:30-9:00	**Invited Speaker Dr. Michaela Teich – Avalanche Protective Forests: What Do We Know and Where Do We Grow from Here?**
9:00-9:30	**Invited Speaker Prof. Dzhamal Amishev – Developments in Forest Operations on Steep and Challenging Terrain**
9:30-10:00	**Forest disturbances and management challenges** Session /part 1/ **Hall „Evropa“**

10:00-10:15	**COFFEE BREAK**

10.15-12:00	**Forest disturbances and management challenges** Session /part 2/ **Hall „Evropa“**	**Wildlife conservation and management** Session **Hall „Conference 5“**

12:00-13:00	**LUNCH BREAK**

13:00-13:30	**Forest disturbances and management challenges** Session /part 3/ **Hall „Evropa“**	**Wildlife conservation and management** Session /part 2/ **Hall „Conference 5“**

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15:00-15:30	**CONFERENCE Closing, „Moskva“ hall**

19:00-22:30	**OFFICIAL DINNER „Panorama“ Restaurant**

SATURDAY, 10 May 2025

Fieldtrip to Rila Monastery and Rila Monastery National Park

Conference
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10:45-12:00	**Climate Change** Session Session Chairs - Tsvetan Zlatanov Momchil Panayotov **Hall „Evropa“**

10:45-11:00	Jakob Pavlin	Adapting to Warmer Conditions: Thermophilic Forests as References for Future Temperate Forests of Europe
11:00-11:15	Ionel Popa	Oak species resilience to drought in South-Eastern Romania
11:15-11:30	Tsveta Davidkova	The concept of “analogue climate” - geographical transfer to adapt to temporal changes of climatic conditions

12:00-13:00	LUNCH BREAK

13-14:15	**Ecosystem biodiversity, conservation and environmental restoration** Session /Part 1/ Session Chairs - Petar Zhelev and Kiril Vassilev **Hall „Evropa“**

13-13:15	Petar Zhelev	Current Status and Future Prospects of Coniferous Seed Orchards in Bulgaria
13:15-13:30	Berthold Heinze	Bulgarian *Populus tremula*: a genetic evaluation based on chloroplast DNA
13:30-13:45	Kiril Vassilev	Subalpine willow shrublands of Vitosha mountain
13:45-14:00	Necmi Aksoy	*Phoenix × golkoyana* comb. et stat. nov., a new combination of natural hybrid palm of *Phoenix dactylifera* and *P. theophrasti* in Southwestern Anatolia of Türkiye
14:00-14:15	Necmi Aksoy	Taxonomic and chorological evidence for the occurrence of ancient date palm (Phoenix dactylifera L.) in the flora of Türkiye

13-14:15	**Agriculture in mountainous and semi-mountainous regions** Session Session Chairs - Rumen Tomov **Hall „Conference 5“**

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13:15-13:30	Milena Yordanova	Evaluation of different substrates for growing microgreens from *Brassicaceae* family
13:30-13:45	Elitsa Blagoeva	Productivity and oil content of *Thyme* sp., cultivated in the Eastern Rhodopes, Bulgaria
13:45-14:00	Iliyan Zhelyazkov	Weed monitoring in three sub-mountainous regions in Southern Bulgaria

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16:15-16:30	Toshko Ljubomirov	Faunistic and ecological studies on ants (*Formicidae*) and other Hymenoptera from forest ecosystems in the Berkovski Balkan region
16:30-16:45	Iva Fikova	Waterholes in Hunting Grounds – Artificial Oases for Amphibian Survival in two Natura 2000 Sites of Ludogorie region in Northeastern Bulgaria.
16:45-17:00	Silvena Boteva	Spatial dynamics of soil bacterial community-level physiological profiles from two spruce forests
17:00-17:15	Dimitar Kasabdanchev	Analysis of the maternity period of the black summer (Burgundy) truffle (*Tuber aestivum*) in the area of Northeastern Bulgaria
17:15-17:30	Teodora Markova	Classification of the forest vegetation of Plana Mt.

16:00-17:30	**Silviculture, forest management and ecosystem services** Session Session Chair - Georgi Kostov and Petia Nikolova **Hall „Conference 5“**

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16:15-16:30	Guenther Bronner	Forest monitoring by the means of aerial and terrestrial laser-scanning
16:30-16:45	Srdjan Keren	The shapes of diameter distributions on small-spatial scales up to one hectare from selected Polish and Bosnian old-growth forests
16:45-17:00	Ibrahim Osewe	Local Community Perceptions on Ecosystem Services Utilisation - Implications for Sustainable Management of Kakamega Tropical Rainforest Forest
17:00-17:15	Konstantin Kolev	Descriptive Analysis of Forestry Competitiveness in Some European Union Member States

17:30-20:00	**Ice Breaker, Moskva Restaurant**

FRIDAY, 09 May 2025

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9:00-9:30	**Invited Speaker Prof. Dzhamal Amishev**	**Developments in Forest Operations on Steep and Challenging Terrain**
9:30-9:45	Momchil Panayotov	Reconstructing avalanche history in the Pirin Mountains, Bulgaria by tree-ring analysis of *Pinus peuce* and *Pinus heldreichii* trees.
9:45-10:00	Kalin Markov	Avalanche hazard mapping using the avalanche terrain exposure scale (ATES) in Pirin Mountain, Bulgaria

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10:45-11:00	Veselina Gospodinova & Denica Gelyazkova	A methodology to estimate forest fire burned area and burn severity degrees using Sentinel - 2 data
11:00-11:15	Nadya Tsvetkova	Study on the spatial relationships between photovoltaic power plants and wildland fires in Bulgaria
11:15-11:30	Ivona Nikolchova	Multicriteria analysis and GIS modelling for effective forest management to minimize risk from forest fires in Stara Zagora
11:30-11:45	Ivona Nikolchova	Natural regeneration of post- fire forest areas in Stara Zagora RDF.
11:45-12:00	Momchil Panayotov	Regeneration after two severe wildfires in subalpine forests in Bulgaria.

10:15	**Wildlife conservation and management** Session Session Chairs - Stoyan Stoyanov and Vukan Lavadinovic **Hall „Conference 5“**

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10:45-11:00	Dejan Beuković	The occurrence of two heavy metals, Cadmium and Lead, in the liver and kidneys of roe deer at several locations in Central Serbia
11:00-11:15	Hristo Lukanov	Colorimetric analysis of eggshell color variations in the common pheasant (*Phasianus colchicus* Linnaeus, 1758)
11:15-11:30	Zoran Popović	Management of Roe Deer (*Capreolus capreolus* L.) Populations in Different Regions of Central Serbia
11:30-11:45	Ovidiu Ionescu	Sustainable management of large carnivores: A case study of Romania
11:45-12:00	Darius Hardalau	Assessing ungulate dynamics in Baltics, Central and Eastern Europe and their impact on key lowland forest ecosystems

12:00-13:00	LUNCH BREAK

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13:30-13:45	Marieta Nesheva	Diversity of wild apple genetic resources in the Central Balkan Mountain region of Bulgaria

13:00-13:30	**Wildlife conservation and management** Session /part 2/ Session Chairs - Stoyan Stoyanov and Vukan Lavadinovic **Hall „Conference 5“**

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13:30 - 15:00	**POSTER SESSION 2 & COFFEE BREAK**

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Distribution and structural diversity of old-growth forests in Bulgaria

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Abstract

Despite being a land of ancient civilizations, Bulgaria still retains valuable old-growth forests. This is largely due to the country's diverse topography, including steep and inaccessible mountainous valleys, as well as variations in climate and soil. Additionally, historical and societal factors have contributed to their preservation. Most old-growth forests are located within national parks and reserves. However, strictly protected areas account for less than 2% of the country's total forested land. As a result, securing the protection of additional forests in or near the old-growth stage has been a key priority for conservation efforts. As a first step, an index for identifying and evaluating old-growth forests was proposed, using the existing stand structure in forest reserves as a reference threshold. Based on our analysis, we determined that the most important characteristics for defining old forests in Bulgaria include: (1) Gradual reduction of the number of trees with the diameter increase, diameter distribution often resembling rotated sigmoid curve or irregular distribution; (2) Presence of at least 25 trees per ha with diameter above 70 cm for *Picea abies* and *Abies alba* forests and at least 15 trees per ha with diameter above 70 cm for *Fagus sylvatica*, *F. orientalis* and *Quercus robur*, 62 cm for Pines, *Q. petrea* and *Q. frainetto* forests, and 50 cm for *Q. pubescens* forests; (3) Presence of standing and fallen dead trees in different wood decomposition classes with accumulation of coarse woody debris (CWD) of at least 80 m^3ha^{-1} for *P. abies* and *A. alba* forests, 60 m^3ha^{-1} for *F. sylvatica, F. orientalis* and *Q. robur* and 40 m^3ha^{-1} for the other oaks and the pines; (4) Heterogeneous spatial structure on predominating part of the forest territory with presence of natural gaps and regeneration in different development phases; (5) Lack of signs or minimal signs of management activities in the past. Applying these criteria, we proposed the protection of approximately 15 kha of state-owned forests. In reality, these were among the last potential candidates for protection outside designated reserves. Currently, around two-thirds of these forests have been placed under strict protection by order of the Minister of Agriculture and Food. Unfortunately, a significant portion of the remaining 5–7 kha is now subject to regeneration fellings. As a result, the country is on the verge of losing nearly half of its remaining old-growth forests – forests that have remained unmanaged for at least 60–70 years.

Key words: Bulgaria, Old-growth forests, Structural diversity

Avalanche Protective Forests: What Do We Know and Where Do We Grow from Here?

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Abstract

Protective forests are forests whose primary function is to protect people and assets from natural hazards such as snow avalanches. In mountain areas, they represent a key Nature-based Solution (NbS) for Ecosystem-based Disaster Risk Reduction (Eco-DRR). However, their full potential remains underutilized within integrated risk management (IRM) strategies (Teich et al., 2022).

This contribution synthesizes current knowledge on protective forests by distinguishing between their protective function (what the forest protects) and their protective effect (how the forest mitigates hazards), focusing on snow avalanches. Recent advancements in avalanche modeling now allow for the identification of forests with protective functions and offer detailed assessments of release areas, runout zones, and impact areas, both with and without forest influence. Simulation tools like the open-source model com4FlowPy (D'Amboise et al., 2022), integrated into the Open Avalanche Framework AvaFrame (www.avaframe.org), provide accessible and flexible platforms for identifying protective forests and estimating their protective effect. However, applying these models in data-sparse regions remains a challenge (Panayotov et al., 2024).

Quantifying the protective effects of forests is more complex. Various approaches, both statistical and process-based, have been developed to assess how factors like crown cover density, gap width, slope angle, and surface roughness influence avalanche release and runout (Teich et al., 2022). Nonetheless, uncertainties persist due to limited observational data and the increasing impacts of natural disturbances and climate change. Events such as windthrow or bark beetle infestations alter forest structure, affecting snowpack conditions and avalanche formation (Teich et al., 2019).

Going forward, integrating empirical data, advanced modeling, and decision-support tools is key to enhancing the role of protective forests in IRM. Interactive maps and digital platforms can guide forest management priorities and silvicultural interventions (Bebi et al., 2021; Perzl and Starsich, 2024). However, cross-border and interdisciplinary collaboration is essential for adapting forest management strategies to changing hazard regimes and ecological conditions, ensuring the long-term sustainability of protective functions and effects. With proper management, protective forests offer a resilient, cost-effective NbS for mitigating snow

Key words: protective forest, protective effect, snow avalanche modeling, nature-based solution, integrated risk management

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Developments in Forest Operations on Steep and Challenging Terrain

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Abstract

Steep and difficult terrain presents persistent operational, safety, and environmental challenges for forest harvesting. This presentation outlines recent innovations in forest operations that aim to improve efficiency, safety, and sustainability under such conditions. Historically reliant on manual labor and conventional ground-based equipment, steep slope forestry is undergoing rapid transformation driven by technological advancement and international best practices. Key developments include the emergence and adoption of winch-assist systems – mechanized equipment supported by tensioned cables that improve traction and stability on inclines. First adopted in Europe and New Zealand, these systems are now increasingly used in North America. Their benefits include expanded use of mechanized felling and extraction on slopes previously limited to manual operations, reduced soil disturbance, and enhanced operator safety. Cable yarding systems remain vital, especially in coastal and mountainous regions. Ongoing improvements in grapple yarders and integration with winch-assist systems support more flexible and efficient operations. Future opportunities lie in automation, in-forest connectivity, and autonomous machinery, which offer the potential to revolutionize forest logistics and wildfire mitigation. This presentation also discusses the broader system-level considerations such as road infrastructure, equipment compatibility, workforce training, and regulatory factors. Insights are drawn from applied research and industry experience across North America and international contexts. Through these innovations, the forest sector is better positioned to operate on steep terrain while minimizing environmental impact and improving safety and productivity across the value chain.

Key words: Steep slope harvesting; Winch-assist technology; Logging safety; Sustainable forest operations; Autonomous mechanization

Adapting to warmer conditions: thermophilic forests as references for future temperate forests of Europe

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Abstract

Ongoing climate change is altering European forest communities directly and indirectly via shifts in disturbance regimes. Rising frequency and severity of heatwaves and droughts (and associated biotic outbreaks) have caused widespread tree growth declines and mortality over recent decades. Under current climate projections, these patterns serve as early warnings of potential future trends. To mitigate the impacts of climate change on forest functioning and support climate adaptation, forest management approaches must be updated. According to vegetation models, mesophilic communities with *Fagus sylvatica* and *Picea abies* are expected to shift northward and upward as climate becomes warmer and drier, whereas less productive yet generally biodiverse thermophilic-type vegetation dominated by *Quercus spp.*, *Pinus spp.*, and other minor species are expected to expand in the temperate zones of Europe. Despite these predictions and trends, thermophilic forests have received relatively little attention in published literature, likely due to historical exploitation, land use change, and/or misconception of their transient successional nature. As a result, only scarce remnants of preserved thermophilic temperate forests are left in Europe, with limited to no information regarding their demographic and structural traits. To learn more about the structure and dynamics of these thermophilic refugia developing at the warm and dry edge of temperate landscapes, we established a network of permanent sampling plots across several unmanaged stands in Central and Southeastern Europe. Besides traditional structural and compositional data surveys, we collected a large number of tree cores (over 2000) of dominant tree species (mainly *Ostrya carpinifolia*, *Fraxinus ornus*, *Quercus cerris*, *Quercus petraea*, *Sorbus aria*, *Carpinus betulus*, *Acer campestre*, *Acer obtusatum*) for subsequent dendrochronological analyses, whereas most of the good-quality cores of the dominant species have been successfully cross-dated. Preliminary results on the structure, age, and tree growth in the analyzed communities shall be presented. Our results may encourage discussions on the potential opportunities for advancing dendroecological and related research of European thermophilic temperate forests.

Key words: Drought, tree growth, tree rings, forest structure

Oak species resilience to drought in South-Eastern Romania

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Abstract

Increasing warming-related drought frequency and severity impact treegrowth in lowland forest ecosystems. Oak species are the key speciesin forests in steppe and forest-steppe regions, ensuring high biodiversity levels and ecosystem functionality under limited climatic conditions. In this study, we evaluate the effect of climatic factors on the basalarea increment and drought resilience of five native oak species (*Quercus robur*, *Quercus pedunculiflora*, *Quercus frainetto*, *Quercus pubescens*, *Quercus cerris*) and one exotic oak species (*Quercus rubra*) in the forest-steppe zone of southeastern Romania. To assess the climate-growth relationships we used boot strap Pearson correlation between BAI and aggregated daily climatic factors (i.e., temperature, precipitation, Standard Evapotranspiration-Precipitation Index). Thetemporal shift of climate sensitivity was evaluated through the difference in climate response between two periods (i.e., 1961–1990 and 1991–2020). For resilience to extreme drought (SPEI <-1.5), we used classical Loret resilience indices. All oak species exhibit a significant response to previous autumn, spring, and summer drought, with an increasing correlation intensity in recent decades. A negative correlation with summer temperature is observed only after 1990, for all native oak species. *Q. rubra* has nosignificant correlation with temperature. Growth synchrony between trees is higher and stable over time for *Q. cerris* and *Q. rubra*. Incontrast, *Q. robur* and *Q. pedunculiflora* show a decline ininter-series correlation after 1990. *Q. frainetto* shows the highest resistance to extreme drought, while *Q. rubra* has the lowest. The recovery rate after water deficit periods is high for *Q. robur* and *Q.pubescens*. Overall, *Q. frainetto* fully recovers after extreme drought (mean resilience index >1), where as the lowest resilience is observedin *Q. cerris* and *Q. rubra*. Our results indicated similar resilience and adaptability to extremedrought conditions for *Q. robur*, *Q. pedunculiflora*, *Q. frainetto*, and *Q. pubescens*, while *Q. cerris* and *Q. rubra* are the most vulnerableones in the forest-steppe zone of South-Eastern Romania.

Key words: forest-steppe, resilience, climate-growth

The concept of "analogue climate" – geographical transfer to adapt to temporal changes of climatic conditions

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Abstract

During the last two decades, the forests of Central Europe suffered significant damage due to extreme heat, drought and windstorm events. Scientists are evaluating which tree species and proveniences are best suited to future forest site conditions to ensure the long-term provision of forest ecosystem services and the safeguarding of biodiversity. Transferring species and practices from regions with an analogue climate has been identified as a useful tool for adapting central European forest management to climate change. We report insights of a group of Bavarian scientists from a study tour in May 2024 to Bulgarian forest sites which today have a climate comparable to that predicted by models to occur in Bavaria before the end of the century. The tour led us from Sofia to the central range of the Balkan Mountains and further to the very dry region in the northeast, where the annual amount of rainfall is hardly enough to allow tree growth. Finally, we visited the Strandzha Nature Park with its rich biodiversity. The park serves as a refugium for vegetation that survived the Ice Ages. Many of these Tertiary relict plant species, which were once widespread across Europe during warmer periods of the Tertiary era, are now found mostly in this region. Especially the trial plots with various *Quercus species* (*Q. frainetto*, *Q. cerris*, *Q. pubescens*) across the country were impressive and informative for the ongoing transformation of forest types dominated by conifers to mixed forests composed of at least five different tree species in Bavaria. Examples of the analogue-climate-concept will be presented as well as a ranking of the different tree species according to their drought stress tolerance. This highlights the growing importance of assisted migration - a strategy of artificially expanding tree species' ranges and that of their provenances from, e.g. Bulgaria, affording close cooperation between the respective countries.

Key words: Climate Change, Forest Damage, Extreme Weather Events, Tree Species, Analogue Climate Regions, Assisted Migration, Drought Stress Tolerance

Acclimation changes in photosynthesis of *Fagus sylvatica*, *Populus tremula* and *Acer platanoides* after natural disturbance

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Abstract

Large-scale natural disturbances in forests drastically alter the light regime for the remaining saplings in the affected area, putting their survival at risk. Light acclimation of photosynthesis is a key factor in maintaining a positive carbon balance, which enables saplings to sustain a defence system suited to the challenges of the changed environment. This study examines changes in the light dependence of photosynthesis in saplings of three forest species – *Fagus sylvatica*, *Populus tremula*, and *Acer platanoides* – following large-scale natural disturbances. The results indicate a very rapid acclimation of photosynthesis in *P. tremula*. Although *F. sylvatica* and *A. platanoides* respond more conservatively to the altered conditions, the observed changes still demonstrate significant potential for maintaining a positive carbon balance and ensuring its continued presence in the disturbed area. The obtained data contribute to a deeper understanding of species-specific acclimation mechanisms, which could be essential for predicting forest regeneration dynamics in the context of more intensified disturbance regimes due to climate change.

Key words: carbon balance, light-response curve, photosynthetic plasticity

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The Trend of Altitude Ascension of the Timberline in the Bucegi Mountains, Romanian Carpathians: Preliminary Data

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Abstract

In the context of recent climate change, the timberline, defined as the maximum altitude at which the forest remains dense, has undergone shifts in elevation. However, trees are not expected to migrate uniformly with rising temperatures, as latitude, altitude, topography, climate, and human influence can all impose certain differences. In this preliminary study, we aimed to assess the current elevation of the upper forest limit in the Bucegi Mountains, Romanian Carpathians. To achieve this, we used the dendrogeomorphologic approach to determine the age of trees, sampling 25 *Larix decidua*, either growing individually or in tree islands. Additionally, to quantify the temperature-growth relationship during the vegetation season, when trees form wood cells, we calculated mean ring-width series for each analyzed tree. The resulting reference chronology was then correlated with climate data. This relationship between climate data and tree-ring growth series was evaluated using two indices: the dynamic coefficient and the static coefficient. For this analysis, we used the R Studio statistical software along with the dpR package. Our results indicated that the studied trees are located at altitudes between 1850 and 1950 m a.s.l., approximately 150–200 meters higher than the upper forest limit recorded on the 1: 25,000 topographic map edition of 1961. Considering that anthropogenic impact is minimal in the studied area and that the terrain does not impose restrictive conditions, we can deduce that the current tree altitude is primarily determined by climatic factors.

Key words: timberline, dendrogeomorphologic approach, dynamic coefficient, static coefficient, Bucegi Mountains, Romanian Carpathians

Potential global sequestration of atmospheric carbon dioxide by drylands forestation

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Abstract

Drylands forestation offers the potential for long-term sequestration of atmospheric CO_2. Israel's Yatir Forest is a 28 km^2 planted Aleppo pine forest growing at the semi-arid timberline, having 280 mm average annual precipitation (with no irrigation or fertilization). The organic and inorganic carbon sequestration rates (assumed representative of global drylands) were measured at Yatir to be ~550 g CO_2 $m^{-2}.yr^{-1}$ (150 g C) organic carbon in the tree's biomass, and ~132 g CO_2 $m^{-2}.yr^{-1}$ as calcite ($CaCO_3$) precipitates (primarily from root exhaled CO_2 to ~6 meter depth). Drylands trees have deeper roots compared to temperate regions, therefore providing greater active volume for inorganic sequestration. In addition, microbial processes in soil organic materials also precipitate calcite. The root exhaled CO_2 combines with soil H_2O to form bicarbonate (HCO_3^-), which combines with soil Ca^{2+} to form calcite. Low rainfall precludes dissolving the precipitated calcite. The potential maximal efficacy of global forestation for reducing global warming and ocean acidification depends on the maximal area available for sustainable forestation. The dominant limitation, particularly in the vast drylands regions, is the apparent lack of water. This would reduce the potential area for sustainable forestation to a published estimate of roughly 4.5 million km^2, ~10% of global hot drylands. However, in many drylands areas, plentiful water is available from immediately underlying local paleowater (fossil) aquifers. Using such water, until now not previously taken into consideration, would yield a functional dryland forestation area of ~9.0 million km^2. This would yield a potential total annual sequestration rate of at least ~7.0 Gt CO_2 yr^{-1}, divided between 5.0 Gt CO_2 yr^{-1} (organic) and 2.0 Gt CO_2 yr^{-1} (inorganic); a respectable ~35% of the annual rate of atmospheric CO_2 increase. Significantly, this quantity removed from the atmosphere would also reduce ocean acidification. Note however that the transformation of bright high albedo deserts to darker forests could reduce the positive projected climate cooling effects attained by as much as ~25%. For a 7.0 Gt yr^{-1} total rate, based on published estimates, the total CO_2 "equivalent" atmospheric cooling sequestration rate would be reduced to 5.0 Gt yr^{-1}. The effective reduction may be less, considering that increased forestation evapotranspiration would decrease surface temperature; and increase albedo via increased cloud cover. Our sequestration estimate demonstrates the global potential, the need for further measurements, and the need to begin implementing a global land management policy of widespread tree planting in drylands regions.

Key words: Global Forestation, Drylands, Organic and Inorganic Carbon Sequestration, Fossil Aquifers

Carbon stock changes along age gradients in temperate mixed beech-dominated forest ecosystems

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Abstract

Old-growth forests are irreplaceable environments that promote biodiversity and offer significant carbon stock potential. Although it is established that forests make a meaningful contribution to climate change mitigation, the extent to which this ability is influenced by tree age appears to be inconsistent across various studies. To clarify this relationship, we examined old-growth forests from five southern European countries, encompassing about 40% of all old-growth forests in Europe. By employing a dendrochronological approach and considering key environmental factors such as altitude, slope, temperature, and presence of trees exceeding 60 cm in diameter, we analysed the complex relations between tree age and carbon stock in selected pools (aboveground, standing and downed deadwood). The average plot age was 220 years and the plot stores about 230 t C ha^{-1} of carbon in biomass and necromass. We found a positive correlation between age and carbon stock at both the individual tree and plot levels. Notably, mature trees remained the strongest indicators of ecosystem carbon stock, while younger *Fagus sylvatica* trees (at 100 years old) accumulated only a limited amount of their total carbon storage potential at a reference age of 350 years. We found no evidence of a carbon stock decline in carbon-age dependency across study sites. However, while old-growth forests continue accumulating carbon at advanced ages, rising temperatures were found to have a significant negative impact on the aboveground carbon enrichment, suggesting potential future shifts in carbon stock. Despite the ecological importance of old-growth forests, many of them remain unprotected and are disappearing across Europe. Our findings highlight the importance of preserving old-growth forests to maximise their role as long-term ecosystem carbon reservoirs.

Key words: Old-growth forests, carbon stock, physiographic features, tree ring increment, climate change mitigation

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Blue intensity in *Pinus peuce* and *Pinus heldreichii*: a pilot study for developing climate proxies from tree rings

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Abstract

Climate change, with its regional patterns, and the need for accurate predictions, stands as one of the scientific challenges of our time. Among the diverse tools employed to reconstruct past climate variations, tree-rings have emerged as invaluable archives. However, the reliability of tree-ring width (TRW) as a climate proxy is often compromised by its limited sensitivity to climate factors in certain tree species and geographic regions, hindering the extraction of robust climate signals. In addition, the effect of various disturbances such as avalanches, windthrows or damages from heavy snow can also have strong reflection in TRW. This further necessitates good distinction between climate-forced and disturbance-induces signals in tree rings.

To address these limitations, researchers have explored alternative tree-ring parameters, such as maximum latewood density (MXD), which exhibits a stronger correlation with summer temperatures, particularly in conifer species. Nevertheless, the high costs associated with MXD measurements present a significant barrier to its widespread application. Consequently, the exploration of cost-effective surrogates has gained momentum. One such promising alternative is blue intensity (BI), a technique based on the analysis of high-resolution images of wood samples. This method has demonstrated its efficacy in various tree species, offering a potentially more accessible avenue for climate reconstruction. However, its application to *Pinus heldreichii* Christ (PIHE) and *Pinus peuce* Griseb. (PIPE), two species with restricted distribution on the Balkan Peninsula, remained unexplored. These species are characterized by their remarkable longevity, frequently exceeding 500 years and potentially reaching over 1000 years.

Correlation analyses between the BI chronologies and climate parameters revealed compelling results. Notably, PIHE BI series, specifically delta BI (ΔBI) and latewood BI (LwBI), exhibited strong and statistically significant positive correlations with summer temperatures. The highest correlation coefficient, 0.74 ($p < 0.05$), was observed between ΔBI and July-August average temperatures for the period 1933–1983. Remarkably, ΔBI maintained correlation values above 0.6 throughout the entire period (1933–2014) and sub-periods, encompassing both average monthly and average maximum temperatures. LwBI values of the PIHE chronology also demonstrated robust correlations, exceeding 0.52 (reaching 0.64) with August and August-July temperatures.

While PIPE BI chronologies also displayed positive correlations with summer temperatures, their values were generally lower and exhibited less temporal stability compared to PIHE. The most consistent correlations were observed between LwBI and average August temperatures, consistently surpassing 0.52. Delta BI series in PIPE showed high correlations during the 1933–1983 period, but experienced a subsequent decline, resulting in lower overall correlations with August temperatures.

Our findings strongly suggest that both PIHE and PIPE possess significant potential for the development of long BI chronologies and the reconstruction of past climate variations. In addition, the construction of BI chronologies helped us in distinguishing climate-induced production of narrow tree rings from such caused by avalanche disturbances in Pirin Mountains, which assisted in tree-ring reconstruction of avalanche history.

Key words: temperature reconstruction, dendroclimatology, dendrochronology, BI-related parameters, South-Eastern Europe

Acknowledgement

This work was supported by projects “Composing and comparison of summer temperature reconstruction based on Blue Intensity data of conifer trees species from the Caucasus and Pirin Mountains” funded by the National Science Fund of Bulgaria, “Modelling of avalanches in forested and alpine terrain in Bulgaria and Austria - similarities and differences” (bilateral cooperation Bulgaria-Austria 2022), and project “Reconstruction of summer temperatures in Southwest Bulgaria: a new approach through blue light analysis in coniferous tree species” funded by the Scientific Research Sector (NIS) at University of Forestry.

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Pioneering dendrochronological studies of *Quercus protoroburoides*

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Abstract

The Rila oak (*Quercus protoroburoides* Donchev and Bouzov ex Tashev and Tsavkov) is a rare and geographically restricted species, endemic to the slopes above Rila Monastery in Bulgaria's Rila Mountains. Occurring at elevations between 1500 and 1750 meters above sea level, it forms small, scattered populations primarily on ridges, slightly above the local *Quercus petraea* (Matt.) Liebl. populations and mixed fir-beech forests. Discovered in 1968 by Boris Buzov and formally validated in 2017 by Tashev and Tsavkov, *Q. protoroburoides* has remained dendrochronologically unexplored, lacking data on its climate-growth relationships.

This study aimed to address this knowledge gap by conducting the first dendrochronological analysis of *Q. protoroburoides*. We analyzed 42 tree-ring series from 22 individuals at two locations (Drushlyavitsa and Brichebor), comparing them with *Q. petraea* samples from the same region. *Q. protoroburoides* individuals ranged in age from 30 to 170 years, with a significant proportion around 50 years old. The resulting *Q. protoroburoides* chronology spanned 1856 to 2019, with robust representation after 1870. *Q. petraea* trees were generally older, yielding a chronology from 1743 with reliable data after 1786.

Climate-growth analysis, using local and gridded climate data, showed positive growth correlations with previous August and current April-June precipitation, as well as previous May-June temperatures. Conversely, growth was negatively correlated with August temperatures. Pointer years of reduced growth were associated with extreme climatic events, including summer droughts, unusually cold summers, and delayed vegetation onset due to late frosts in late May or early June. Our findings demonstrate that both *Q. protoroburoides* and *Q. petraea* at these unusually high elevations for oak species in Bulgaria are sensitive to climatic conditions, including summer drought stress.

Key words: Rila oak, dendroecology, tree-ring analysis, Mountain forests, South-Eastern Europe

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The Urdoviza Shipwreck, Kiten, Bulgaria: Timber identification and dendrochronology of the hull of a 19th Century ottoman wooden sailing ship

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Abstract

The current poster presents the interim results of dendro-anatomical and chronological analyses of timber samples from the hull of the Urdoviza shipwreck, Kiten, Bulgaria.

The Urdoviza Shipwreck is an international research project between the Bulgarian Centre for Underwater Archaeology (CUA, Ministry of Culture of Bulgaria) and the US Institute of Nautical Archaeology (INA). It is one of the most significant underwater archaeological sites in the Black Sea and beyond.

The Urdoviza shipwreck lies in 8.5 m of water in the South Bay of Kiten. The ship is lying on a close to even keel, the hull is oriented NE-SW, bow pointing NE. The preserved length of the ship is 23.75 m at a breadth of 7.3 m, the depth of hold exceeds 4 m. Over 90% of the wooden hull structure is preserved in the archaeological record, buried in anoxic sediments down to a depth of 4.5 m beneath the seabed.

Since the project's beginning in 2022 numerous timber samples have been collected to identify the species of timber used to build Urdoviza and build a dendro-chronological sequence to provide an absolute terminus post quem for the construction of this significant underwater archaeological site.

The anatomical analysis show that the main construction material was from oaks (Roburoides). To this moment we have been able to measure tree-ring sequences from 12 wooden samples from various parts of the ship. Initial tree-ring dating against living trees from Strandzha mountain and a long chronology from Suceava region of Romania (Roibu et al., 2021) shows good match of samples dating from the early 1700s to 1829. This indicates the construction of the ship as to the late third or early fourth decade of the 19th century.

Key words: Black Sea, underwater archaeology, tree ring analysis, dendroarchaeology

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The authors would like to thank Dr Nayden Prahov, Director of the Centre for Underwater Archaeology, Sozopol, and Mr John de Lapa, Chairman of the Board of Directors of the Institute of Nautical Archaeology. This research would not have been possible without the tireless work of all participants in the Urdoviza shipwreck excavation project.

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Current Status and Future Prospects of Coniferous Seed Orchards in Bulgaria

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Abstract

Seed orchards are important source of high-quality seeds for afforestation practices. The high genetic diversity in the seed orchards' crop is a prerequisite for adaptability of the future plantations to the changing environmental conditions.

This paper summarizes research conducted on seed orchards in Bulgaria over the past two decades and describes their current status. More detailed information is provided for orchards of four coniferous species: *Pinus sylvestris*, *P. nigra*, *P. peuce*, and *Abies alba*. The information presented focuses on the key traits and parameters characterizing both clonal and seed-origin orchards. The survival rate of clones and individuals is relatively high but varies depending on the site conditions and the species. Due to the decline in afforestation activities in Bulgaria – and consequently, the decreased demand of seeds – many seed orchards have not been managed for extended periods, resulting in the deterioration of their condition. They seed orchards urgently require improvement measures. Phenological observations revealed good flowering synchrony among the clones. Seed orchard crops exhibited high genetic diversity and outcrossing rates. Repeatability (broad-sense heritability) of cone size was high (0.4–06) indicating potential for future selection of superior clones. Seed orchard development is most advanced in the case of *Abies alba*, which is the only species in Bulgaria with a second-generation seed orchard.

The results are discussed in the context of meeting the demands for high-quality seeds for the afforestation efforts in Bulgaria, as well as in a broader European context of assisted migration of species and provenances.

Key words: seed production, seed orchards, genetic diversity, afforestation, assisted migration

Bulgarian *Populus tremula*: a genetic evaluation based on chloroplast DNA

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Abstract

The description of the genetic composition of less valuable forest tree species has received relatively little attention. However, in the course of climate change, substantial changes may occur to species distribution, meaning that they may disappear from regions or altitudinal zones where they are present today. *Populus tremula* is a species of upland to montaneous areas, possibly under significant pressure in more southern regions of Europe, where it reaches its distribution limits. An attempt is therefore made at assessing patterns of genetic diversity of this species in Bulgaria. Leaf samples were collected from across the country, and chloroplast DNA marker data were obtained. First results indicate that the species is quite polymorphic, also within stands (not fully clonal). A haplotype that is rare in more distant regions of Europe predominates, and there are others that may be rare and local only. At the same time, haplotypes shared with other regions in Europe demonstrate the genetic connectivity of the species. Taken together, *Populus tremula* in Bulgaria seems to present a rich source of genetic variation that deserves attention and conservation efforts.

Key words: trembling aspen, population genetics, DNA sequence variation, haplotypes

Spatial dynamics of soil bacterial community-level physiological profiles from two spruce forests

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Abstract

Forests are highly productive ecosystems that act as carbon sinks, where soil organic matter is formed from the residues after biomass decomposition and as well as from carbon deposited by the rhizosphere. Soil microorganisms play a crucial role in these processes by decomposing plant litter, thereby causing changes in the physical and chemical properties of the soil.

In this study, Biolog Ecoplate assay was used for analyzing community-level physiological profiles (CLPPs) from spruce forest soils. Samples were taken from two plots in coniferous forests with soils classified as Dystric Cambisols (Sampling plot 1, SP 1) and Eutric Cambisols (Sampling plot 2, SP 2) in three depths (0–10, 10–20 and 20–30 cm). Soils were with sandy clay loam and clay loam texture, respectively. Average microbial activity (represented as area under curve, AUC) was nearly two times higher in SP 2 than in SP 1. In SP 1 highest activity was measured at the 10–20 cm depth, while in SP2 it was measured at 20–30 cm. CLPP showed higher bacterial affinity for polymers and lower for carbohydrates.

There was a significant difference in the metabolic activity among carbon guilds utilization ($p<0.05$) but not among different depths ($p>0.1$). Common for both sampling plots was the higher rate of Tween 80 and D-Mannitol utilization and the lower rate of 2-Hydroxy benzoic acid utilization. The strong linear correlation between Shannon and Evenness indices showed that depth influenced the rate but not the number of utilized carbon sources. Results from the conducted analyses proved that microbial activity can be used as a reliable indicator for the functioning of the forest ecosystem and soil health.

Key words: bacterial functional profiles, bacterial metabolic activity, Biolog Ecoplate, spruce forests

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Subalpine willow shrublands of Vitosha mountain

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Abstract

Subalpine shrublands are locally distributed in the subalpine zone of Vitosha Mt. and are dominated by low-growing willows (*Salix lapponum*, *Salix waldsteiniana*) above 1800 m s.l. During the 2021–2022 field seasons, 21 relevés were collected following the Braun-Blanquet approach. The sample plot size was in the range of 64–78 m^2. Complete information on the species composition and abiotic characteristics of the environment (elevation, exposure, slope, soil depth, base rock type) in all sample plots was collected.

All relevés were contributed to the Balkan Vegetation Database (EU-00-013). The nomenclature of the species was standardized according to the Euro+Med PlantBase. PC-ORD hierarchical clustering was used for classification from class to association and community levels. Diagnostic, constant and dominant species were determined for all syntaxa established.

For the first time, the distribution of 2 associations representing subalpine willow shrublands has been established for the vegetation of the country – *Salicetum lapponum* Zlatník 1928 and *Salicetum waldsteinianae* Beger ex Oberdorfer 1978. Association *Salicetum lapponum* is dominated by the downy willow *Salix lapponum*. It reaches a height of 1–1.5 m and covers 85–100%. Association *Salicetum waldsteinianae* is dominated by *Salix waldsteiniana* which makes cover 95–100%. In both associations 2 layers are formed – shrub and grass.

In species composition of the shrub layer *Salix caprea*, *Rubus caesius*, *Juniperus sibirica*, *Vaccinium myrtillus* are to be found also. The grass layer is consisted mainly of *Agrostis capillaris*, *Aegopodium podagraria*, *Carex nigra*, *Senecio nemorensis*, *Calamagrostis arundinacea*, *Geum coccineum*. These species are widespread in adjacent grasslands (classes *Scheuchzerio palustris-Caricetea fuscae*, *Juncetea trifidi*) and shrublands (class *Loiseleurio procumbentis-Vaccinietea*).

This vegetation is protected by Directive 92/43/EEC as habitat type 4080 Sub-arctic *Salix spp.* scrub, Red Data Book of the Republic of Bulgaria (14F2 Sub-alpine willow (*Salix spp.*) communities) and Biological Diversity Act. A significant part of the habitat localities also fall within the Torfeno Branishte and Bistrishko Branishte reserves. The small areas that these phytocoenoses occupy create difficulties for their mapping within SCI BG0000113. The main threats are related to drought processes, reduced water flow and prolonged drying of streams, especially during the summer period. Proposing adequate conservation measures is difficult.

Key words: habitats, Natura 2000, shrub communities, syntaxonomy

High rank syntaxa of riparian shrubland and forest vegetation in Bulgaria

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Abstract

Riparian shrub and forest vegetation is widely distributed on the territory of Bulgaria but still treir syntaxonomical diversity has not been completely studied. All available relevés published were gathered, as well as new data were sampled from different parts of the country.

In total 892 reléves were collected predominantly following the Braun-Blanquet approach. All relevés were contributed to the Balkan Vegetation Database (EU-00-013). The nomenclature of the species was standardized according to the Euro+Med PlantBase. PC-ORD hierarchical clustering was used for classification from class to association and community levels. Diagnostic, constant and dominant species were determined for all syntaxa established.

Riparian vegetation were classified to 2 classes (*Salicetea purpurea*, *Alno glutinosae-Populetea albae*), 4 orders (*Populetalia albae*, *Alno-Fraxinetalia excelsioris*, *Salicetalia purpureae* and *Tamaricetalia ramosissimae*) and 5 alliances (*Alnion incanae*, *Platanion orientalis*, *Alno-Quercion roboris*, *Salicion albae*, *Salicion triandrae* and *Tamaricion parviflorae*).

The Mediterranean influence in the country is presented by forests of *Alno-Quercion roboris* and *Platanion orientalis*, which were found in the southern part of Bulgaria and dominated by *Fraxinus angustifolia* and *Quercus robur* or *Platanus orientalis*, respectively. Alliance *Alnion incanae* presents phytocoenoces dominated by *Alnus glutinosa* and *Alnus incana* and occur in the semi-mountainous and mountainous regions of the country. Phytocenoses of *Salicion albae* alliance were widespread in the plains along rivers and water bodies. This vegetation was dominated by different willow species – *Salix purpurea*, *S. alba*, *S. fragilis*. Alliance *Salicion triandrae* included shrub communities dominated by *Amorpha fruticosa* and *Salix triandra*. Alliance *Tamaricion parviflorae* was restricted to the rivers in the southern part of the country. Its phytocoenoses were dominated by *Tamarix tetranda* (incl. *T. parviflora*) and *T. smyrnensis*.

Key words: Braun-Blanquet approach, classification, wetlands

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Waterholes in Hunting Grounds – Artificial Oases for Amphibian Survival in two Natura 2000 Sites of Ludogorie region in Northeastern Bulgaria

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Abstract

The study was conducted between June 2022 and June 2023 to confirm the presence of the unidentified amphibiotic species Ivan Buresch's Crested Newt (*Triturus ivanbureschi*), Fire-bellied Toad (*Bombina bombina*), and European Pond Turtle (*Emys orbicularis*) in the Natura

2000 protected sites: BG0000168 Ludogorie and BG0000171 Ludogorie-Boblata. A total of 81 reservoirs, waterholes, and mudflats were surveyed, and in 30, one or more target species were recorded. This supports their continued inclusion on the target list for both protected areas.

The study established that the priority habitats for these species are mudflats and waterholes, located in three hunting areas: "Voden – Iri Hisar," „Karakuz," and „Seslav". These areas contain 28 (93%) of the water bodies where the three target species were found, emphasizing their importance. Providing water for game species through artificial and semi-natural water bodies remains the only means of ensuring the survival of these rare species, especially amid global warming and drying trends. Additionally, 13 other species, all dependent on these water bodies, were documented.

Another contribution of the study is the first population data for Buresch's Crested Newt in the region. For the first time in Bulgaria, 419 mature newts were captured, measured, and analyzed for sex, size, age, and somatometric data within a single area. For each of 16 water bodies with newts, dynamic density was calculated using trap-based methods. In "Baldede," absolute abundance of Buresch's Crested Newt was estimated via mark-and-recapture, along with entry, exit, and metamorphosis timing.

The Ludogorie region is crucial for this species' conservation. Efforts should prioritize preserving permanent aquatic habitats in old mesophilic forests, especially drying mudflats and waterholes. The discovery of the Fire-bellied Toad in "Voden – Iri Hisar" is significant, as no prior data confirmed its presence. Successful reproduction was also documented. Additionally, in the Chetirite Gyola waterbody, new breeding sites for the Common Spadefoot (*Pelobates fuscus*) and European Pond Turtle were found, highlighting the ecological value of these artificial wetlands. The survival of the three target species in Natura 2000 sites (Ludogorie and Ludogorie-Boblata) depends entirely on mudflats and waterholes in these three hunting areas.

This underscores the urgent need to secure water supply for sustainable game management and the long-term survival of water-dependent species.

For the first time in Bulgaria, such measures and mechanisms have been proposed, with potential funding through EU ecological programs. These initiatives benefit both wildlife management and the conservation of rare species in Natura 2000 protected areas.

Key words: Natura 2000, *Triturus ivanbureschi*, *Bombina bombina*, *Emys orbicularis*, artificial wetlands

Phoenix × golkoyana comb. et stat. nov., a new combination of natural hybrid palm of *Phoenix dactylifera* and *P. theophrasti* in Southwestern Anatolia of Türkiye

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Abstract

Phoenix dactylifera L., known as the date palm, is one of the world's oldest, ancient tree fruit species and is the major cultivated fruit crop of the arid regions of the Middle East and North Africa. It has been planted and cultivated for its fruits in Anatolia since ancient times. Today it is widely used as an ornamental palm in the landscaping of parks, hotels, streets and gardens. *P. theophrasti* Grueter is an endemic date palm native to the Eastern Mediterranean region. The natural range of this species extends from the Eastern Aegean Islands, Crete to South Western Türkiye. It currently has a fragmented and localized distribution in southwestern Türkiye. Its populations overlap with other old culture individuals in moist stream and lake ecosystems near the coast in the Gölköy region of Muğla. In several publications on these species, natural hybrids with morphological variations in subspecific taxonomic categories have been reported in the Eastern Mediterranean region and the Eastern Aegean Islands, and many new taxa have been described at the subspecific level.

In this study, a new combination of hybrid is formally identified and described; *Phoenix* × *golkoyana* (Boydak) N. Aksoy, *comb. et stat. nov.* [*Phoenix dactylifera* L. × *Phoenix theophrasti* Greuter]. Taxonomically and systematically, the status, description and morphological differences of this taxon are presented. The IUCN conservation status of the new endemic hybrid taxon originating from the South West Anatolia region of Türkiye is determined by indicating its natural habitat and taxa of distribution.

Key words: Arecaceae, *Phoenix* × *golkoyana*, hybrid, new species, Türkiye

Taxonomic and chorological evidence for the occurrence of ancient date palm (*Phoenix dactylifera* L.) in the flora of Türkiye

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Abstract

The date palm (*Phoenix dactylifera* L.) is one of the oldest, ancient tree fruit species in the world. Historically, it is the main cultivated plant grown for its fruit in the arid regions of the Middle East and North Africa. It has been cultivated, grown and traded for its fruits in Anatolia since ancient times. Herbarium specimens were taken from a large number of date palm individuals clustered along the ancient waterway in the ancient city of Patara in southwestern Turkey. Taxonomic studies on these specimens in the Herbarium of Düzce University Faculty of Forestry (DUOF) revealed that, contrary to many studies, these specimens belong to *Phoenix dactylifera*. The fact that it was found as a relic in an isolated area close to the ancient water channel in the ancient city of Patara and that its clustered individuals have an underground root system indicates that it has survived from the ancient period to the present day.

In this study, the botanical description of the taxon, its differences from the main species, distribution maps and photographs are given. With this new record, the number of natural palm taxa in the flora of Turkey has increased to three.

Key words: *Phoenix dactylfrea*, date palm, new record, ancient tree, Türkiye

Classification of the forest vegetation of Plana Mt.

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Abstract

Insufficient research is carried out through the means of the Braun-Blanquet approach concerning the forest vegetation of Plana Mt. (Southwest Bulgaria). Therefore, the main objective of our study was to conduct a syntaxonomic analysis and create a classification.

A total of 178 relevés were made in the period 2022–2024, resulting in 17 syntaxa. Some of them are already known in Bulgaria: beech forests (ass. *Festuco drymejae-Fagetum sylvaticae,* ass. *Aremonio agrimonoidis-Fagetum sylvaticae,* ass. *Galio psudaristati-Fagetum sylvaticae*) and oak forests (ass. *Genisto carinalis-Quercetum petraeae*, ass. *Quercetum frainetto-cerridis*). Some pine, riparian, ravine, birch and hazel phytocoenoses are grouped in the rank of ''community'' and are mentioned for the first time. The syntaxa belong to the following alliances *Dicrano-Pinion sylvestris, Fagion sylvaticae, Quercion petraeo-cerridis, Fraxino excelsioris-Acerion pseudoplatani, Quercion confertae, Astrantio-Corylion avellanae, Alnion incanae* and *Fragario vescae-Populion tremulae*. Brief information about the identified syntaxa is presented.

Plana's forests are included in the Natura 2000 network in the protected area BG0001307 Plana. Following the research's classification, several habitats were recognized: 9130 *Asperulo-Fagetum* beech forests, 91W0 Moesian beech forests, 9180 *Tilio-Acerion* forests of slopes, screes and ravines, 91M0 Pannonic-Balkan Turkish oak-Sessile oak forests, 91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) and 91CA Rhodopide and Balkan Range Scots pine forests.

Key words: Braun-Blanquet approach, syntaxa, habitats, Natura 2000

Acknowledgements

The current research is financially supported by the Scientific research sector of University of Forestry, Sofia. Taking part in the project "Classification of the forest vegetation of Plana mountain", SRS-B-1296.

Analysis of the maternity period of the black summer (Burgundy) truffle (*Tuber Aestivum*) in the area of Northeastern Bulgaria

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Abstract

Fungi along with bacteria are of great importance for the biosphere. They degrade the organic compounds by rotting and mineralization, and bring them to simple inorganic substances. In this way, the food chain is closed and inorganic substances could be used by green plants to build organic compounds again. It is particularly important to note that fungi, and in particular underground one, help to increase soil fertility.

The black summer truffle, which is the subject of the present study, is a representative of mycorrhizal fungi, which in turn support the nutrition of woody, shrubby and herbaceous plants. Mycorrhiza is a symbiotrophic relationship that is non-pathogenic or only slightly pathogenic and results in a mycorrhizal association between a plant and a fungus (Kirk et al. 2008). Underground fungi are an invariable element of forest ecosystems through their interaction with vegetation, but in the last few years, in addition to ecological importance, they also have economic and social importance for very large groups of people who are engaged in their collection. As a material product from the forests, fungi are used mostly in cooking, in raw, dried or processed form.

In order to carry out the present analysis, detailed observations were carried out on the ripening of the fruit bodies of the black summer truffle (*Tuber aestimum*) and the change of their weight over the time, as the aim of the specific development is to determine the permissible period for the collection of the most widespread species of truffle in Northeastern Bulgaria. At this time, underground fungi and in particular the collection of truffles is one of the main livelihoods in this region. Regulating the exact period for the collection of the truffle species will contribute to the preservation of the available deposits and improvement of their condition, as well as to their sustainable integrated management.

Key words: fungi, truffles, ecosystems, periods

Protected forests ecosystems – a refuge for biodiversity

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Abstract

Protected forest ecosystems play a crucial role in the conservation of biological diversity by providing critical conditions for the preservation of endangered animal species. As natural refuges, these areas support stable populations, contribute to the restoration of disrupted ecological balances, and act as buffers against the negative impacts of human activity. This presentation analyzes the importance of forest reserves and national parks through case studies from Bulgaria and other regions, examining key management challenges, effective conservation strategies, and the need for an integrated approach involving cooperation among institutions, the scientific community, and local stakeholders.

Key words: protected areas, forest ecosystems, biodiversity, conservation, endangered species, sustainable management, national parks, forest reserves

Ground beetle (Coleoptera: Carabidae) communities from various habitats in a region where nature and people collide

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Abstract

The “Golak” is a karst hill in the northern foothills of the Karkaria part of the Western Rhodope Mts. in Bulgaria. The area is populated and known with its agriculture and tourism, and currently, intensive cattle-rearing is endangering this habitat with overgrazing, and investment proposals for extraction of marble, limestone and rare metals further threaten the region. However, a number of protected species live there, which gave us reason for a targeted monitoring.

In the period 24 March 2023 – 21 June 2024, we surveyed nine sampling plots with the help of 54 pitfall traps. Additionally, we conducted observations and manual collecting of material. Here we present data obtained about one of the indicative groups of animals, the ground beetles (Coleoptera: Carabidae). During our research we found 92 carabid species, of which five were collected only by handpicking, so they are not included in the mathematical processing. There are 11 species new for the region of the Western Rhodope Mts.; three of them are also new for the whole Rhodope Mts. A total of 3184 specimens were collected in the pitfall traps and further 45 were caught by hand. *Calathus distinguendus* and *Carabus convexus* were eudominants; *Carabus montivagus* and *Laemostenus cimmerius* were dominants; there were five subdominants, three recedents and 75 subrecedents.

Carabus convexus was also a euconstant species, collected in all sampling sites. Beetles belonged to 22 categories from the five main faunal types of Bulgarian carabids: European-Asiatic (30 species, 33%), Mediterranean (21 species, 23%), Northern Holarctic European-Siberian (17 species, 19%), European (15 species, 16%) and Endemic (8 species, 9%). Most represented were the European-Neareastern and European-Central Asian (13 species, 14% each) elements. From the two established classes of life forms, class *Zoophagous* contained 49 species (54%) and *Mixophytophagous* were 42 species (46%), which is close to the typical ratio for the meadow steppes from the Forest-steppe zone of Eurasia. Macropterous were 51 species (57%), di(poly) morphic (some individuals have fully developed wings, others only vestigial ones) were 21 species (23%) and brachypterous (hind wings shorter than elytra, or missing) were 18 species (20%). The relatively low number of winged species is comparable only with typical montane habitats. In relation to their humidity preferences, mesoxerophilous carabids had the largest share (35 species, 38%). Mesophilous were 25 species (28%), 13 species (14%) were mesohygrophilous; eurybiontic group included 8 species (9%); xerophilous were 6 species (7%) and hygrophilous were only 4 species (4%).

Mathematical processing showed that: 1) there was a clear separation of the forest habitats, based on the indicator species *Carabus montivagus* and *Tapinopterus balcanicus*; 2) overgrazed habitats formed another well-defined group; 3) in addition to the habitat type separation, the ecotone edge effect and ecological catastrophic effect were both present, as well.

Key words: carabids, ecology, diversity, Western Rhodope Mts., bioindication, overgrazing

Faunistic and ecological studies on earthworms (Oligochaeta: Lumbricidae) from forest ecosystems in the Berkovski Balkan region

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Abstract

In the period 2016 – 2018, during a research on the stocks and role of dead wood biomass in forest ecosystems from the Berkovski Balkan region (Western Stara Planina Mts., Bulgaria), we experimented for the first time in Bulgaria the analysis of earthworms (Oligochaeta: Lumbricidae) caught with the method of the pitfall traps. We developed a system for analysing lumbricofauna and lumbricocenoses that takes into account both natural environmental gradients and those of the anthropogenic factors.

With the help of 156 pitfall traps set in 13 sampling plots, over 500 individuals belonging to 20 species and 9 genera were collected. For the purposes of the applied science experiment and the subsequent analysis, their species, zoogeographic and ecological affiliations were determined, taking into account different aspects of the faunas and cenoses necessary to analyse the nature and condition of the forest environment.

The earthworms were subjected to a comparative faunistic analysis aimed at demonstrating the suitability of the method for reporting the qualitative component of the biomonitoring. Various aspects and parameters were discussed: comparative analysis of the lumbricofauna of the three parts of the Balkan Mountains – Western, Central and Eastern; analysis of the identified species of conservation significance (three Balkan endemics and one rare species); analysis of two species reported for the first time in the region, *Dendrobaena platyura* and *Cernosvitovia rebeli*, first of them being new for the territory of Bulgaria; analysis of seasonal dynamics of the species and specimens; analysis of age and size structure and ecological groups of earthworms.

The ecological analysis showed a clear trend of species and numbers impoverishment according to the type and strength of anthropogenic impact. This "exhaustion" was directly proportional to the degree of deprivation of the lying dead wood, which was probably due to the consequent nutrient deficit and reduced soil surface moisture. The presence of a given species and the proportion of the three groups of earthworms – surface dwelling (epigeic), mid-depth dwelling (endogeic) and deep dwelling (anecic), were also dependent on the type and condition of the forest ecosystem, and can be used in biomonitoring system.

From this first experimental study on pitfall trapped oligochaetes, it was concluded that this method is suitable for both species composition studies and for collecting ecological information on communities. Among the advantages of the method are its year-round duration, relatively low cost and the possibility to use it simultaneously with the collection of biological material and information on other epigeobionts and pedobionts. The method is suitable and promising for ecosystem biomonitoring, but experimental calibration and refinement of the system of biotic parameters used is necessary.

Key words: earthworms, ecology, Western Stara Planina Mts., forests, dead wood

Analysis of the timing, methods and methodologies for the study of the Eurasian beaver (*Castor fiber* L.) and its habitats in Bulgaria

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Abstract

Eurasian beaver (*Castor fiber* L.) is the last mammal recently recorded in Bulgaria, despite its impressive size, visible traces it leaves (gnawed trees) and its permanent establishment in Bulgaria more than 15 years ago. This giant rodent was photo-documented for the first time in March 2021 in the area of the confluence of the Cherni and Baniski Lom Rivers. Since then, the authors have documented the persistent colonization of beavers along the entire 470 km length of the Danube, its islands and six of the tributaries – the Timok, Ogosta, Lom, Osam, Yantra and Rusenski Lom Rivers.

Finding the species in more than 45 localities with over 200 family groups in different habitats required the development of a system for recording of occupied territories, as well as for monitoring the groups, their dynamics and rate of dispersal. Survey timeframes and methodologies vary greatly depending on the size and type of the reservoir inhabited.

Depending on their size, the rivers were divided into large (Danube), medium (Rusenski Lom, Yantra, Osam, Ogosta, Lom and Timok) and small (Bely, Cherni and Baniski Lom).

The Danube and its islands proved to be only passable and accessible during the summer-autumn low water months from mid-July to the end of September. In this period, all traces of beaver activities are visible and the boundaries between occupied territories and the age groups can be accounted.

The main methods used to account the number of family groups are the statistical and morpho-ecological, which are applied according to the possibility of full traversal or limited access to the occupied territory. The medium and small rivers should be surveyed during the autumn-winter period, when visibility along the banks is best, given the fallen leaves, as well as due to the strongly increased activity of beavers preparing stocks of branches (food stores) for the winter. Suitable period is from the last ten days of September to the end of December. In January, beavers' breeding season begins and surveys should be interrupted. Suitable for these rivers are the morpho-ecological and ecological-statistical methods and, exceptionally, when banks are difficult of access, the statistical method. We applied the survey methods at the Danube and its islands in August–September 2022 and September 2023 and 2024, and at medium and small rivers – annually after 2021 in each season. We installed photo cameras near two family groups on the Yantra and Cherni Lom Rivers, aiming to identify specific features in their biology and ecology.

Our experiments demonstrated the unsuitability of remote and photodocumentary methods for studies on distribution, number of size-age groups and occupied territories, and for reporting boundaries between family groups. Drone or aircraft surveys are inapplicable given the dense vegetation canopy and limited visibility on the bank. The only appropriate method is by traversal of the entire riverside sector when it is small and passable, and applying sample transects and subsequent biological extrapolation for the large coastal areas of the Danube and its islands.

Key words: Eurasian beaver, Danube, tracks, monitoring, Bulgaria

New chorological data for the flora of Sakar Mt., SE Bulgaria

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Abstract

Sakar Mountain is a low mountain and hilly area located in Southeast Bulgaria and Northwest Turkey, with altitudes between 50 and 856 m (highest peak Vishegrad). It hosts very rich biodiversity in various biotope types – grasslands, mixed forests (*Quercus cerris, Quercus*

frainetto, Pinus nigra, etc.), rock formations (granite, limestone, etc.), freshwater ponds and arable land. The climate of the area is characterized by certain Mediterranean influence.

The flora of Sakar Mt. is far from well-studied. The territory of the mountain is shared between two floristic regions in Bulgaria – Tundzha Hilly Plain and Thracian Plane.

We report eight vascular plant species from Sakar Mt. as new for the floristic region of Tundzha Hilly Plain, incl. *Pulsatilla montana* Rchb. and *Osyris alba* L. Two species are new for the floristic region of Thracian Plane, incl. *Legousia pentagonia* (L.) Thell. assessed as vulnerable in the Red List of Bulgarian vascular plants. The distribution of two species (*Acer monspessulanum* L. and *Digitalis grandiflora* Mill.) in the floristic region of Tundzha Hilly Plain is confirmed.

The presence in Sakar Mt. of an interesting member of the *Campanula rotundifolia* group is briefly discussed. Its finding at relatively low altitude (700 m) prompts a dedicated study as this species complex is known to have more or less mountain distribution in this country.

Key words: biogeographic records, flora, chorology, Sakar Mountain, Bulgaria

The impact of deforestation on bee populations

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Abstract

Deforestation is one of the leading factors contributing to the decline of bee populations, which play a critical role in pollination and the maintenance of biodiversity. Bees are essential for the health of ecosystems and agricultural systems, as they support the reproduction of numerous cultivated and wild plant species. Despite their ecological and economic importance, bee populations worldwide are facing serious threats, with habitat loss – largely driven by deforestation – being among the most significant.

This study examines the impact of deforestation on the availability of food resources, migration patterns, and behavioral changes in bees. Special attention is given to ecological imbalances caused by the destruction of forested areas that serve as vital habitats for bees. The loss of plant diversity and the reduction of nectar-bearing species limit access to nutrition and impair the bees' ability to effectively pollinate.

The research includes case studies from regions experiencing advanced stages of deforestation and evaluates the effects on local bee populations and their role in plant pollination. The findings aim to support the development of conservation strategies and the restoration of bee habitats through joint efforts for sustainable natural resource management.

Key words: deforestation, bees, populations, pollination, biodiversity, sustainable management, habitats

Verification of forest high resolution layers 2018 for Bulgaria: tree cover density and dominant leaf type

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Abstract

The high-resolution layers (HRLs) are Pan-European land cover datasets aimed at monitoring soil sealing (imperviousness, forest, grasslands, wetness and water, and small woody features.

The main purpose of this article is to present the methodology and results from verification of two Forest HRL products for the 2018 reference year for Bulgarian territory: Dominant Leaf Type (DLT) and Tree Cover Density (TCD). The verification task aims at identifying systematic classification errors and the results are supposed to be used for improvement in future product updates. Qualitative approach for assessment of the HRL quality is applied in two steps, called General overview of data quality and Look-and-feel verification. The latter is performed within dedicated strata through non-random sampling, checking HRLs for omission and commission errors.

We show results from a verification at country level based on local expertise and best available in situ data. We also provide comments and recommendations concerning commission and omission strata. Several cases of both of the above types of errors are identified and analysed in the DLT and TCD high resolution layers. Despite of errors found, both DLT and TCD receive a 'good' mark, and the same rating prevails in the strata level evaluation.

Key words: commission error, high resolution layers, land cover, omission error, verification

Ectomycorrhizal hypogeous fungi diversity on cork oak plantations in Southwestern Bulgaria

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Abstract

Cork oak is an evergreen plant that does not naturally occur in Bulgaria. Due to the significant economic interest in this species and the availability of suitable habitats in Bulgaria, past experiments have been conducted to introduce it as a crop.

As a species that forms ecto-mycorrhizal associations, specific fungal species are of utmost importance for its adaptation and successful establishment in these introduced environments.

The current study aims to shed light on the composition of hypogeous fungi found in the cork oak plantations established in the Petrich and Melnik regions of Bulgaria, providing important insights into the ectomycorrhizal fungal communities associated with this non-native tree species in the country.

Key words: fungal diversity, hypogeous mycota, ectomycorrhizal community

Faunistic and ecological studies on ants (Formicidae) and other Hymenoptera from forest ecosystems in the Berkovski Balkan region

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Abstract

In the period 2016–2018, during a research on the stocks and role of dead wood biomass in forest ecosystems from the Berkovski Balkan region (Western Stara Planina Mts., Bulgaria), we experimented with the analysis of *Hymenoptera* caught with the method of the pitfall traps. We developed a system for analysing the ant (*Formicidae*) fauna and ant coenoses that takes into account both natural environmental gradients and those of the anthropogenic factors. With the help of 156 pitfall traps set in 13 sampling plots, we collected 6121 ant individuals belonging to 50 species and 18 genera, and 84 other hymenopterans from 15 families.

Myrmica bibikoffi Kutter, 1963 is reported for the first time in Bulgaria, proving the reliability of the method for collection of biological material and information. For the purposes of the applied science experiment and the subsequent analysis, ants' species, zoogeographic and ecological affiliations were determined, taking into account different aspects of the faunas and coenoses necessary to analyse the nature and condition of the forest environment. The ants were subjected to a comparative faunistic analysis aimed at demonstrating the suitability of the method for reporting the qualitative component of the biomonitoring.

Various aspects and parameters were discussed: comparative analysis of the hymenopteran fauna of all sampling sites; analysis of seasonal dynamics of the species; analysis of bioindicators of forest ecosystems status. The ecological analysis showed a clear trend of species and numbers impoverishment according to the type and strength of the anthropogenic impact. This "exhaustion" was directly proportional to the degree of deprivation of the lying dead wood, which was probably due to the consequent nutrient deficit and reduced soil surface moisture. From this experimental study on pitfall trapped hymenopterans, it was concluded that this method is suitable for both species composition studies and for collecting ecological information on communities.

Among the advantages of the method are its year-round duration, relatively low cost and the possibility to use it simultaneously with the collection of biological material and information on other epigeobionts and pedobionts. The method is suitable and promising for ecosystem biomonitoring, but experimental calibration and refinement of the system of biotic parameters used is necessary.

Key words: ants, Western Balkan, dead wood, forests, new records

The Canary Islands dragon tree (*Dracaena draco* (L.) L. subsp. draco) – a symbol of centuries-old natural and cultural heritage

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Abstract

The Canary Islands dragon tree (*Dracaena draco* (L.) L. subsp. draco) is an endangered Tertiary relict species endemic to the Canary and Madeira archipelagos. D. draco being a plant icon of the Canary Islands, is widely cultivated as an ornamental plant and its reddish resin known as dragon’s blood has a great significance for human till today.

According to the International Union for Conservation of Nature, the current status of D. draco was defined as endangered. The decline in dragon tree populations can be attributed to habitat loss, climate change, and overexploitation. Therefore, conservation efforts are critical to their survival. Conservation organizations and local governments are working together to protect these magnificent trees through habitat preservation, legal protections, and public education campaigns.

These efforts aim to ensure that dragon trees continue to thrive in their natural habitats for centuries to come. The Dragon Tree’s legacy is not just about the survival of a species but about the enduring connection between nature and humanity. It stands as a symbol of hope and a reminder of our responsibility to protect our planet’s precious resources.

Key words: dragon tree, Canary Islands, IUCN, conservation

Spatial distribution of some heavy metals in the Botevgrad Valley – Bulgaria

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Abstract

Heavy metal pollution in Bulgaria is a serious environmental problem, mainly resulting from industrial activities, transportation, agricultural practices and military operations. The predominant pollutants include copper, lead, zinc, and cadmium. Soils in the Botevgrad Valley show that heavy metal pollution has only few spots with concentration higher than permissible concentrations or trigger vales only in isolated places, near places affected by anthropogenic activity.

Sources of lead (Pb) pollution of the soils in the Botevgrad area can be roads, mines, industrial enterprises that release lead into the environment. Nearby is the Elseysna station, where copper is mined, and there is pollution with lead, zinc and arsenic, which can be carried with fine particles. Pollution above the trigger values is only in the area of the village of Trudovets, where lead pollution is observed twice above the norm (268 $mg.kg^{-1}$).

Cadmium (Cd) is a heavy metal that occurs naturally in the earth's crust, but human activity significantly increases its concentration in soils. In the studied area, only one sample with value 3.32 $mg.kg^{-1}$ has trigger values. It is located near an industrial zone of the city of Botevgrad.

Soil contamination with copper (Cu) is a significant problem for Bulgaria. In agriculture, it is a source of pollution through the use of copper-containing fungicides and herbicides. As mentioned, the Eliseina station copper mold is nearby. Pollution above the trigger values are only in two places near town of Botevgrad and village Trudovets with values 143 and 113 $mg.kg^{-1}$.

Zinc (Zn) is a natural element in soil, but its excessive accumulation is usually the result of anthropogenic activity. Main pollutants are metallurgy, battery, tire, paint and electronics production, mining and ore processing. Zinc is often found in wastewater and tailings.

Only in one spot on west side of Botevgrad has zinc contamination that exceeds the trigger values with value of 208 $mg.kg^{-1}$. The average values are about 103 $mg.kg^{-1}$, which is within the norm. Soil pollution in Botevgrad valley by copper and zinc is observed in

areas where intensive agriculture is practiced due to the use of pesticides and mineral fertilizers. Increased heavy metals in the soil, such as lead and cadmium are observed near industrial zones, main roads along which are spread unregulated landfills and scattered household waste.

Key words: heavy metals, soil pollution, spatial variation, Botevgrad valley

Acknowledgements

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Lichen clues to a century of forest knowledge: *Chaenotheca* as an indicator of old-growth forests

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Abstract

Chaenotheca is a genus of corticolous and lignicolous lichenized fungi that inhabit the bark of veteran trees and decaying wood of snags in old-growth forests. Their existence depends on the microclimate that old forests provide and substrates that are usually removed in the managed stands. Nine species are recorded for Bulgaria, four of them (*Ch. hispidula*, *Ch. phaeocephala*, *Ch. subroscida*, *Ch. chlorella*) are referred to as indicators for old forests with long forest continuity, two of which are present in the Red list of lichenized fungi (*Ch. hispidula* and *Ch. chlorella*). Three new species of *Chaenotheca* are presented for the country within this study, two of which are also known as indicators for old-growth forests (*Ch. laevigata* and *Ch. stemonea*). The study aims to obtain the actual number of species and their distribution in Bulgaria, as well as to gather data of their preferred ecological conditions. This information will serve as a valuable tool for assessing forest continuity in the Bulgarian forests.

Key words: Bulgarian forests, forest continuity, new records

Response of catalase and cellulase to microbial biomass carbon and some soil indicators in forest and agroecosystems

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Abstract

Microbial biomass carbon and enzyme activities were studied in soils from the territory of Sofia municipality: village Zheleznitsa, village Pasarel, Vrazhdebna district, Nature Park “Vitosha”, in seasonal dynamics, with and without the influence of analyzed water bodies. In general, the values of microbial biomass carbon, as well as the enzymes catalase and cellulase are higher in agrogenic soils compared to forest soils, which is also due to the fact that they are arable and with a controlled humidity regime, with clearer trends for higher microbiological activity in spring compared to summer.

Catalase activity depends significantly, and cellulase activity highly, positively, on the accumulated microbial biomass. Microbial biomass carbon and enzyme activities depend moderately, positively, on soil temperature. In summer, the accumulation of microbial biomass is from mesophilic groups of microorganisms, while in spring psychrophiles also participate. A negative correlation is established between humidity and microbial biomass, as well as between humidity and enzyme activities, respectively significant between humidity and cellulase, moderate between humidity and catalase and high between humidity and microbial biomass. In most over-moistened soils of Nature Park “Vitosha”, with the spillage of water from local water sources to them, the quantity of aerobic microorganisms decreases at the expense

of anaerobes, the accumulation of microbial biomass decreases and, accordingly, the enzymatic activity of microorganisms decreases. A significant positive correlation is established between pH and catalase, and a weak between pH and microbial biomass, while between cellulase and pH the correlation is moderate, negative.

At the sites of Nature Park “Vitosha”, village Zheleznitsa and village Pasarel soils have an acidic reaction, while the agrogenic soils from Vrazhdebna district have a neutral reaction, which suggests an accumulation of biomass mainly of bacterial origin in the agrogenic soils, and in those with an acidic reaction an increase in the quantity and activity of mold fungi, but on the other hand, anaerobic conditions in over-moistened soils limit the development of mycelial groups of microorganisms.

Key words: microbial biomass, catalase, cellulase, forest and agrogenic soils

A revised checklist and evaluation for the flora of the Canary Islands, Spain

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Abstract

The Canary Islands (Spain), a volcanic archipelago situated in the north-eastern Atlantic Ocean, is one of the most biodiverse oceanic insular systems of plants on the planet, being one of the most relevant hotspots of plant biodiversity within the Mediterranean Basin. The flora of the Canary Islands has been subject to botanical studies for more than 200 years.

There are various reasons for changes in actual biodiversity. Island floras are both: exposed to species loss and to species introductions, either through natural processes or by anthropogenic factors. Additionally, the evolution of endemic plant species plays a substantial role. Endemic species are sensitive to population decline due to small population sizes and possible low competitiveness against incoming species. Additionally, there is continuous progress in systematics and taxonomy. Species names or their taxonomic attribution can be modified.

The Canary archipelago not only exhibits high levels of endemism (539 vascular plants which means almost 40% of the native flora) but also of alien species. This work represents the current state of knowledge on Canary Island plant diversity, including introduced and recently described taxa.

Key words: flora, Canary Islands, endemic species, alien species

Acknowledgements

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Study on the dendroflora of calcareous terrains in the region of Forest Enterprises Trun, Bulgaria

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Abstract

Data from the study of the dendroflora in 25 sample plots at different altitudes – 800–1100 m are presented. In each sample plot, the number of individuals of each tree species is listed and their biometric indicators are presented. The work presents characteristics of species from the dendroflora of Bulgaria (48 species), facultative (17 species), indifferent (29 species) and obligated (2 species) – their systematic structure according to families and genera, division according to biological types and live forms, as well as floristic geoelements and spreading on vertical belts.

The total number of individuals is 8872, of which *Fraxinus ornus* is represented by largest number. *Sorbus aria*, *Prunus avium*, *Prunus cerasifera* are represented by only 1 individual each. The largest number of species (33) was found at 900 m a.s.l. More than half of the total number of individuals is concentrated in the range between 850 and 950 m a.s.l. Individuals with the largest average sizes are also concentrated in this range.

Based on the characteristic of the dendroflora, analysis of the distribution of some rare tree species (*Corylus colurna* and *Crataegus pentagyna*) was carried out.

Key words: dendroflora, Trun district, limestone, conservation importance

Dendrological Study on the Common Oak (*Quercus robur* L.) in State Hunting Enterprise "Karakuz" in Dulovo, Bulgaria

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Abstract

Data from the study of the morphological variability. It was studied based on leaf indices. For this purpose, 30 individuals were randomly selected from two populations of common oak. Elongated twigs containing at least five normally and correctly developed leaves were obtained from each individual. The leaves were measured by 19 indexes. Through variational statistical processing, based on these 19 characteristics, there are average values that have been established. After comparing the two different populations we find out that the most striking differences between them are the leaf length with coefficient of variation around 20% for both populations, the length of the petiole which is presented by nearly 68% for the one and 38% for the other population.

Other criteria with high coefficient of variation is the average leaf width which comes out to 24% for the first population. The distance from the widest part of the leaf to the tip of the leaf is characterized by approx. 32% coefficient of variation. There are more noticeable characteristics revealing the pure and strict individuality between trees from the same species, though from different populations.

A Student's T-test was conducted, through which we establish that for almost all indicators the data are statistically reliable. After conducting an inventory in the studied sites, the results show that a total of 21 tree species and 4 shrub species are found therefore it is indeed an indicator of the importance of this forest ecosystem and the need for its preservation.

During the research it was concluded that there was a significant amount of common oak regeneration which is encouraging for such dry areas as the one that the study was conducted on.

Key words: Ecosystem biodiversity, conservation and environmental restoration

Assessment of soil parameters related to soil health status of soils in Pirin Nature Park

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Abstract

Forest soils are an essential part of terrestrial ecosystems globally. They play a crucial role in the water cycle, soil organic carbon sequestration, nutrient cycle, and climate change. Therefore, it is highly important to maintain their good health status. Healthy soil can provide optimal conditions to maintain a diverse community of soil organisms, available water, organic carbon, nutrients and to ensure their ecological functions.

Our study is focused on the assessment of basic soil parameters related to the health status of the soil. A total of 10 soil profiles of Cambisols were studied on the territory of Pirin Nature Park. It was established that soil depth varied between 30 and 64 cm, and soils were assessed as shallow. The average depth of A horizon was 12 cm. The established pH values in A horizon are assessed as very strongly acidic (SP 5, 6, 7, and 9) to neutral (SP1). Soil reaction indicated ongoing acidification processes in some of the soil profiles. The soil texture in the studied soils

was dominated by sand, followed by silt. It varies in the category of loamy soils, which can negatively impact the soil health status of these soils. The studied soils were porous and with lower values of bulk density. They were poorly (45 t/ha) to well stocked (284 t/ha) with humus and total nitrogen. The cation exchange capacity (CEC) of the A horizon ranged between 11.96 cmol(+).kg^{-1} (SP 2) and 33.52 cmol(+).kg^{-1} (SP1). It was assessed as high to very high and was entirely dominated by the content of exchangeable calcium. For the metamorphic horizon (Bw) CEC values range from 3.03 cmol(+).kg^{-1} (SP3) up to 19.80 cmol(+).kg^{-1} (SP1). It was assessed as low to high. In 50% of cases (SP 1, 2, 4, 5, and 10) soil was assessed as unsaturated with bases (16 to 45%). In the other 50% of the soils (SP 3, 6, 7, 8 and 9), they were saturated with bases (58 to 99%).

It was found that shallow soils, acidic soil reaction, low BS, and low CEC are the main factors for the deterioration of soil health. The assessment of basic soil parameters showed that the soil health status of some of the studied soils is poor due to ongoing acidification processes, and low content of organic matter. It is highly recommended that these forest soils be monitored and managed over time to improve and enhance their soil health status.

Key words: Ecosystem biodiversity, conservation and environmental restoration

The Carob moth, *Apomyelois ceratoniae* (Zeller, 1839) (Lepidoptera:Pyralidae), a new pest of common walnut in Bulgaria

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Abstract

The Carob Moth Apomyelois ceratoniae (Zeller, 1839) is reported as a new pest of common walnut (*Juglans regia* L.) in Bulgaria. During a 2024 survey for the early detection of alien species, larvae and pupae of the moth were found in walnut fruits collected from plants in urban and suburban areas of the Belovo, Chernichevo, Chernomorets, German, Gorski izvor, Plovdiv, Simeonovgrad, Kapitan-Andreevo, Lyubimets, Parvomai, Svilengrad and regions. The species appears to be widespread throughout Bulgaria and is likely even more prevalent than currently recorded. It was most likely introduced through imported walnut plants for planting in Bulgaria.

Key words: alien, pest, Juglans regia, distribution

Acknowledgements

This study was conducted in the framework of the Project NIS-B-1280 “Assessment of the level of study of alien economically important pests of agricultural crops in Bulgaria” funded by the Scientific sector of University of forestry.

Diversity of wild apple genetic resources in the Central Balkan Mountain region of Bulgaria

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Abstract

In Bulgaria, the apple (*Malus ×domestica* Borkh.) has a long history of cultivation, and a big diversity of genetic resources is found in the country. Wild relatives of this fruit species could be found in forests or other habitats. The local genetic resources are valuable for their good adaptation to the natural habitat's climatic and soil conditions. In addition, they often have a number of valuable characteristics, such as resistance to diseases and pests that should be preserved and used as donors in the breeding programs. The current study aimed to investigate the diversity of the wild seedlings mapped in expedition studies in the region of Troyan, Central Balkan Mountain region of Bulgaria, to assess their value and select the most valuable for future breeding purposes. To complete this objective fruit size, fruit flesh firmness, total soluble solids content (°Brix), skin, and fruit flesh colour were measured. All studied characteristics were highly variable in the population. Fruit flesh colouration varied from white to pinkish. Very high sugar content had PM 11 (18.08%), PM 12 (18.32%), PM 25 (17.44%). All analyzed samples had higher invert sugars and lower sucrose content. Of all the studied forms, PM 17 and PM 104 had very low acid content.

Key words: Biodiversity, local forms, local gene pool, apple

Condition of natural meadows and pastures in the conditions of the Middle Balkan Mountains

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Abstract

Natural grasslands in Bulgaria cover a significant part of the mountainous and semi-mountainous areas of the Middle Balkan Mountains. The fodder obtained from them is a source of ecologically clean production with high nutritional value. Meadow grasslands have a number of valuable qualities for the production of grasses with a favourable chemical composition, which are readily accepted by animals. This article gives an overview of the importance and distribution of meadows and pastures in the Middle Balkan Mountains. Their floristic composition is presented, divided into botanical groups. The biodiversity of species in grasslands of different habitats is identified and agrotechnical measures for the conservation and improvement of useful grass species are presented. The influence of climate on the development of grassland species and its impact on the productive capacity of grasses is being studied. It has been shown that the yield of these grasslands is low and is strongly influenced by temperature, rainfall and its distribution. Meadow grasslands are characterized by their species-rich composition (*Agrostis capillaris* L., *Festuca ovina* subsp., *Anthoxanthum odoratum* L., *Trifolium campestre* L.) and good hay quality. The pasture of the *Nardus stricta* L. type is dominated by the species cardoon, as well as species such as *Agrostis capillaris* L., *Anthoxanthum odoratum* L., *Trifolium repens* L., *Hypericum perforatum* L., *Potentilla erecta* L., *Geum montanum* L., *Thymus vulgaris* L., etc.). Fertilization with mineral and organic fertilizers is presented, which increases the amount of leguminous grasses and useful perennial grasses. Agrotechnical measures are an important prerequisite both for increasing the number of economic grass species and for achieving a balanced quality of forage for animals.

Key words: natural grasslands, distribution, productivity, biodiversity, quality

Productivity and oil content of *Thyme* sp., cultivated in the Eastern Rhodopes, Bulgaria

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Abstract

Thyme is a perennial herb from the Lamiaceae family, particularly valued for its essential oils, which contain bioactive compounds with significant therapeutic and culinary properties. Thyme essential oil is rich in volatile components such as thymol, geraniol, citral etc, which contribute to its antibacterial, antifungal and antioxidant properties. The oil composition varies significantly due to factors like genetic diversity and geographical distribution, resulting in distinct chemotypes. Thyme cultivation offers a valuable alternative of harvesting natural recourses which disturb and diminish biodiversity and natural sustainability. A comparative field study was set up in 2021 at the Agricultural Experimental Station at the Eastern Rhodopes in town of Kardzhali with thymus species. Four genotypes with differing chemotypes were included in the study: a thymol-type cultivar "Deutscher Winter" (*Thymus vulgaris* L.), and two Bulgarian cultivars: citral-type Slava (*Thymus siptorpii* L.) and geraniol-type Pagane (*Thymus marcshallianus* Willd.). Phenological and biometrical indexes were gathered and analyzed in order to determine growth and development of thyme cultivars in first years after plantation establishment. Data on oil content and mass productivity were also presented. At the Eastern Rhodopes full bloom period is cultivar-dependent and occurs as follows: 10–20 may for German winter thyme, 1–10 June for Slava cultivar and 5–20 June for Pagane cultivar. 2024 was the third year of thyme cultivation at the experimental station. The highest fresh mass per plant was gathered from German winter variant (445 g), followed by Slava (345 g) and Pagane (219 g). The highest FW/DW ratio was evaluated for Slava cultivar (1:4). In the first years, fresh mass yield harvested per da varied significantly among the studies variants: 1029–1362 kg.da^{-1} from German winter plants, 580–1366 kg.da^{-1} from Slava cultivar and 207–736 kg.da^{-1} from Pagane cultivar. Subsequently, oil harvest followed fresh mass yield – the highest essential oil yield was recorded for German winter (1.96–2.45 kg.da^{-1}), followed by Slava (1.28–3.28 kg.da^{-1}) and Pagane (0.81–1.73 kg.da^{-1}). Oil content was dependent on the year of cultivation. The highest amount was recorded for Pagane, followed by Slava and German winter. Oil composition differed also among the cultivars.

Key words: thymus, Thyme sp., yield, essential oil, thymo

Weed monitoring in three sub-mountainous regions in Southern Bulgaria

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Abstract

The studies were carried out on areas where the conservation agricultural systems was applied (No-Till). The winter oilseed rape – winter wheat crop rotation unit has been applied for the last five years. The lack of rotation and differences in the herbicidal application, as well as the presence of the same species in the years of the survey, can be considered as the first signs requiring the conduct of annual, regular, surveys, according to the methodology, for the detection of herbicide-resistant weed species. The weed flora monitoring was performed in three agricultural lands – the town of Brezovo and the villages of Streltsi and Varben. The weedy plants were represented by a total of 54 botanical species, distributed in 22 botanical families, in a ratio of 89:9:2 (monocarpic:polycarpic:parasitic) species, from a total of eleven biological groups, of which 43 are annual (monocarpic), 10 perennial (polycarpic) species, and 1 parasitic species. The annual species were presented by 6 monocotyledonous and 36 dicotyledonous species, 1 representative of the bulbous species and 1 representative of the parasitic ones. The Poaceae family is most abundant in the weed associations in the surveyed areas, a total of 9 botanical species distributed in four biological groups: Annual species from which winter spring: Apera spica venti (L.) P.B.; overwintering: *Bromus arvensis* L.; Late spring: *Setaria viridis* L., *Echinochloa crus-galli* L., *Setaria glanca* L.; Early spring: *Avena fatua* L., *Lolium temulentum* L.; Perennial (Rhyzome weeds) *Sorghum halepense* (L.) Pers and *Cynodon dactylon* (L.) Pers.

Key words: Sub-mountainous regions, weeds monitoring

Structural fiber components of the cell walls of forage legume grasses grown in mountain areas

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Abstract

In the period 2020 in the experimental field of the Research Institute of Mountain Stockbreeding and Agriculture-Troyan a research experiment has been conducted with the following species of perennial leguminous meadow grasses: bird's-foot trefoil (*Lotus corniculatus* L.), hybrid clover (*Trifolium hybridum* L.), alfalfa (Medicago sativa L.), red clover (*Trifolium pratense* L.), white clover (*Trifolium repens* L.). The experiment aimed to monitor the composition of the structural fiber components of the forage cell walls average two-year period and determine the dry matter digestibility and energy nutritional value. The legume crops studied were found to have different compositions of forage cell wall fractions. The forage mass of red clover showed the lowest content of neutral and acid detergent fiber, and acid detergent lignin and the highest dry matter digestibility. The alfalfa forage had the highest hemicellulose values and that of hybrid clover had the maximum cellulose values. Good energy nutritive value was recorded by the forage of bird's-foot trefoil and white clover.

Key words: legume grasses, cell wall fiber components, digestibility

Normalized Digital Vegetation Index in Drip Irrigation

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Abstract

The objective of this study was to enhance the analysis of vegetation information using the Normalized Digital Vegetation Index (NDVI) through remote sensing data. NDVI values were correlated with ground measurements to derive insights into vegetation health and productivity.

The experiment focused on zucchini cultivation, where NDVI was measured at full growth using a Trimble Green Seeker handheld sensor. Various nitrogen and phosphorus fertilizers were applied, including ammonium nitrate, phosphates, and polyphosphates.

The highest NDVI value achieved was 0.802 with ammonium nitrate (nitrogen treatment) lacking phosphorus. On a polyphosphate background, the nitrogen source with the highest NDVI was KSC, yielding 0.800. With an orthophosphate background, KSC produced the best NDVI of 0.815. Highest NDVI values were consistently linked with the orthophosphate background, and these results were statistically validated. A strong correlation coefficient of 0.72 was observed between NDVI and zucchini yield. The integration of NDVI into our analytical approach significantly refined the analysis of vegetation data, yielding more precise insights.

Key words: NDVI, zucchini yield, fertigation, nitrogen, phosphorus, potassium

Comparative evaluation of biometric parameters of local cherry cultivars and forms

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Abstract

In 2023, during scientific expedition in the regions of Shumer, Ruen, Kuklen, Osmar, Varna and Aytos, part of a project for preservation of local genetic resources, nine local cherry cultivars and forms were discovered. Specimens were mapped with GPS coordinates in the project's database, the ripening period of the fruits was determined, as well as their pomological characteristics. Biometric analyses of fruit and stones were performed and compared to the standard cultivars 'Van' and 'Bigarreau Burlat'. The earliest ripening fruits are of specimen SS-08 on June 8, and the latest ripening are of SM-29 is on June 26. Specimen SS-06 had the highest fruit weight 6.09 g from the discovered cherry forms, and SM-29 had the lowest fruit weight 1.31 g. The stone weight ranged from 0.15 g in SM-29 to 0.36 g in SS-06. The shortest stalk was measured for SS-09 at 22.88 mm and the longest for SS-08 at 62.61 mm.

Key words: local cherry cultivars, cherry forms, genetic resources, biometric analyses, fruit, stone

Study on the impact of fertilization types on sweet corn productivity and the behavior of soil microbial communities

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Abstract

The global cycle of organic and inorganic substances, soil health and fertility, and obtaining optimal yields are directly dependent on soil microorganisms. Changes in the diversity or activity of microbial communities can also have adverse effects on soil ecology and health. Nowadays, problems related to population nutrition and soil fertility are becoming more pronounced. In this regard, the role of microorganisms is indispensable. Our study investigates the effect of applying different types of fertilizers on the growth and yield of sweet maize *(Zea mays* L., var. *saccharata*), changes in the activity, abundance and quantity of the soil rhizosphere microbiome, the relationship with the physicochemical indicators of the soil and the biometric characteristics of plants. The randomized experiment was conducted at the experimental field of ISSAPP „N. Pushkarov“ in the village of Tsalapitsa, Plovdiv region, and the laboratory work was carried out at the Agricultural University – Plovdiv. Five treatments were designed (untreated control, application of mineral fertilizer, organic fertilizer, combined organo-mineral treatment, and with microbial fertilizer) with four replications each. Physicochemical soil characteristics, community-level physiological profiles and NGS of soil microbiome were performed in addition to plant development, climatic factors monitoring, etc. The results showed statistically significant differences between the individual treatments. The highest maize yield was found in when microbial fertilizer was applied, followed by organo-mineral fertilization. In this treatment and in the one with organic fertilizer, the highest microbial activity and the greatest species diversity were also found. Mineral nutrition led to the highest values of the studied enzymatic soil activities and greatest plant vegetative wieght. Investigating the absorption intensity of individual groups of carbon sources before sowing and during ripening, the greatest increase was observed with the application of organic fertilizers and microbial fertilizer, the least with mineral and combined fertilization. The research was based on classic approaches and in-depth analyses of microbial communities, their interaction with plants and the environment. The results are related to guidelines for reducing the use of mineral fertilizers to mitigate the effect on agroecosystems and the environment as a whole.

Key words: sweet maize, soil microbiome, CLPP, fertilization

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Can herbicide-damanged oilseed rape (*Brassica napus* L.) recover after ameliorative biostimulant treatment?

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Abstract

Oilseed rape (*Brassica napus* L.) is among the most essential oil crops worldwide. The main limiting factor for the growth and development of the oilseed rape is the uncontolled weed infestation. In modern agriculture primary method for weed control is the application of herbicides. if applied improperly they can cause toxic effects on the crop – herbicidal phytotoxicity. One phenomenon for herbicidal stress is the herbicide drift from one field close to another. Therefore, the current study aimed to investigate the response of the conventional oilseed rape variety „PT 225“ to simulated herbicide drift and subsequent ameliorative treatment with plant biostimulant. In this regard, herbicidal drift from a field of Clearfield oilseed rape to a conventional one was imitated. The herbicidal product used was Cleranda SC (17.5 g.l^{-1} imazamox and 375 g.l^{-1} metazachlor) which is registered for weed management in Clearfield oilseed rapes. The trial was conducted during 2020/2021 and 2021/2022 on the experimental field of the Agricultural University – Plovdiv, Bulgaria. Variants of the trial were: 1. Untreated control; 2. Cleranda SC – 0.40 l.ha^{-1} (20% of the rate 2.00 l.ha^{-1}); 3. Cleranda SC – 0.60 l.ha^{-1} (30% of the rate 2.00 l.ha^{-1}); 4. Cleranda SC – 0.40 l ha^{-1} + Amino Expert Impuls – 3.00 l.ha^{-1}, and 5. Cleranda SC – 0.60 l.ha^{-1} + Amino Expert Impuls – 3.00 l.ha^{-1}. The imitation of the herbicide drift was performed in BBCH 14–15 (4th – 6th true leaf of the oilseed rape), and the ameliorative application Amino Expert Impuls was performed seven days later. The levels of phytotoxicity caused by the herbicidal drift by the 9-score scale of European Weed Research Society on the 7th, 14th and 28th day were evaluated. Several parameters as total leaf chlorophyll content, number of primary branches and plant height at the end of the vegetation, seed yield, absolute seed mass, and seed oil content were studied. The drift of Cleranda SC caused phytotoxic symptoms to the grown oilseed rape hybrid. The damages were more severely pronounced at 30% of the solution fallen to the plants. The ameliorative treatment with the plant biostimulant Amino Expert Impuls helped the plants overcome the herbicidal stress, and the plants showed higher results for the studied indicators.

Key words: oilseed rape, herbicide drift, herbicide stress, plant biostimulant

Influence of the predecessor crop and the fertilization type on some structural elements of common wheat yield and soil microbiome properties

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Abstract

Intensive use of soils in agriculture has led to their depletion and loss of organic matter. The prolonged application of mineral fertilizers can lead to increased carbon dioxide emissions from the soil and a disturbed structure of the soil microbiome. In addition, organic fertilization has the potential to overcome some of the above-mentioned shortcomings, but at the same time to balance crop nutrition and positively affect yields. The aim of the present study was to determine the effect of the type of fertilization (organic, mineral and combined) and the preceding crop on wheat development, yields, and soil microbiome. To achieve the goal in 2023/2024, field trials with common wheat, variety “Farmer”, were conducted at the Agricultural University of Plovdiv, Bulgaria. The first trial was realized after a preceding crop silage maize-soybean intercropping, while the second after single cultivation of silage maize. The trials included an unfertilized control and the following fertilizer options: NPK (15:15:15) – 0.1 t.ha^{-1}; Vermicompost – 12.0 t.ha^{-1}; Vermicompost + NPK (15:15:15) – 6.0 t.ha-1 + 0.05 t.ha^{-1} and biochar – 1.0 t.ha^{-1}. The fertilizer products were applied before sowing the crop with incorporation. A number of physiological and biometric indicators of the crop, carbon dioxide emissions from the soil, photosynthetic activity, changes in the soil microbiome were analysed. After fertilization with Vermicompost + NPK, regardless of the preceding crop, similar values were found for hectolitre seed mass. For the other indicators of the same treatment, such as the number of grains in the central class, mass of 1000 seeds and biological yield, higher values were found after sowing the wheat after silage maize as a preceding crop.

Key words: winter wheat, predecessor, fertilization, yield, soil microbiome

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Application of beneficial microbial consortium conducts to increased sorghum grain yield of Foehn and Kaladur varieties and significantly alters soil microbial properties

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Abstract

Climate change has a significant impact on modern agriculture. In recent years, water scarcity and high temperatures have become a critical problem for many regions of Europe, including Bulgaria, which has led to severe economic losses associated with reduced yield and quality of crops. The ability of sorghum to tolerate higher temperatures and drought, as well as the excellent functional properties of its grain in healthy diets, suggests a greater focus on its cultivation and research to achieve optimal characteristics in the soil-microbiome-plant system. The objectives of our study were related to the monitoring of *Sorghum bicolor* (L.) Moench, var. *Foehn и* var. *Kalatur* plants with or without the application of a consortium of beneficial soil microorganisms (SynCon). In order to reach the objectives, sorghum seeds of both varieties were sown in the Training and experimental field of Agricultural University – Plovdiv (Bulgaria) on 900 m^2 in 2024 with 220,000 seeds per hectare. We used four treatments: control (without SynCon) and seeds application of SynCon. The results showed a statistically proven difference between grain yields of sorghum. Thus, the application of SynCon resulted in a 34% increase in the yield of var. Foehn and 11.77% in case of var. Kaladur. The study of soil microbiome revealed improved activity in the rhizosphere of var. Foehn after inoculation of SynCom by 31.3%, while the microbial biomass was enhanced by 42.3%. In the case of var. Kaladur, the increase was 34.9% and 67%, respectively. On the contrary, the study of community-level physiological profiles of C-sources utilization showed faster consumption in treatments without SynCon, which could result from competence between autochthonous and allochthonous communities. In all rhizosphere samples, the community's utilization capacity was significantly improved compared to their behaviour before the sowing of plants. These results were confirmed with a study on soil enzyme activities (dehydrogenase, β-glucosidase and phosphatase), where the increase was by 57.4–196.4%. In conclusion, applying beneficial microbial communities is valuable for obtaining higher yields and improved plant and soil properties.

Key words: sorghum, SynCom, yield, climate change, microbial activities

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Hemical weed control in lavender field

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Abstract

An open-field study was carried out in 2023–2024 at Institute for roses and aromatic plants – Kazanlak aiming at evaluation of herbicide weed control in lavender plantation (*Lavandula angustifolia* Mill.) cultivar Jubilejna. Herbicide efficacy and selectivity of BeFlex (500 g.l^{-1} beflubutamid) и Battle Delta (400g.l^{-1} flufenacetate + 200g.l^{-1} diflufenican) applied on soil in two concentrations before beginning of lavender vegetation were evaluated. The effect of the herbicides on weed infestation and on lavender growth and development was followed. Results analyses shows that BattleDelta successfully controls annual dicotyledonous and monocotyledonous weeds (*Chenopodium album* L., *Polygonum aviculare* L., *Veronica arvensis* L., *Sonchus oleraceus* L., *Alopecurus myosuroides* L., *Poa annua* L.). The soil activity of the herbicide persists up to the 60th day after treatment. That makes it possible to eliminate the competitive impact of weeds on lavender growth after beginning of vegetation. BeFlex exerts effective action on annual dicotyledonous weeds reducing their number by 14–17% compared to the control. No phytotoxicity was observed after herbicide application. On the contrary, lavender fresh mass and oil yields were higher in treated area than from the untreated control.

Key words: *Lavandula angustifolia* Mill., weeds, herbicides, efficacy, selectivity

Evaluation of different substrates for growing microgreens from Brassicaceae family

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Abstract

Microgreens from the Brassicaceae family are recognized for their high nutritional value and health benefits. This study evaluated the performance of four substrates – peat, coconut fiber, vermiculite, and zeolite – in the cultivation of microgreens, using a laboratory containerized set-up, at the University of Forestry. Six crops were tested: three kale varieties (green, red, and black), red cabbage, broccoli, and radish. The results show that, for the different indicators studied and depending on the crops studied, the four substrates performed differently: the coconut substrate had the highest percentage of seed germination (100% in 4 species and 90% in two), followed by the peat substrate (100% in 3, 90% – 2 and 85% – 1). The peat substrate had a better effect on the size of the cotyledons (1–1.4 cm) and on the content of chlorophylls and carotenoids in 5 of the tested species. Zeolite increased the total sugar content (4.6–5.5% in 4 species), followed by vermiculite (4.6–5% in 2). These findings suggest that peat is the optimal substrate for general growth, while zeolite and vermiculite may be suitable for improving specific nutritional components in microgreens.

Key words: carotenoids, peat substrate, sugar content, vermiculite, zeolite

Reconstructing avalanche history in the Pirin Mountains, Bulgaria by tree-ring analysis of *Pinus peuce* and *Pinus heldreichii* trees

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Abstract

Snow avalanches represent a critical disturbance factor in mountain ecosystems. However, their impact on the endemic *Pinus heldreichii* and *Pinus peuce* forests of Bulgaria's Pirin Mountains remains largely unexplored. These forests, which are among Europe's few remaining old-growth examples with intact natural dynamics, face increasing pressure. The expansion of tourist infrastructure near Bansko ski resort, adjacent to these pristine forests, has amplified tourist activity. This includes backcountry skiing and snowboarding within avalanche-prone areas, potentially exacerbating disturbance regimes.

This study aimed to utilize dendrochronological techniques to investigate avalanche impacts on *Pinus peuce* and *Pinus heldreichii* trees. We sought to identify characteristic damage patterns and tree responses, enabling the reconstruction of past avalanche events and the assessment of their magnitude. Our analysis revealed that large-magnitude avalanches (LMAs) have occurred frequently in the vicinity of Bansko ski resort throughout the 20th century, with recurrence intervals ranging from 9 to 20 years. Forests were also affected although LMAs were less frequent in the last few decades.

Avalanche impacts were evident in tree-ring records, indicating mechanical damage to surviving trees along couloir banks. The most prominent tree-ring responses included abrupt growth suppressions, sometimes with missing rings, followed by reaction wood formation, and less frequently, visible scars and callus tissue. The identified frequency of LMAs underscores the need for prioritized avalanche risk assessment, particularly in the Palashica couloir, which poses a direct threat to ski infrastructure and facilities within Bansko ski resort.

Key words: avalanches, mountain ecology, dendrochronology, Bosnian pine, Macedonian pine.

Acknowledgements

The study was funded by projects KP-06-N31-3/2019 "Avalanche-forest interactions in the Pirin Mountains, Bulgaria and bilateral cooperation Bulgaria-Austria 2022 "Modelling of avalanches in forested and alpine terrain in Bulgaria and Austria - similarities and differences", National Science Fund of Bulgaria

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The amount of mature forests surrounding severely disturbed patches positively affects their recovery in temperate Europe

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Abstract

Forest recovery after disturbances is a crucial process for the continuous provision of ecosystem services, particularly following severe events that result in low potential seed availability, due to seed dispersal limitations. Post-disturbance regeneration, a prominent indicator of recovery, can be affected by both environmental and biotic drivers across various spatial scales (i.e. local site to landscape), yet it is unclear how far the surrounding landscape actually influences local recovery. Utilizing a comprehensive ground-based dataset of post-disturbance tree regeneration from temperate European forests and Landsat-derived products, we investigated the relative influence of recovery drivers at plot, patch, and landscape scale, focusing on local topography, disturbance characteristics, and spatial configuration of mature undisturbed forest, respectively. We applied a novel distance-weighted regression approach to accurately assess the spatial extent and influence of the landscape effect, improving upon traditional buffer methods and enhancing our understanding on recovery drivers at various spatial scales. We found that the landscape effect on recovery extends up to 116 m from the plot centers, with mature forests in the immediate surrounding positively affecting post-disturbance regeneration, likely through increased seed availability. Conversely, plot-scale predictors like disturbance severity and elevation showed a significant negative impact on recovery, suggesting that the amount of biological legacies removed

by disturbances and the harsher climatic conditions at the local scale may hinder regeneration establishment and survival. Patch-scale predictors related to disturbance characteristics showed more ambiguous effects. Our study emphasizes the importance of considering scale-specific drivers of forest recovery and highlights the need for management strategies that integrate both landscape-scale conservation and localized interventions to enhance post-disturbance recovery.

Key words: Post-disturbance regeneration, ground-based inventories, European disturbance map, recovery drivers, landscape effect

Regeneration after two severe wildfires in subalpine forests in Bulgaria

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Abstract

The link between human-caused climate change and the growing threat of wildfires is undeniable. Rising global temperatures are fundamentally altering fire weather patterns, leading to an increase in both the frequency and severity of wildfires in mountain and highland forests. In Bulgaria these forests are typically dominated by Norway spruce (*Picea abies* (L.) Karst.), Scots pine (*Pinus sylvestris* L.), and endemic species such as Macedonian pine (*Pinus peuce* Griseb.) or Bosnian pine (*Pinus heldreichii* Christ), and at higher elevations, dwarf mountain pine (*Pinus mugo* Turra). Understanding the natural processes of development and regeneration, especially after disturbances like fires, is crucial for the sustainable management of these forests.

This study investigates natural regeneration 20 years post-fire at Malyovitsa (2000), Rila mountain, and 10 years post-fire at the "Bistrishko Branishte" reserve on Vitosha Mountain (2012).

In the burnt areas, a dominance of pioneer species such as Goat willow (*Salix caprea* L.), Aspen (*Populus tremula* L.), Rowan (*Sorbus aucuparia* L.) and Silver birch (*Betula pendula* Roth) is observed. Under the protective influence of pioneer species, an increase in Norway spruce saplings was observed; However, their density is significantly dependent on the proximity of surviving mature trees. Nevertheless, natural regeneration, although slow, is successful, being dominated by pioneer species. The weaker regeneration of late-successional species can be explained by limited preliminary regeneration and its dieback after a combination of natural disturbances, as well as the massive development of rosebay willowherb (*Epilobium angustifolium* (L.) Scop.) and species of the genus *Luzula*. The fact that a portion of the dead wood, which is a key substrate for the regeneration of Norway spruce, was burned in the fires also has an impact.

Key words: Norway spruce, disturbance ecology, ecological restoration, Southeastern Europe

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Natural regeneration of post- fire forest areas in Stara Zagora RDF

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Abstract

The rapid and persistent climate change in recent years has amplified the occurrence and spread of various extreme weather events, causing significant socio-economic, ecological, and cultural damage. Forest fires have become a constant threat to human life and a major challenge to the resilience of forest ecosystems and their ability to recover after severe disturbances. The focus is on the topic of forest vegetation regeneration as the first stage of recovery and adaptation.

The study conducted within the FIRE-RES project covers the area of one of the most severe fires near the village of Dabovo, in the region of RDG Stara Zagora. Due to its characteristics, the area faces the constant threat of extreme fires and subsequent disturbances of other kinds. To assess regeneration processes, the established methodology for evaluating regeneration and the development of understory vegetation in forested areas has been applied. For this purpose, three areas with different exposures, i.e., different types of habitats, were selected within the burned area, where three transects were laid, covering all altitudes within the fire zone. The inventory in the survey plots was carried out by tree species, origin, coverage, and height. The results demonstrate significant relationships between post-fire regeneration dynamics and the structural and ecological condition of the landscape following the disturbance.

The real assessment of regeneration after major disturbances allows for the precise determination of appropriate forestry measures and the creation of a landscape resilient to various challenges.

Key words: Forest fires, Recovery, Adaptation, Resilient landscapes

Acknowledgements

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Avalanche hazard mapping using the avalanche terrain exposure scale (ATES) in Pirin Mountain, Bulgaria

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Abstract

Avalanches are frequent in the Bansko ski resort area of the Pirin Mountains, significantly impacting both the natural dynamics of forests and tourism. The region attracts a large number of visitors, many of whom are insufficiently informed about the avalanche risk. For this reason, developing a model of avalanche-prone areas is of critical importance. This study defines avalanche terrain using the Avalanche Terrain Exposure Scale (ATES) model. The ATES model classifies regions into categories based on terrain characteristics and vegetation - simple, challenging, complex, and extreme. The input data required for the analysis includes a Digital Terrain Model (DTM) and forest percent canopy cover. Based on these, morphometric terrain variables were calculated within a GIS environment to identify potential avalanche release areas (PRA). They were then used as input into the specialized software FlowPy to model potential avalanche paths. Finally, machine learning algorithms were used to combine all the information into the final ATES map. Particular attention was given to examining the protective function of forests, with a detailed analysis of the extent of risk zones both with and without this parameter. Our results indicate that avalanche-prone terrain would cover significantly larger areas in the absence of dense forest, whereas the current forested landscape restricts avalanche hazards primarily to areas with sparse tree cover or clearings. The analysis reveals that large parts of the upper sections of the slopes are characterized by complex terrain on the ATES scale, offering minimal opportunities for safer route selection. There are also several pockets of extreme terrain, representing very steep sections with cliffs and vertical drops. A significant portion of the lower sections of the Bunderitsa Valley is classified as challenging terrain, periodically subject to being affected by large avalanches coming from above. The simple terrain class is more limited, mainly within dense forests or flat regions far away from steep slopes. The results and methodology presented in this study can be utilized for developing avalanche risk management plans in Pirin National Park. The generated avalanche hazard models can also assist winter visitors in planning safer routes when travelling through the mountains.

Key words: avalanche-prone areas, Avalanche Terrain Exposure Scale (ATES), FlowPy, forest protective effect, Pirin Mountains

Acknowledgements

The study was carried out in the framework of project “Modelling of avalanches in forested and alpine terrain in Bulgaria and Austria - similarities and differences” funded by the National Science Fund of Bulgaria (Project KP-06-Austria/4/2023)

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Remote Sensing for Wildland Fuel Mapping: Review of Technology, Classification Methods and Applications

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Abstract

Wildfires are a key natural or human induced disaster with complex negative consequences – loss of resources, biodiversity, threat of human life and economic damages. When assessing the risk of wildfires the three main components should be considered - hazard, exposure and vulnerability. No successful risk management decisions are possible without knowing the real situation related with the fire hazard – what is the current fuel and its characteristics on the ground, the type of orographic characteristics and meteorological conditions. The last two fire hazard components are easily accessible – advances in digital elevation mapping and meteorological forecasts could provide timely and precise information. On the other hand, classification and mapping of fuel in wildland with its current characteristics, especially on large scale, is still subject to testing and applying new technologies and models. Wildland fuels have specific spatial distribution – horizontal and vertical. Horizontal distribution is related with the fuel continuity and connectivity of different fuel materials. The vertical distribution of fuels describes what is the type of ground, surface, ladder and aerial fuels. Fuel maps are used not only in assessing fire hazard, but are an essential source of information in fire spread models. Here information on specific fuel characteristics, such as vegetation species, tree height, biomass, canopy base height, canopy bulk density which have impact on fire behaviour is needed. The paper review the current status of research done for large scale mapping of wildland fuels with remote sensing data. The advances in passive (e.g., optical, infrared) and active (e.g., LiDAR, radar) remote sensing systems, together with the possibilities to use hyperspectral imagery and multi-temporal data analysis offers huge possibilities in mapping specific fuel characteristics. The open access of data, together with cloud infrastructure possibilities are essential. Processing of big data with methodologies, ranging from supervised and unsupervised machine learning algorithms to object-based image analysis (OBIA) and spectral unmixing techniques with more recent approaches - deep learning techniques - such as convolutional neural networks (CNNs) are discussed. The paper reviews the use of high-quality datasets and cloud infrastructure enabling scalable data processing, model training, and real-time analysis, and improving the accuracy of wildland fuel classification and fire behavior prediction.

Key words: Wildfires, Fuel Map, Fuel Classification, Remote Sensing, Fire Risk

Multicriteria analysis and GIS modelling for effective forest management to minimize risk from forest fires in Stara Zagora RDF

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Abstract

Forest fires in Bulgaria cause significant economic damages every year. On average, over the past 15 years, the loss of timber amounts to approximately 2 million BGN per year. When viewed from the perspective of risks to human health, biodiversity, infrastructure, cultural heritage, flood protection, etc., the risk of increased size and intensity of forest fires in Europe and Bulgaria is recognized as a leading challenge for forest management. In forest fire risk management, the main focus is on prevention, as once fires occur, response and recovery activities require significant resources. Additionally, the specific condition of some coniferous plantations and coppice oak forests in the country, combined with environmental changes and resulting ecological consequences, require objective, multi-factorial, and aggregated information about the state of forests and forest landscapes. Reducing the risk of forest fires at the national level is associated with improving the allocation of efforts and resources. These should be directed both towards the most fire-vulnerable areas and towards those where such an event would cause significant damage to various types of assets. As part of the FIRE RES project under the EU Horizon 2020 program, a methodology has been developed for prioritizing management zones in forest landscapes to prevent large forest fires, protect areas with high asset value, and optimize firefighting activities. The methodology has been piloted in the RDF Stara Zagora region. The methodological approach is a multi-criteria model using hierarchically grouped indicators related to the type and condition of fuel in forests, the vulnerability and exposure of assets, as well as long-term changes – climatic and infrastructural. A GIS model has been created for the objective assessment of hazard and the risk of occurrence and spread of large forest fires. The system has multi-functional potential, with its primary goal being to highlight high-risk areas and support forest managers in identifying the need for appropriate and necessary forest interventions.

Key words: Multicriteria analysis, GIS model, Forest fires, Forest management

Acknowledgements

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A methodology to estimate forest fire burned area and burn severity degrees using Sentinel-2 data

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Abstract

A study has been conducted to identify burned areas in the region of the village of Otets Paisievo in the Plovdiv District, Bulgaria. The research aims at locating the burned areas and determining the degree of damage caused by a wildfire which occurred in the summer of 2024. Remote sensing and GIS methods were applied for the study. Various spectral indices (NDVI, MIRBI, NBR, NBR2, RBR, BAI, BAIS2) were generated using data from the Sentinel-2 satellite. The separability index (SI) was calculated, which showed the highest values for dMIRBI, dNBR2, dNBR and dBAIS2. Based on these four differential index differences, the burn area was determined and compared with data from the European Forest Fire Information System (EFFIS) and the local forestry sector. The results demonstrated a strong correlation with the actual burned area. Based on the analysis of spectral index values and the corresponding histograms, the study area was classified into four burn severity categories: unchanged, low, moderate, and high. The research indicates that for the surveyed area, indices based on red-edge, shortwave infrared (SWIR), and longwave infrared (LWIR) bands are effective in detecting and delineating forest fire burned areas. Future research work could expand the scope of the study, including additional objects and expanding the study area (for example, to other parts of Bulgaria).

Key words: forest fire, Sentinel-2, spectral indexes, separability index, burn area mapping

Study on the spatial relationships between photovoltaic power plants and wildland fires in Bulgaria

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Abstract

Wildland fires are the most common disasters that occur in Bulgaria. Regardless of their source (microclimatic changes, industrial accidents or human error), their study and the implementation of constant and targeted preventive actions are mandatory. Quite naturally, the focus is placed on fires in forest and agricultural areas. The most sensitive are the territories where the prerequisites for high fire hazard of environmental components coincide with human activity. In connection with the latter, more and more territories are occupied by photovoltaic power plants. The rapid development of the sector continues, the interest of investors is evident. Photovoltaic power plants are being built throughout the country, with different characteristics of the terrain and land use, and the area occupied varies from 0.01 to over 5 km^2. Could photovoltaic installations create the prerequisites for the occurrence of fires or help them spread? In this study, the authors investigate the spatial relationship between wildland fire incidents and their proximity to the existing photovoltaic power plants. The main question the authors seek to answer is whether there is an increase in fire incidents near photovoltaic power plants. The challenges in the study are in several areas. The first is the exact localization of the photovoltaic parks in Bulgaria. Despite the existence of a public register of installations for the production of electricity from renewable energy sources, the exact location and a comprehensive list of all facilities are missing. For this purpose, a specially created algorithm for recognition from satellite images was used. The obtained data was supplemented with data in the public register in order to identify the start of operation of each installation. Regarding fire incidents, the localization of the events was performed and information about their start date was added. For this purpose, a set of different spatial data based on satellite image processing was used. The analysis also presents statistical analyses of the spatial location of photovoltaic power plants and characteristics of the territory they occupy. The study covers the entire country, and the studied photovoltaic power plants are those with an installed capacity greater than 100 kW. The time frame of the study is between 2000–2024.

Key words: photovoltaic power plants, wildland fires, satellite images, GIS analysis

Acknowledgement

This work has been granted funding from the National Scientific fund program with grant number: КП-06-КОСТ/23.

Influence of European mistletoe (*Viscum album* L.) on the defoliation of the crowns of *Populus* host trees

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Abstract

The aim of this study is to investigate the relationship between the quantitative participation of European mistletoe (*Viscum album* subsp. *album*), the diameter of the stems and the degree of defoliation of the crowns of host trees from genus *Populus*. The study was conducted in the period July-August, 2024 in dune complexes of the city of Nessebar (South Black sea coast). Within the studied territory with an approximate area of about 1212 km^2, measurements were carried out on 1158 individuals of *Populus x canadensis* Moench. The study in the plantations of Canadian (Euro-american) poplar confirms the positive relationship established in other broadleaf and coniferous tree species between the number of individuals of European mistletoe on a host and its diameter, and the degree of defoliation of the crown. At this stage, the infestation with mistletoe in the studied area cannot directly cause complete defoliation and drying of its hosts, but it can enhance the impact of other factors (abiotic and biotic), which lead to their death. With the help of the presented in this analysis “Decision Tree” algorithm, up-to-date models for the specific region can be developed, predicting the degree of defoliation (and respectively the related changes in the health status of infested poplars) based on data on the diameter of the host stem and the quantitative participation of European mistletoe.

Key words: plant parasitism, poplars, forest health, dunes

Assessment of ice-storm disturbances in forests using the Normalized Difference Vegetation Index

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Abstract

Periodic natural disturbances are part of forest dynamics, but when their scale is large, they pose a serious challenge to forest management. The present study proposes a simplified method for remote assessment of ice storm damage affecting the Western Stara Planina Mountains in the winter of 2021. The evaluation is based on the Normalized Difference Vegetation Index subtractions after and before the disturbance. Freely available images from Copernicus satellites were used. The results show the remote assessment coincides with the field-described damage established with heavy and prolonged terrain walks. The method's main advantage over present practices is that it classifies the damage by degree and allows prioritizing activities in the stands at higher risk for secondary disasters.

Key words: forest disturbances, remote sensing assessment, NDVI

Acknowledgements
The present study was supported by grant No NIS-B-1292 'Evaluating the damage and recovery rate of forests impacted by ice storm in the TEFR 'Petrohan' through remote methods', University of Forestry, Sofia.

Monitoring of xylophagous insects in forests, affected by fires in Southwestern Bulgaria

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Abstract

Wildfires as well as other abiotic damage – ice breakage, wind breakage, frost and flooding – are among the most important factors that have a negative impact on the composition and structure of forest ecosystems. In contrast to other types of damage, they have a complex and irreparable negative impact not only on forest tree vegetation, but also on forest ecosystems as a whole, ground cover, microflora and wildlife.

The ecological and population characteristics of xylophagous insects are the reason why the effects of fires are felt long after the event itself, not only in the affected area but also in all neighboring stands.

To achieve the project objectives, field studies were conducted to determine and assess the amount and characteristics of deadwood and trees and the loss of ecosystem services of fire-affected forests. Assess the health status of fire-affected forests and adjacent stands by applying ground-based forest ecosystem monitoring methods. Determination of species composition and population density of xylophages using classical entomological methods. Use of control trees (hunting trees) to monitor the flight and abundance of bark beetles in spring and summer. Monitoring the flight dynamics and sex ratio of the most aggressive bark beetle species using "WitaTrap" slit traps (traps) "in combination with dispensers with pheromone attractants. Investigations of the bark beetle-parasitoid complex by placing the collected biological material (eggs, larvae and adult xylophages and plant samples) in photoelectric boxes, climatic incubators for breeding insects. The imaginal parasitoids are separated for identification, and the dead larvae and adult xylophagous insects are placed in a moist chamber (sterile Petri dishes with moist filter paper). The dead individuals are examined for the presence of pathogenic microorganisms.

Remote sensing methods to assess the health status of forest areas affected by fires and adjacent stands include analyzing satellite data to identify forest areas affected by fires and examining stands using unmanned aerial systems. The mapping of the investigated areas is carried out using technical means and methods of Geographic Information Systems.

All data from the applied remote sensing methods were verified in the field and the health status of fire-affected forest areas and adjacent stands was assessed.

Key words: xylophagous insects, wildfires, ecosystem services, remote sensing, Southwestern Bulgaria

Acknowledgements

The study was supported by the Scientific Research Fund, Ministry of Education and Science of the Republic of Bulgaria, under the project "Monitoring xylophagous insects in fire-damaged forests in southwestern Bulgaria" (Agreement with the Scientific Research Fund KP-06-M86/2 of 09.12.2024).

Assessment of ice-storm disturbance in forests by remote sensing

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Abstract

The study aims to compare the applicability of three vegetation indices based on satellite imagery in assessing damage from large-scale forest disturbance caused by an ice storm in the Western Stara Planina Mts. The rate of damages was assessed using the relative differences in the Normalized Difference Vegetation Index (NDVI), Plant Phenology Index (PPI), and Leaf Area Index (LAI) between August 2020 and August 2021. The results showed that NDVI is less sensitive for canopy changes in complex phytocoenosis such as forests. Due to the forest's understory phenology, PPI has a low relation with canopy destruction and indexes false positive changes between 2020 and 2021. LAI reduction was closely related to terrain assessment results, but there was still an index increase in stands with high damage values established during field assessments. A significant challenge in forest disturbance damage analysis based on changes in vegetation indices remains the objectivity of the field assessments used as a control for comparing the applicability of indices.

Key words: Leaf Area Index, Normalized Difference Vegetation Index, Plant Phenology Index

Acknowledgements

This research was supported by LTER-BG (Agreement No TO1-320/30.11.2023) and the project NIS-B-1292/2023.

Snow Avalanche Activity in the Sinaia Ski Area, Bucegi Mountains, Romanian Carpathians

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Abstract

Avalanches represent the most significant natural hazard in mountain regions worldwide, causing damage to road infrastructure, tourism, forests, power lines, and recreational areas while also resulting in human casualties. The aim of this study is to assess avalanche activity using a dendrogeomorphological approach in the Bucegi Mountains, Romanian Carpathians. The primary methodology used was dendrogeomorphology combined with GIS techniques. The objective of the study was to evaluate avalanche activity in the Sinaia ski area of the Bucegi Mountains, focusing particularly on the return period, correlated with other relatively recent studies conducted in the same region. We collected samples from three stands, coded as follows: 41 *Picea abies* in stand T2, 41 *Picea abies* in stand C2, and 54 *Larix decidua* in stand F1. Trees affected by avalanches record disturbances in their annual growth rings, such as scars, rows of traumatic resin, sudden suppression of wood growth, or abrupt growth suppression. We obtained valuable spatial and temporal information on avalanche activity using the avalanche activity index as well as the return period. In total, 68 growth disturbances were recorded in stand T2, 80 in stand C2, and 85 in stand F1. In stand T2, seven events were recorded over a period of 36 years, four events in stand C2 over 40 years, and eight events in stand F1 over 54 years. By analyzing frequency and return period, we calculated the following average return period values: 12.2 years for stand T2, 14 years for stand C2, and 16.9 years for stand F1. We consider that our results complement previous studies conducted in the same area but in different stands and provide an overview of avalanche activity in the Sinaia ski domain.

Key words: snow avalanches, dendrogeomorphologic return period, Bucegi Mountains, Romanian Carpathians Thematic field: Climate Change and Forests

Intelligent technologies for ultra-early detection and prevention of forest fires

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Abstract

Forest fires represent one of the most serious environmental and economic threats in Bulgaria, leading to the loss of significant forest areas, biodiversity and negative consequences for soil and air. The analysis of fire activity in the forest territories of the TP DGS “Hisar” for the period 2016-2023 reveals the increasing frequency and scale of fires, with human activity remaining the main factor for their occurrence - negligence, deliberate arsons and agricultural practices. Climate change, characterized by increased temperatures and droughts, further increases the risk of fires. The study covers the natural and production conditions in forestry, the impact of forestry activities on fire activity and the assessment of the effectiveness of existing fire prevention measures. On this basis, a concept for the implementation of a system for ultra-early detection of forest fires has been prepared. This system combines IoT-based temperature, humidity and smoke sensors, automated drone platforms and machine learning algorithms for prediction and detection of potential outbreaks. Such a system is expected to improve monitoring of forest areas, reduce response time to fire, and limit damage to ecosystems. The implementation of ultra-early detection systems can be a key step in increasing the resilience of forest ecosystems to fires and reducing their negative impact.

Key words: forest fires, prevention, ultra-early detection, IoT, artificial intelligence

Long-term biomass dynamics in temperate old-growth forests of Slovenia

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Abstract

Although it is widely known that old-growth temperate forests store large amounts of biomass, less is known about the stability of this biomass pool over decadal time scales. A long-held view is that once in an old-growth stage, stand-scale biomass should be stable over longer time scales. An alternative view holds that periodic intermediate severity disturbances result in non-equilibrial biomass dynamics. However, there are few multi-decade studies of biomass dynamics in old-growth temperate forests, particularly in Europe, where such conditions are rare. We take advantage of a network of permanent plots in old-growth remnants of Slovenia to assess these different conceptual models of long-term biomass dynamics. The study sites are dominated by mixtures of *Fagus sylvatica* and *Abies alba*, with permanent plots established around 1980 and censused multiple times through 2024. Several of the old-growth forests were damaged by intermediate disturbances during the past few decades, and some also experienced a strong decline of A. alba populations, providing opportunities to examine how these disturbance processes influence long-term biomass dynamics. Preliminary results suggest that biomass is strongly dependent on disturbance at plot scales, with periods of decline and recovery, while plots lacking intermediate disturbance exhibit more stable biomass dynamics. These results will be discussed in the context of ongoing climate change and debates about protection of old-growth forests in Europe.

Key words: beech-fir, biomass, carbon, disturbance, old-growth

Combining Aerial and Terrestrial Methods to Assess Regeneration Success in Mountain Forest Stands

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Abstract

The present project explores how aerial LiDAR data and terrestrial surveys can be combined to assess key forest regeneration parameters in complex mountain environments. The aim is to develop and test methods for detecting individual regeneration trees and tree groups, mapping their spatial distribution, and estimating canopy cover.

Three study sites with artificially and naturally regenerated plants were selected: a structured plantation with *Abies bornmuelleriana* and *Cedrus libani*, and two forest stands dominated by *Picea abies* and *Abies alba* in the Swiss Alps. In total, over 1,000 regeneration plants were recorded in the field, including tree height, crown dimensions, spatial position, and accompanying ground vegetation. A RIEGL miniVUX-2UAV drone was used to acquire LiDAR data and produce high-resolution vegetation height models.

At the plantation site, detection rates were promising: up to 82% of trees were identified within a 50 cm radius of their field position. Tree height estimates derived from LiDAR deviated by approximately 30 cm from field measurements. In contrast, detection rates in natural stands were significantly lower (around 24%), mainly due to canopy cover from adult trees, irregular stand structures, and dense ground vegetation. Nevertheless, the spatial distribution of regeneration trees, including groupings, could be effectively modeled.

Regeneration cover estimates from LiDAR corresponded reasonably well with field data, particularly under leaf-off conditions. However, both over- and underestimations were observed, resulting from the misclassification of shrubs, stumps, and other non-tree elements, as well as occlusion effects beneath the canopy.

In summary, LiDAR performs reliably in structured plantation settings but currently faces limitations in heterogeneous, naturally regenerated forests. Still, the integration of aerial and terrestrial data holds considerable potential for advancing regeneration monitoring. Ongoing research will aim to improve detection algorithms and adapt the approach for use in more diverse forest types.

Key words: Forest regeneration, LiDAR data, vegetation height models, detection algorithms, plant position

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Forest monitoring by the means of aerial and terrestrial laser-scanning

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Abstract

Airborne LIDAR is a perfect method for mapping forest areas in a high resolution, showing single trees, tree heights, tree crown volumes, lying dead wood and natural regeneration below the canopy. Stock volume can be derived accurately. Terrestrial LIDAR is the perfect supplement to forest inventory fieldwork when it comes to enhance accuracy, repeatability and cost-efficiency. Inventory design based on a combination of airborne and terrestrial LIDAR allows the calibration of wall-to-wall single tree models. The presentation summarizes the experience of 15 years of operational forest inventory and forest management planning experiences based on airborne and terrestrial LIDAR data.

Key words: forest inventory, aerial LIDAR, terrestrial LIDAR, forest mapping, forest management planning

A state-space model for even-aged forest stands in Bulgaria: a pilot study of Scots pine (*Pinus sylvestris* L.) plantations

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Abstract

Although the empirical growth models are often regarded as inadequate under the changing environment, certain methodological approaches, such as the state-space modelling, can actually accommodate the dynamics of environmental conditions, including climate change, and therefore are capable of reflecting the outcomes of variable conditions on natural and management-driven forest dynamics. Considering the state-of-the-art of forest inventory in Bulgaria, the objective of this study is to derive a parsimonious and biologically sound whole-stand dynamic growth model for even-aged forest stands and to examine it with longitudinal data from permanent sample plots in Scots pine plantations. The state-space approach was employed and the model consists of a three-dimensional state vector, defined by dominant stand height, basal area per hectare and quadratic mean diameter, and three transition functions. A site index model, based on the function by Gompertz and fitted in a generalized algebraic difference equation form, was incorporated for height growth projection. It can be applied in a purely phytocentric form as well as expanded with environmental predictors and not only accounts for the changing environmental conditions, but also reflects the population-specific rate of increase in height, related to the genetic background of the trees and the management practice applied. The second transition function projects growth of stand basal area with respect to age, while the third transition function estimates mean diameter growth with respect to dominant stand height increase. The model structure was adapted to use the information of stand age, mean stand height and diameter and total volume, available from the forest inventory descriptions, to derive the values of the stand state variables by two initialization functions. The state-space model was approximated with data from permanent sample plots in Scots pine plantations at 38 locations in Bulgaria, where measurements have been collected two to six times. Model consistency was validated in terms of three application pathways – prediction, projection and thinning simulation. Model incorporation into a computer program (simulator) and dissemination for practical implementation is envisaged.

Key words: whole-stand growth model, longitudinal data, climate-sensitive model, transition functions, state vector

Acknowledgements
This research is financially supported by the Bulgarian National Science Fund under the project "Adaptive management of forest stands under climate change: a pilot study of Scots pine (*Pinus sylvestris* L.) plantations" (Grant Agreement KP-06-N51/1, 2021).

Study of the current volume increment of high-stemmed beech stands on the territory of „Petrohan“ Training and Experimental Forest Range

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Abstract

The aim of this study is to determine the current volume increment of high-stemmed beech stands on the territory of Petrohan Training and Experimental Forest Range at elevations ranging from 1400 to 1600 meters above sea level. Permanent and temporary sample plots were used in pure, simple, relatively even-aged stands. The trees were measured by callipering in the sample plots, and several heights of each diameter class were measured to establish the volume using tables for height class and volume. Increment cores from trees of varying diameter classes were taken by using a Pressler increment borer to measure the current radial increment over the last ten years. The width of annual rings was measured using CooRecorder software. The current volume increment was established by two methods. The first method is based on the difference between the volume measured at the time of the study and the volume ten years ago. The second method uses Gerhardt's formulas which employ the volume from growth tables for the tree species and the relative stocking of each sample plot. A comparison was made between the volume increments obtained by the two methods.

Key words: beech stands, height-diameter curves, growing stock, increment cores, current volume increment

The shapes of diameter distributions on small-spatial scales up to one hectare from selected Polish and Bosnian old-growth forests

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Abstract

Forest management in Europe has throughout history been primarily focused on timber production. However, from the onset of 21st century, especially with the development of communication technologies, the new societal demands for better preservation of forest ecosystems and overall biodiversity have motivated forest researchers to more intensively study old-growth forests as their structural elements are often missing in the landscape. The interest in these forests has not been amplified only due to failure to preserve their structural attributes to a larger degree in managed forests, but also for the reason that they are, at least in the broad alpine (montane) belt in Europe, found to be highly resistant and resilient towards severe disturbances. In this research we studied spatial changes of tree diameter distribution shapes on relatively large sample plots of 1.44 ha from six old-growth forests in Poland, three old-growth forests and three selection-managed forests in Bosnia. We analyzed how these distributions developed by gradually increasing small spatial scales from 0.04 ha to 1.0 ha. The frequencies of different distributions shapes were compared among old-growth forests in different regions. This comparison was also conducted between old-growth and neighboring selection-managed forests in Bosnia. The results from old-growth forests were further compared and discussed in regard to widely adopted theory from 20th century that assumes the existence of even-aged and\or even-sized patches with simultaneous scarcity of steady state (negative-exponential classical selection structure) on small-scale patches in nature, and to newer studies that contradicted this assumption but have not been yet widely accepted in the forestry practice. In our opinion, further evidence is needed to solve this issue of contrasting assumptions.

Key words: old-growth forests, small-scale structure, shapes of diameter distributions, selection-managed forests

Acknowledgements
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Forestry activities as a tool to overcome growth depression rate in spruce forests: tree-ring study from Rila and Western Rhodopes mountains, Bulgaria

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Abstract

One of the main tree species in Bulgarian forests is the Norway spruce (*Picea abies* (L.) Karst.), which forms monodominant and mixed stands in the mountains at elevations between 1400 and 2200 m a.s.l. The species is highly important both for its ecological role in high mountains and its valuable timber for the forestry and wood processing sectors in the country. However, increasing number of publications in Europe and Bulgaria acknowledge the fact that, since end of 1980s, Norway spruce forests experience a permanent growth depression, characterized by a minimum annual growth in diameter, which retains low values for decades. One reason could be the increase in the average annual air temperatures, which brings a corresponding reaction of the forest communities globally. This study is focused on Norway spruce forests' response to forestry activities, mainly cuttings, and the outcome of it. To achieve this goal, the dendrochronology method was used, which allows the reaction of the spruce individuals to be studied through an analysis of annual rings. The study was carried out in monodominant spruce forests growing in Western Rhodopes and Rila mountains. Core samples for dendrochronological analysis were taken from spruce stands experiencing a permanent growth depression, which were divided into two groups – subjected to cuttings in last decades and reference stands, where no cuttings have been performed. By applying a multiple regression, the influence of temperature and precipitation on the course of annual growth in the studied spruce forests was studied. A positive reaction of the Norway spruce stands after performed cuttings was observed to overcome the growth depression, expressed by a permanent increase in the width of the annual rings since the next vegetation period, following the cut year. A positive correlation of spruce forests' growth with precipitation in summer was also found.

Key words: Norway spruce (*Picea abies* (L.) Karst.), growth depression, forestry activities, dendrochronological analysis

Acknowledgements
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Local community perceptions on ecosystem services utilization – implications for sustainable management of Kakamega forest in Kenya

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Abstract

Forests play a vital role in sustaining the livelihoods of local communities, offering a range of important resources and services. Forest ecosystems provide more than just wood products – they are central to the cultural, economic, and social well-being of many communities worldwide. This is also the case of Kenyan Kakamega tropical rainforest where the participatory forest management face population pressures that impact the provision of ecosystem services (ES). However, the extent to which these ES flows affect local communities remains unclear. This study aimed to examine the relationship between forest ES and the local forest community using a mixed-methods approach. This approach combined qualitative data from key informant interviews and focus group discussions and quantitative data from a survey of 453 households. Analysis was conducted using Kruskal-Wallis Test and ANOVA. The study identified 20 acknowledged ES, firewood being the most critical ES (86%). While provisioning ES are used mostly domestically, significant differences were identified across wealth groups in both domestic and commercial use. Furthermore, there were significant differences across wealth groups in terms of perceived importance of firewood, grazing grass, environmental education and water. Poorer households exhibited lower ES usage, highlighting challenges related to forest access through Community Forest Associations. Additionally, significant differences were observed in their perceptions of land uses supporting ES, indicating either differentiated knowledge or disparities to resource access, decision-making and education. These findings underscore the need to integrate diverse community perspectives across wealth groups to inform researchers and policymakers in developing equitable, inclusive strategies that promote sustainable livelihoods.

Key words: Human well-being, land use supporting ecosystem services, participatory forest management, wealth groups, domestic use, commercial use

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Assessing soil organic carbon stock changes following land use conversions in Bulgaria: A nationwide analysis

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Abstract

Soils are important for sustaining life, as they provide essential nutrients, retain water, and support microbial activity necessary for plant growth. They also play a key role in decomposition, nutrient cycling, and carbon sequestration processes. Soil represents a major carbon pool in natural and semi-natural ecosystems and significantly impacts the overall ecosystems' greenhouse gas emissions balance. It is widely accepted that under specific climatic and management conditions, soil carbon content can reach an equilibrium. However, changes in land use are known to alter the carbon dynamics in terrestrial ecosystems. Thus, the potential for carbon sequestration and storage in soils varies significantly among different land use types and depends on the distribution of soil types, land use, management practices and environmental conditions. The current study aimed to derive nationwide soil organic carbon stock change factors due to land use conversions between the main land use types – forest land, arable lands, grasslands, wetlands and settlements – to be used in assessing the contribution of soil carbon pool to climate regulating services due to land use changes. The analysis is based on long-term monitoring data, proposing a methodological approach based on a detailed stratification of the country, capturing the different soil types and climatic conditions that occur under different land uses. Besides the use of data form Soil Monitoring Programme (16x16 km grid), the analysis relies also on detailed information on soil type distribution in Bulgaria according to the Soil Map of the country (1:400 000) and land cover data from Land Parcel Identification System (LPIS). The results of the analysis show that there is a loss of carbon from the soil pool for all land use conversions to settlements, as well as for conversions from shrubs and grassland to other land use types. Land use changes from arable land to forest, pasture, shrub and grassland lead to carbon accumulation in the soil pool. The quantitative results of the study are summarized as carbon stock changes in tons per hectare and presented as a matrix showing the associated carbon gains or losses between possible land use conversions.

Key words: land use change, soil organic carbon, carbon stock change factors

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Cultural ecosystem services of protected parks of Ukraine during the war

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Abstract

Human society depends on the benefits provided by nature, such as food, clean water, clean air, climate regulation, flood prevention and recreation. Currently, war continues in Ukraine, which has already caused profound economic and social transformations. Some cities and green spaces have been destroyed, as a result of which the ecological situation is deteriorating, and cultural ecosystem services are decreasing. At the same time, rapid urbanization is causing conflicts between blue-green spaces and other urban infrastructure. Such changes force the remaining cities of Ukraine to improve the quality of the environment through urban green spaces and solve the problem of satisfying the aspirations of residents. Improving green infrastructure is possible by harmonizing human activities with the natural environment, which will increase opportunities for the socio-economic development of local communities. In addition, access to blue-green spaces with the provision of cultural ecosystem services, especially during a full-scale invasion, can improve the mental and physical health of urban residents.

The aim of the study was to identify the importance and effectiveness of eight cultural ecosystem services (aesthetics, recreation, awareness of nature, social relations, cultural heritage, inspiration, sense of place, spiritual or religious enrichment) during the war for visitors to six protected parks in four regions of Ukraine (Volyn, Rivne, Zhytomyr, Kyiv). The following methods were used in the study: field (route), analytical, systematization, sociological, statistical; the Likert psychometric scale was used to survey visitors to protected parks. The data were analyzed using descriptive statistics.

The study of the importance and effectiveness of cultural ecosystem services in protected parks in Ukraine showed that the war affected park visitors. In all parks, female respondents prevailed, their participation ranged from 52.8% to 69.0%. In the four regions, visitors to the six parks were predominantly young people aged 16-30 (from 23.6% to 77.5%) and people aged 51-64 (15.8-31.4%). During the war, visitors to all the parks studied noted the importance and satisfaction in wartime of cultural ecosystem services, such as recreation, aesthetics, and awareness of nature. The greatest need for such services was among young people aged 16-30 and people aged 51-64. The effectiveness and importance of such a service as inspiration was confirmed. Spiritual enrichment is the lowest for all age groups in the four parks. Almost a third of visitors to the five parks provided suggestions for improving the quality of the environment, with the greatest need for improving the landscape and increasing the number of trees. The quality of plantings and the location of the parks influenced the overall satisfaction of visitors.

The research results can be used to improve the quality of cultural ecosystem services of the studied parks, as well as in the creation or reconstruction of urban and rural parks in various regions of Ukraine in the post-war period, to create a comfortable park environment and improve the quality of cultural ecosystem services, taking into account the needs of different users.

Key words: ecosystem services, aesthetics, recreation, knowledge of nature, social relations, cultural heritage, inspiration, sense of place, spiritual or religious enrichment.

Soils' carbon and nitrogen stocks after thinning activities in spruce plantations

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Abstract

Forestry thinning is a management practice designed to enhance tree growth, stand stability, and biodiversity, but it also significantly affects the soil properties. Previous studies indicate that the impact of thinning on soil varies depending on factors such as thinning intensity, climate, and soil type. In Bulgaria, research on the effects of thinning on soil properties has mostly been conducted in localized cases. Logging, especially at varying intensities, alters the microclimate beneath the canopy, affecting temperature and humidity at the forest floor and soil level, which in turn influences soil processes. In Bulgaria, thinning plays an essential role in managing spruce plantations, particularly in the country's mountainous regions, where spruce trees are critical for both timber production and ecological services such as soil conservation and watershed management. Their dense root systems help prevent soil erosion, regulate water flows, and contribute to groundwater recharge. Depending on the intensity, thinning in spruce plantations can increase the risk of wind damage, due to their shallow root systems, if the forest canopy is opened too widely. Thinning can also lead to a loss of organic material in the forest floor if large amounts of biomass are removed, potentially leading to nutrient depletion in the soil. Considering the importance of the spruce plantations, in this study we focused on gaining a more comprehensive understanding of how thinning affects the accumulation of organic carbon and nitrogen in their soils. For this study, soil samples were collected from six Forestry Enterprises located on the northern slopes of the central Balkan Mountains. In each enterprise, samples were taken from three types of plots: Control, Thinned 1, and Thinned 2, with varying thinning intensities. Soil was analyzed in layers ranging from 10 cm to 30 cm in depth. The study focused on key soil characteristics related to carbon and nitrogen stocks, including bulk density, rock content, and carbon levels. The findings suggest that thinning practices conducted at low intensity, with attention to habitat preservation, result in no significant changes in soil carbon content. These insights emphasize the importance of proactive management strategies to monitor and guide thinning activities in Bulgarian forests, with a special focus on soil carbon and nitrogen stocks. By anticipating natural processes and adjusting thinning practices accordingly, it is possible to utilize the accumulated biomass without causing ecological disruptions.

Key words: soil carbon, nitrogen stocks, coniferous, forestry activities.

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Forest transformation as a tool of adaptation to climate change

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Abstract

The forestry sector plays an important role in mitigating the effects of climate change through carbon fixation and the substitution of non-renewable energy sources and materials. At the same time, it needs to adapt (adjust) to climate change, which itself requires significant investment. The challenge is to find an optimal balance between the different functions of forests in the context of a changing climate and societal needs. The complexity of forest ecosystems and the identification of the different risks to which they are subjected makes adaptive forest management a difficult task, requiring a holistic approach and bringing together different institutions and stakeholders. One of the many measures outlined in the National Strategy for Adaptation to Climate Change (2020 – 2030) requires sustainable and efficient use of forest resources through the implementation of management strategies based on ecosystem and close to nature management. In Bulgaria, for decades, methods have been applied to transform the coppice stands into high forest. One of the approaches adopted in the 1950s involved a total change in the composition of stands and establishment of thousands of hectares of coniferous plantations predominantly of Scots pine and Black pine. In the face of climate change, these conifer plantations have been characterised over the last 20 years by poor health, reduced productivity and total decay. Continuous cover forestry requires urgent measures and a differentiated approach to the transformation of these stands. This study presents a classification of Scots pine plantation in Southwest Bulgaria according to their ecosystem fit and proposes different management regimes. The transformation of coppice oak stands into high forests is also important. These forests occupy about 47% of the Bulgaria's forest area and are located at low altitudes, where the unfavourable conditions for their growth and development are increasing in the face of climate change. Decades of efforts by generations of foresters have not fully achieved the original objectives. Not only has the proportion of seed oak stands not increased since 1960, it has declined at the expense of an increase in the proportion of coppice (seed and coppice) and conifer plantations. An idea is proposed for classification of the coppice oak stands in Western Bulgaria into three production groups with different management objectives and transformation periods.

Key words: adaptive management, ecosystem fit, coppice oak, Scots pine plantations, Western Bulgaria

Comparison of Four Types of Skidders: Productivity and Costs Analysis

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Abstract

Cable skidders are the most used timber extraction machines in Central and Eastern Europe. Cable skidders and many adapted skidders were used to increase productivity and to reduce labor. This work compared the work cycles, productivity and costs of four types of skidders situated in two similar coniferous stands, in Bulgaria and Italy: a dedicated cable skidder, a dedicated cable-grapple skidder, a dedicated grapple skidder and an adapted skidder. The comparison of delay-free work cycles of the four skidders showed the largest share is occupied by travel loaded. The cable-grapple skidder demonstrates the highest average speed of 5.6 km.h^{-1}, followed by the grapple skidder at 3.97 km.h^{-1}, the cable skidder at 3.79 km.h^{-1}, and the adapted skidder with an average speed of 3.31 km.h^{-1}. The average delay-free productivity of the studied skidders is highest for adapted skidder (17.93 m^3.PMH^{-1}), followed by grapple skidder with a slightly lower rate (17.90 m^3.PMH^{-1}), the cable-grapple skidder (17.25 m^3.PMH^{-1}), and cable skidder (14.53 m^3.PMH^{-1}).

In conclusion, the mean load capacity of the grapple skidder and the cable grapple skidder is less than the maximum load capacity of the machine. This is attributable to the narrow skidding roads and the incompatibility of these skidders with the specific site-selective felling of marked single and small groups of trees. The productivity of the dedicated cable skidder and the adapted cable skidders is comparable.

Key words: forest operations, mechanization, performance, time-motion study

Comparison of Two Options for Long-Distance Road Transport of Roundwood in Mountain Conditions

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Abstract

Long-distance road transport of timber prevails in Europe. Long-distance transport from sites to consumers is very often carried out by trucks and trucks with trailers. It is difficult for a tractor-truck with a semi-trailer to reach the roadside landings in mountain forests with rugged terrain and frequent curves on forest roads. In these cases, trucks and trucks with trailers are the predominant options for transporting assortments to the customer.

To study the last two options for long-distance transport, 30 work cycles (turns) of each were observed in the conditions of the Lesidren State Forest Range, Northwestern Bulgaria. The average duration of the truck's delay-free work cycle was 3.73 h, while that of a truck with a trailer was 5.83 h. The scheduled machine time was 3.91 hours for the truck and 6.07 hours for the truck with a trailer. The average transport distances were 34.23 km and 49.19 km, respectively. The average payload for the truck was 12.90 m^3, and more than twice that, 31.14 m^3, for the truck with a trailer. The average delay-free productivity of the two vehicles was 3.63 $m^3.PMH^{-1}$ for the truck and 6.11 $m^3.PMH^{-1}$ for the truck with trailer, whereas scheduled productivity was 3.45 $m^3.SMH^{-1}$ and 5.84 $m^3.SMH^{-1}$ respectively. The gross costs for the two timber haulage options were 66.12 €.PMH^{-1} and 18.32 €.m^{-3} for the truck and 78.89 €.PMH^{-1} and 13.00 €.m^{-3} for the truck with trailer.

Despite the larger initial investment for acquiring the truck with trailer configuration, its hourly costs are about 30% lower than those of the cheaper truck, making it more cost-effective. The average speed of the truck is 55.34 $km.h^{-1}$, slightly higher than that of the truck with a trailer of 54.13 $km.h^{-1}$. At the work shift level, with sufficient assortments on the roadside landings, the truck can perform 2 work cycles (turns), unlike the truck with a trailer, which can only do one.

Key words: payload volume, transportation distance, forest operations, transportation costs

Wood Supply Chain Traceability with Blockchain Technology

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Abstract

In a context where traceability, transparency and safety of processes and products are increasingly under scrutiny, this study explores the integration of blockchain technology into electronic traceability systems, from standing trees to the final product by creating a decentralized and distributed ledger accessible to all participants in the supply chain. This research also integrates traceability information with product quality data in a secure online platform. This technology in fact uses blockchain to ensure the immutability and transparency of recorded transactions, including all steps from tree felling to the sawmill process, and allowing every actor, from producers to final consumers, to access reliable and verifiable data on the provenance and characteristics of the wood. Furthermore, it reduces the risk of fraud, such as document alteration or material substitution, thus strengthening trust in traceable products. Blockchain also supports sustainability, by enabling precise tracking of forest resources and ensuring that wood comes from responsibly managed sources. This work demonstrates how digital technologies and traceability frameworks can improve transparency, accountability and sustainability in the wood sector, as well as reduce the costs and time associated with manual controls and traditional certifications.

Key words: forest resources, digital technologies, certification, wood quality

Determination of Bearing Loading During Longitudinal Milling of Specimens from Scots Pine and Oak

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Abstract

This study presents how some technological factors influence over bearing loading of the cutting mechanism in a woodworking shaper. The rotation frequency used for the experiments was 6000 min^{-1}. During the experiment scots pine (*Pinus sylvestris*) and oak (*Quercus sp.*) test samples were milled. Measurements were made at four points in the radial direction. Two of them are located in the upper bearing housing and the other two are in the lower bearing housing. A universal milling machine with a lower position of the working shaft is used for the experiment. During the research, attention was paid to some technological factors such as cutting speed, feed speed of the processed material which is from 4 $m.min^{-1}$ to 16 $m.min^{-1}$, milling width 12 mm and thickness of removed layer 4 mm, 8 mm and 12 mm. The study is aimed at improving the reliability and efficiency of a wood shaper machine as well as ensuring to ensure the accuracy and quality of products.

Key words: wood shapers, vibration speed, bearing

Research on the Operational Properties of the FAE SSM/HP 250 Forestry Tiller for Soil Preparation for the Field Protection Forest Belts Establishment

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Abstract

This paper presents results from the experimental study on a FAE SSM/HP 250 forestry tiller, driven by a Fendt 939 Vario tractor with a 265 kW rate power, for soil preparation of open areas for the field protection forest belts establishment in the Dobrudja region in Northeastern Bulgaria. The influence of the mechanical composition and hardness of the soil, the depth of tilling, the speed and frequency of rotation of the tiller on the operational productivity and relative fuel consumption was studied. Experimental observations were conducted in open forest areas, with different mechanical composition and soil hardness. The experimental areas are located on terrains with clay-sandy soils with hardness = 345 kPa, on sandy-clay soils with hardness = 690 kPa and on clay soils with hardness = 2100 kPa.

The obtained results were used to establish mathematical models for determining the operational productivity and fuel consumption of the studied machine per unite area, depending on the rotation frequency of the tiller, the mechanical composition of the soil and the depth of processing. The optimal rotation frequency of the tiller for soil preparation for creating field protection forest belts has been established depending on the mechanical composition of the soil and the depth of cultivation.

Key words: operating performance, relative fuel consumption, rotation speed, processing depth, soil hardness

Comparative Analysis of Typical Transport Technologies for Transporting Small-Sized Wood in Mountainous Area in Bulgaria

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Abstract

Transport and technological development in the transportation of small-sized wood is a key aspect of sustainable forestry, especially in hard-to-reach mountainous areas. This study examines traditional and modern methods of transportation, including the use of animal power and gravity transport (chute systems). The two methods of transporting wood in a typical mountain logging region were analyzed – a chute system and animal power. The results show that the chute system reduces operating costs by 15% compared to animal power, while increasing productivity by up to 20% depending on terrain conditions.

Animal transport, despite low initial costs, demonstrates significantly lower efficiency in transporting wood from the cutting site to temporary storage. On the other hand, gravity transport offers the highest efficiency in steep terrain, but requires specific conditions for optimal functioning, which increases costs. Through the comparative analysis of the technical and economic indicators, optimization strategies have been proposed to improve transport, reduce costs and minimize the ecological footprint of the used transport systems. The conclusions emphasize the importance of modernizing logging technologies to achieve sustainability in forest resource management and increasing economic efficiency.

Key words: transport technology, logging, sustainability, gravity transport, animal power

Comparison of the Technical Productivity of Battery-Powered Chainsaws and Petrol-Powered Chainsaws

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Abstract

The aim of the research is the comparison of two technologies in the production of chainsaws, the petrol-powered chainsaws and the battery-powered chainsaws. The comparison is made between two of the latest chainsaw models produced by Stihl – MS 261 C-M (petrol) and MSA 300 C-O (battery-powered), which are comparable in both terms of size and power. The comparison can be divided in two parts – technical productivity and maximum operating time (maximum sawing time). In the first part of the research, the productivity of the chainsaws is evaluated while sawing wood from five of the most common tree species in Bulgaria – aspen, spruce, scots pine, beech and sessile oak. The technical productivity of the MSA 300 C-O chainsaw is evaluated while using all three power modes. This part of the research is carried out in the "Mechanisation in Forestry" laboratory of the "Technology and Mechanization in Forestry" department in the University of Forestry Sofia. In the second part of the research both maximum operating time and the volume of the processed wood (felling, pruning and cutting to length) are evaluated for one fully charged battery for the MSA 300 C-O and a full tank of fuel mixture (490 ml A95H petrol and 10 ml two-stroke oil) for the MS 261 C-M chainsaw. This part of the research is carried out in a scots pine stand near Maritsa village, Samokov municipality, Bulgaria.

The research shows the stage of development of the technology of battery-powered chainsaws compared to the technology of petrol-powered chainsaws, which are commonly used in forest harvesting in both Bulgaria and around the world. In the same time the compatibility of the battery-powered chainsaws with the processes involved in forest harvesting is proved. After the analysis of the results, the MS 261 C-M petrol-powered chainsaw achieves higher technical productivity with all five tree species with average of 0.0007 $m^2.s^{-1}$ a.k.a. 7 $cm^2.s^{-1}$, while when evaluating the maximum operating time, it achieves higher maximum sawing times with an average of 401 seconds. In terms of the volume of the processed wood the MSA 300 C-O battery-powered chainsaw achieves results with an average of 2.8 m^3 lower during each workday or 1.4 m^3 for each battery compared to the results for one full tank of fuel of the MS 261 C-M chainsaw. In conclusion the MSA 300 C-M battery-powered chainsaw has enough power for the all the processes which are executed in forest harvesting and a battery with a larger capacity can improve its performance even more. At the same time the MS 261 C-M chainsaw achieves good results. After all, besides the slight differences in the results, both chainsaws prove to be highly productive and suitable for work in the forest.

Key words: chainsaws, battery-powered, petrol-powered, productivity, thinnings

Descriptive Analysis of Forestry Competitiveness in Some European Union Member States

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Abstract

The forest territories of the European Union (EU) Member States cover an area of 182 million ha, which is about 5% of the world's forest territories. Forests are one of the most significant renewable resources with proven economic, social and ecological functions. Maintaining these functions is closely related with the forestry competitiveness. Its objective assessment allows adequate management decisions to be made, aimed at increasing the forestry competitiveness and rational use of forest resources. In this regard the aim of these article is to analyse and estimate the competitiveness of forestry at national level in some Europea Union (EU) member states and on this basis to outline opportunities for its increasement. The analysis of forestry competitiveness at national level is based on multidimensional statistical methods – cluster analysis, factor analysis and data envelopment analysis (DEA). Through cluster analysis based on a system of adopted indicators characterizing forestry competitiveness at national level, the forestry of the states are distributed into homogeneous groups (clusters). By applying factor analysis to the system of the adopted indicators an index of national forestry competitiveness is constructed. Through which it is possible to compare and rank the national forestry competitiveness of the countries. The factor analysis is supplemented with DEA. It evaluate the efficiency of use of forest territories, timber stock and total annual growth in relation to the gross value added (GVA) produced in forestry and achieves a comprehensive explanation of the obtained quantitative assessments of the level of competitiveness of the forestry at national level.

Key words: competitiveness, forestry, cluster analysis, factor analysis, data envelopment analysis

Application of GIS Analysis in Forest Management and Inventory of Forest Areas in Bulgaria in the Period 2000-2025

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Abstract

The Strategy for the Development of Forests in the European Union until 2030 requires harmonization of reporting and collection of forest data. An important priority is the building of capacity for scientific research, education and dissemination of the results of data analysis. The article provides a historical overview and comparison between the detailed forest inventory, traditional for Bulgaria, and the European statistical inventory, which is about to be introduced. The paper uses the capabilities of GIS for the analysis of forest databases and the organization of the management of forest areas in Bulgaria for the period 2000-2025. For this purpose, an integrated GIS database has been created with data for the years of inventory of state forest enterprises in Bulgaria during the considered 25-year period. A spatial analysis has been carried out at different administrative levels (Executive Forest Agency, Regional Forest Directorate, State Enterprise and District) for the dynamics of forest management in forest areas in our country. The data include 2 and 3 time horizons, which corresponds to the adopted 10-year data update period. The principles of organization and construction of forest databases for the country have been analyzed using GIS. Conclusions have been formulated for optimization, synchronization with the European standard and implementation of thematic layers of the national forest database. Recommendations have been made for improving the process of organization and automation of the activities in the forest areas of Bulgaria.

Key words: GIS, database, forestry, forest management, forest inventory

Wild cat population density in forest habitats estimated by random encounter model

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Abstract

Estimating abundance and population density is crucial for wildlife conservation. Population density of European Wild Cat (*Felis silvestris* Schreber, 1777) in Bulgaria is poorly known, with maximum density in the beginning of 1990's estimated as 0.84 ind./ 10 km^2, being among the highest densities across its European range. It is a species of conservation interest, included in Appendix II of CITES, in Appendix II of the Berne Convention, in Annex IV of Habitat Directive 92/43/EEC, and in Bulgarian Red list as "critically endangered". Main conservation threats are road mortality, habitat fragmentation, poaching and the interactions with the domestic cat, source of potential hybridization. Wild Cat is an elusive carnivore species with mainly crepuscular or nocturnal activity, low population densities, and preference for dense cover. Hence, population density estimation of the species is a challenge. Camera traps have emerged over the last decade as one of the most powerful tools for wildlife research. We applied two different approaches to estimate Wild Cat population density in Voden – Iri Hisar State Hunting Ranch. The random encounter model (REM) was applied as the main method that eliminates the requirement for individual recognition of animals by modelling the underlying process of contact between animals and cameras. The study area was covered by randomly chosen regular square grid of 56 camera trap stations. The population density was estimated as 0.54 ind./km^2 (± 0.21 SE). The day range was 7.33 km (± 1.81 SE), and the daily activity was estimated to be 10.5 hours (±1.44 SE), mainly nocturnal. The results were consistent with applied spatially explicit capture recapture approach, or spatial mark resight (SMR) model. Subject to unbiased camera placement and accurate measurement of model parameters, this method opens the possibility to obtain reasonably precise estimates with reduced labour costs. It could be widely used in wildlife conservation of elusive carnivore species such as European Wild Cat.

Key words: Wild Cat, *Felis silvestris*, REM, SMR, camera traps

First results from the Common Quail (*Coturnix coturnix*) monitoring in Bulgaria

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Abstract

The Common Quail (C*oturnix coturnix* Linnaeus, 1758) is migratory gallinaceous bird which population in Bulgaria is considered declining. The species is listed in Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). As a Party of the Convention Bulgaria shall take different actions for the conservation of the common quail, including research on its ecology and monitoring of its population. In this paper we present the results of the first 2 years (2023 and 2024) of the National Quail monitoring scheme.

The survey was focused on Common Quail abundance in the lowland of the country in relation to different habitat variables. For this purpose, the number of singing males was recorded during point counts on 14 survey sites in 2023 and 10 sites in 2024. The counts were carried out biweekly from the beginning of May until the end of July on 12–20 representative points per site, so that each point was visited 6 times. Throughout the census period the number of singing males and the habitat variables on each point were recorded during a total of 1106 and 709 point counts in 2023 and 2024, respectively. During the second year of monitoring distance sampling was applied in 4 survey sites where the observer recorded the number of singing males within and beyond 100 m radius around the point.

The abundance index of the Common Quail in 2023 averaged 1.20 ± 1.57 SD (min-max 0-8) singing males per point and was insignificantly higher than the observed in 2024 of 0.92 ± 1.61S D (min-max 0-12) (Kruskal-Wallis chi square = 2.077, p = 0.1495). In the survey sites where distance sampling was used, we estimated a mean density of 5.03 males.km^{-2}. In both years the quail abundance index, as well as the density of breeding males had lower values in May compared to that in June and July. In 2023 there was a continuous increase in the number of singing males per point throughout the entire census period, whereas in the second year of the survey the abundance index decreased after July 15. According to the best-fitting model (with lowest Akaike Information Criterion value) the number of singing males per point was determined by four variables– altitude, temperature, counting date and crop type around the point. The Generalized linear mixed model showed weak negative relationship between the abundance index and the altitude and temperature during observations. The number of singing males per point was significantly higher between June 15 and July 31 and on census points near cereals, fodder and unsown fields. Common Quail conservation in Bulgaria requires further research to better understand the drivers of the species abundance and distribution at different habitat scales.

Key words: point count, habitat variable, abundance index, census

Application of locally manufactured GPS tracking technology in wildlife reintroduction in Serbia

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Abstract

In Serbia, many game and threatened species currently exhibit low population abundance and fragmented distributions, prompting state authorities and expert bodies to initiate species reintroduction programs. The conservation translocation of species to habitats from which they have been disappeared is a complex process that depends heavily on careful planning and effective monitoring. GPS telemetry, particularly through the use of modern GPS tags, has become a valuable tool for obtaining critical data on spatial and behavioral ecology, resource selection and their conservation. However, the implementation of GPS technology in Serbia is still emerging due to limited resources and the high cost of imported equipment. Developing locally manufactured alternatives could provide a cost-effective and readily available solution for advancing wildlife research in the region. This study evaluates the performance of GPS tags developed by the Serbian company CANANDI (Niš), a pioneer in the field, in tracking three species: Chamois (*Rupicapra rupicapra* Linnaeus, 1758), Red Deer (*Cervus elaphus* Linnaeus, 1758), and Eagle Owl (*Bubo bubo* Linnaeus, 1758). A total of four GPS tags were deployed to assess their effectiveness in monitoring above-mentioned species and to evaluate their potential for broader application in conservation efforts. Preliminary findings, although limited, highlight the usefulness of GPS tags in the reintroduction process. Results provided valuable insights into the ecological requirements of marked individuals, including the detection of mortality in a Chamois; the successful adaptation of an Eagle Owl to its new environment; and dispersion patterns of two Red Deer stags, one of which adapted to the pre-release enclosure while the other moved outside the fenced area. These initial findings demonstrate the potential of locally manufactured GPS technology in supporting wildlife conservation and management. As such they provide a valuable foundation for future research and improved species reintroduction strategies in Serbia and neighboring areas.

Key words: GPS tags, Chamois, Red Deer, Eagle Owl, reintroduction

Colorimetric analysis of eggshell color variations in the Common Pheasant (*Phasianus colchicus* Linnaeus, 1758)

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Abstract

The aim of the study was to perform a colorimetric assessment of eggshell color variations in the Common Pheasant (*Phasianus colchicus* Linnaeus, 1758) used for resettlement in Bulgaria. A total of 360 eggs were divided into five groups according to eggshell color: green, gray-green, beige, beige-green, and olive green. Using a colorimeter, the color characteristics were determined in the CIELab color space, and Chroma (C) and the Shell Color Index (SCI**) were calculated. The highest lightness (L*) values were observed in the beige eggshells (68.62 ± 0.62), while the lowest were found in the olive-green eggshells (55.89 ± 0.49) ($P < 0.001$). Low negative mean values for the a* coordinate were observed only in the green eggs (−1.41 ± 0.78), while low positive values were recorded for the other groups, reaching 6.8 ± 0.93 for olive-green eggshells. Positive values were recorded for the b* coordinate, ranging from 13.96 ± 0.80 (green) to 21.90 ± 0.77 (beige), indicating a yellow spectrum position ($P < 0.001$). The Shell Color Index (SCI**) had the lowest values for olive-green eggshells (−35.07 ± 1.42) and the highest values for green eggshells (−53.07 ± 2.17) ($P < 0.01$). The analysis of the color characteristics in the different zones of the eggs (polar and equatorial) did not show statistically significant differences in any of the studied traits ($P > 0.05$). The study revealed significant variations in the pigment distribution in the eggshells of the Common Pheasant, with differences in the color index ranging up to 51.67% between the maximum and minimum individual values. It is possible that these differences in eggshell coloration are linked to the genetic purity of the most widely bred subspecies of the Common Pheasant (*Phasianus colchicus mongolicus*) in the country's game farms. Conducting a phylogenetic analysis of the population could shed light on this issue.

Key words: Chroma, Shell Color Index, lightness, egg

Sustainable management of large carnivores: A case study of Romania

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Abstract

Located in Eastern Europe, Romania boasts approximately 7 million hectares of forest cover, of which 58% is situated in mountainous areas, 33% in hilly regions, and 9% in plains. These vast and diverse landscapes provide critical habitats for various wildlife species, including some of Europe's most notable large carnivores: the Brown Bear (*Ursus arctos*), the Grey Wolf (*Canis lupus*), and the European Lynx (*Lynx lynx*). These three species not only play pivotal roles in their ecosystems but also pose significant management challenges due to their protected status under both European and national laws. Conventional wildlife management practices cannot be applied to these species, leading to the need for specialized conservation efforts. As a result, their populations require meticulous monitoring through a combination of traditional methods and advanced technologies. Conventional techniques may include reproductive units method, footprints measurements, and direct observation, while modern approaches involve radio-telemetry to track movement patterns and genetics methods for assessing genetic diversity, health within populations and to quantify the number of individuals. This study aims to provide an overview of the status and dynamics of large carnivore populations in Romania, examining the various ecological, economic, and social factors that influence their conservation. Specifically, it will highlight changes in habitat availability and prey dynamics. Moreover, the study will assess the impact of carnivore populations on human safety, particularly in rural areas where encounters are occurring. Understanding these interactions is essential for developing effective coexistence strategies that mitigate human-wildlife conflicts. Additionally, the study will explore the positive and negative role of large carnivores in their effects on trophic chains. Through this comprehensive analysis, the study seeks to contribute to the ongoing discourse on wildlife management and conservation strategies in Romania and provide insights that could inform policy-making and community engagement in conservation efforts.

Key words:

Assessing ungulate dynamics in Baltics, Central and Eastern Europe and their impact on key lowland forest ecosystems

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Abstract

Improved forage and living conditions in certain parts of Europe over the past few decades have led to alarming levels of ungulate densities. Understanding the dynamics of ungulate populations is crucial for effective wildlife management and conservation efforts. In areas where ungulate densities exceed the carrying capacity, damage occurs in both the forestry and agriculture sectors, and human safety is jeopardized through road accidents.

This study first explores the evolution of deer populations in the Baltics, as well as Central and Eastern Europe, by analyzing hunting bag data, which represents the total number of specimens harvested annually. It focuses on the trends in hunting bag numbers for Red Deer (*Cervus elaphus* L.), Roe Deer (*Capreolus capreolus* L.), and Fallow Deer (*Dama dama* L.) from 2012 to 2022, while also projecting the future growth of these deer populations and considering the impact of the sex ratio.

Secondly, the study quantifies the levels of ungulate browsing in oak stands using a permanent sample grid of 42 plots situated in both natural and artificial regeneration areas. A total of 3,223 individual saplings were measured, revealing browsing intensities of 49.65% in clearcut systems and 12.8% in continuous forest cover systems. With high ungulate densities identified as the primary cause of these browsing incidents, the Sustainable Population Threshold was calculated using a comprehensive set of indices and compared to the actual ungulate numbers, both of which were translated into stock unit equivalents.

Ultimately, this study aims to underscore the necessity for changes in wildlife management strategies in order to mitigate the impact of the growing ungulate population on the forestry sector.

Key words: For Darius Hardalau: ungulate expansion, growth trends, ungulate browsing, wildlife management

Management of Roe Deer (*Capreolus capreolus* L.) Populations in Different Regions of Central Serbia

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Abstract

The significance of Roe Deer (*Capreolus capreolus* Linnaeus, 1758) research lies in the fact that it is the most numerous species among ungulates and is widely distributed across most hunting grounds in Serbia. The aim of this study is to analyze the management of Roe Deer populations in hunting areas of different regions in Central Serbia. The research was conducted during the period 2018–2021. In 2021, a total of 86,755 individuals were recorded in Central Serbia, representing 97.54% of the optimal stock. The highest population density per square kilometer was observed in the Eastern (2.06) and Belgrade (2.02) regions, while the lowest was recorded in the Southern (1.02) and Western (1.34) regions. The planned optimal Roe Deer population for the total area of all districts in Central Serbia was 1.60 individuals per 100 hectares, while the actual recorded density was 1.35 individuals per km². The planned harvest rate was 0.18 per km², while the realized harvest was 0.10 per km², amounting to 52.82% of the planned target. In most hunting grounds belonging to districts in southern Serbia, there was a significant deviation between the planned and actual harvest rates. This population size is certainly below the habitat's carrying capacity in the hunting grounds of Central Serbia. In these areas, the reduction of hunting-productive land or the decrease in habitat quality has consequently limited the number of Roe Deer that can be sustained. To investigate Roe Deer fertility, a total of 74 samples were collected from multiple locations over three hunting seasons. Of the analyzed Roe Deer, 23.64% had one embryo, 69.09% had two embryos, and 1.81% had three embryos. Infertility was detected in 5.45% of the examined individuals. The average potential fertility in this sample was 1.67 embryos per Roe Deer, or 1.75 embryos per pregnant female. Actual recruitment depended greatly on the hunting ground and its ecological conditions. The lowest real growth rate was recorded in mountainous hunting areas, at 0.54 fawns per pregnant doe. In hilly hunting areas, the real growth rate was influenced by biotic factors and ranged from 0.54 to 0.83 fawns per pregnant doe. Only 39% of the potential fertility resulted in actual recruitment. Roe Deer losses in hunting grounds exceeded 20%, depending on recruitment, although planning documents report losses of up to 10% relative to the base population. The low utilization rate of roe deer populations in Serbian hunting grounds is primarily due to significant undocumented losses. Unlike two decades ago, when losses were predominantly caused by anthropogenic factors, particularly poaching, the primary causes today are traffic incidents and, indirectly, abandoned domestic dogs that are left in hunting grounds. Effective roe deer population management is hindered by numerous factors, ranging from legal and regulatory frameworks to various biotic and abiotic factors that influence the governance of this gamespecies.

Key words: *Capreolus capreolus* L., Management, Real Growth, Losses

Acknowledgements

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The occurrence of two heavy metals, Cadmium and Lead, in the liver and kidneys of Roe Deer at several locations in Central Serbia

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Abstract

Roe Deer is a valued game species for hunting in Serbia. Heavy metals are unwanted pollutants that often occur in environments as a result of human activities. Wildlife inhabits natural environments, where they obtain essential nutrition and water. Therefore, they serve as biomonitors for environmental pollution. In today's world, pollution is unavoidable, but keeping its levels as low as possible is crucial. In this study the roe deer harvested during the regular hunting season by the local hunters were used as biomonitors. Following the harvest, liver and kidney samples from roe deer were collected to analyze lead and cadmium concentrations. The detected heavy metal levels were compared to current legal limits. The maximum permitted concentration (lead and cadmium) in edible offal is 0.5 $mg.kg^{-1}$, except for cadmium in the kidney, where the permitted concentration is doubled to 1 $mg.kg^{-1}$. A total of 119 samples were analyzed, including 55 liver and 64 kidney samples, from two locations in Central Serbia. The average concentrations of lead in the liver and kidney for both locations were 0.530 $mg.kg^{-1}$ and 0.393 $mg.kg^{-1}$, respectively. The mean concentrations of cadmium in the kidneys were 0.231 $mg.kg^{-1}$ and 0.491 $mg.kg^{-1}$, respectively. There were statistically significant differences in the occurrence of lead based on location (location 1: 0,654 $mg.kg^{-1}$, location 2: 0,378 $mg.kg^{-1}$); however, the effect of the organ was not statistically significant. A statistically significant difference in lead concentration was observed between locations (location 1: 0.654 $mg.kg^{-1}$, location 2: 0.378 $mg.kg^{-1}$). However, organ type did not significantly affect lead levels. The average concentration for the liver and kidney was 0,235 $mg.kg^{-1}$ and 0,481 $mg.kg^{-1}$, while locations 1 and 2 were 0,313 $mg.kg^{-1}$ and 0,394 $mg.kg^{-1}$ respectively.

Key words: Roe deer, Heavy metals, Cadmium, Lead, Environmental pollution

Accumulation of heavy metals in organs and meat of wild boar (*Sus scrofa* L.) and European brown hare (*Lepus europaeus* L.)

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Abstract

Heavy metal pollution is a global concern and poses a significant threat to both ecosystems and human health. Numerous toxic elements have the ability to accumulate in soil, water, and plants and sometimes persist over extended periods. Their introduction into the food chain leads to increasingly concentrated levels in the higher trophic organisms. Thus, wild animals are often regarded as essential bioindicators of environmental pollution, due to the gradual accumulation of toxic metals in their internal organs and tissues.

Our study aimed to investigate the levels of specific heavy metals in the skeletal muscle tissue, adipose tissue, and internal organs (liver and kidneys) of Wild boar (*Sus scrofa* L.) and European brown hare (*Lepus europaeus* L.). This review primarily examines the different sources of contamination, accumulation routes, and potential health risks associated with game meat and organ consumption. The information was gathered from the scientific literature published between 1990 and 2024.

The lasting effects of heavy metal pollution on ecosystem stability and adaptability emphasize the need for effective strategies and environmental regulations to address this pressing ecological threat.

Key words: wild boar, hare, heavy metals accumulation, organs, health risk

Accumulation of heavy metals in organs of representatives of the Cervidae family

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Abstract

Representatives of the Cervidae family are important bioindicators of the environmental pollution caused by various heavy metals. Significant amounts of toxic elements can accumulate in tissues and organs, particularly in the liver and kidneys. The study of accumulation levels can provide valuable information about the state of ecosystems and potential risks to human health, especially for areas with developed intensive industrial activity or near sources of pollution.

Our study covers literature data for the period 2014–2024 on the accumulation of copper (Cu), mercury (Hg) and arsenic (As) in the muscles, liver, and kidneys of the following representatives of the *Cervidae* family: roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), and fallow deer (*Dama dama*).

The literature findings were compared with the established permissible limits according to European and worldwide regulations. The possible health hazards associated with the consumption of meat and by-products, accumulation pathways, and organs affected by toxic damage were also examined.

This information is essential for assessing the safety of wild game meat and by-products for human consumption, as well as for developing effective strategies for environmental protection and management of wild populations.

Key words: Cervidae family, heavy metals accumulation, organs, health hazard

Preliminary modeling of spatial genetic variation of Bulgarian wild boars and their levels of introgression by East Balkan Pigs

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Abstract

Following previous studies that have shown introgression of Wild Boars in Bulgaria by East Balkan Pigs, we used 16 microsatellite markers to estimate individual introgression levels of 81 Bulgarian Wild Boars, to model effects by possible factors on introgression, such as age and climate, and potential impacts of the introgression level on trophy quality. Our preliminary general linear model results suggested that relatively low ambient temperature throughout most of the year and relatively low precipitation, especially during winter, had a positive effect on wild boar genetic purity. Regarding trophy quality, CIC points were not affected by introgression levels but increased significantly with age; they were also higher in regions of silicate geology compared to limestone geology and at locations with higher ambient temperature and precipitation during most of the year. Surprisingly, however, lower tusk lengths increased significantly with increasing introgression levels, regardless of age, relative warm temperature (except for the wettest quarter of the year) and high precipitation, which had also a positive effect on tusk length. The mean width of lower tusks increased with age and individual homozygosity and was larger in males from locations with higher ambient temperature and higher precipitation during most of the year as well as with silicate geology. Gold medals were dependent mainly on age and in males from locations with relatively high ambient temperature and high precipitation during most time of the year. Overall, some genetic effects seem to play a minor role for trophy quality in addition to age, geology, and climate.

Key words: population genetic, Wild Boar genetic variation, introgression, East Balkan Pigs

Genetic Variability and Spatial Genetic Models of Red Deer in Bulgaria

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Abstract

To investigate the spatial distribution patterns of variability in the nuclear gene pool of red deer in Bulgaria and to understand differentiation and migration patterns, we examined allelic variation at twelve microsatellite loci in 278 individuals from six regions of Bulgaria. In addition to region-specific population genetic analyses and Bayesian structure and admixture analyses, we also performed spatial genetic modeling of georeferenced individual samples to investigate possible inconsistencies arising from the different approaches. Of the 139 alleles detected, only 18.7% were common alleles, considering an overall Bulgarian allele frequency of 15% as lower threshold for common alleles. Many alleles (56.8%) occurred with an overall frequency < 5%, 23.02% of all alleles were “rare alleles”, i.e., with a frequency < 0.5%, and 81.25% of the latter were “private alleles”, i.e., found in only one of the six regions studied.

Despite this high level of spatial dispersion of alleles, we found mostly low but significant genetic differentiation between the regions (sig. pairwise Fst: 0.0154–0.058), but relatively high gene flow, i.e., 1.69–15.5 migrants per generation, based on coalescence theory-based estimates. Our structure and admixture models with population priors distinguished all regional gene pools.

Contrary, all spatial genetic models based on georeferenced individual genotypes found less spatial structure: 1) BAPS – 3 populations; GENELAND – 2 populations; 2) spatial PCA – global structure ($p < 0.001$), but no pronounced local structure ($p = 0.83$) and shallow differentiation with somewhat different individual scores in SE Bulgaria; 3) Landscape Shape Interpolation Analysis – differentiation of red deer between SE Bulgaria opposed to the other regions studied and a few local aggregations of less closely related individuals, particularly in SW and NE Bulgaria.

Seemingly, our traditional approach based on the six regions indicated a better spatial resolution.

Key words: red deer, *Cervus elaphus*, genetic variability, spatial modeling, Bulgaria

Distribution and density of Common Woodpigeon (*Columba palumbus* L.) in Central Northern Bulgaria

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Abstract

The aim of this study is to present new data on the breeding density of the Woodpigeon (*Columba palumbus* Linnaeus, 1758) in different habitats in the LH 79 quadrant, 35T of Universal Transverse Mercator (UTM) in Bulgaria. The breeding density of the Woodpigeon was assessed in square LH75 from March to May 2023. A point count method was used, along with an evaluation of habitat characteristics. Anova main effects was used to test for a relationship between the mean number of Woodpigeons reported over this study period and the different types of breeding habitats and cropland within the fixed radius. We also used a multiple regression model to determine whether there was correlation between the number of pigeons recorded in fixed radius, and the independent variables, the average height of trees, and shrubs again within the fixed radius. The breeding density of the Woodpigeon in this study was 16.42, 12.75, and 14.44 pairs per 100 hectares in March, April, and May 2023, respectively, showing a decreasing trend over the time. ANOVA analysis revealed statistically significant differences in the mean number of singing Woodpigeons across habitat and cropland types ($F = 8.11$, $p = 0.005$). Their numbers were significantly higher in open habitats with single large trees or small groups of large trees within grassland and meadows compared to other breeding habitats. Additionally, relatively high numbers were recorded in Silver Lime forests, coniferous plantations, and the fringe strips of all forest habitats. The abundance of singing Woodpigeons was also higher in areas lacking arable land within the fixed radius or in the presence of wheat fields. Furthermore, their numbers increased with greater average tree height, showing a positive correlation ($r = 0.49$, $F = 2.132$, $p < 0.0001$). The most recent data on Woodpigeon breeding density in Bulgaria date back to the late 20th century. The study provides the first insights into the species breeding distribution and density in a previously understudied area.

Key words: tree height, breeding density, Silver lime forests, confirmed breeding

Food spectrum of the Common Wood-Pigeon (*Columba palumbus*) in Bulgaria

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Abstract

Determining the diet of a species is crucial for understanding various aspects of its population dynamics and management. Food resources directly influence its distribution and reproductive potential. The Common Wood-Pigeon (*Columba palumbus* L., 1758) is naturally distributed across Europe, parts of Western Asia, and Northern Africa, including Bulgaria. It is classified as a species of least concern, with an increasing population. This widespread bird inhabits forests, shrublands, and anthropogenic environment. In Bulgaria, its distribution and density are increasing. The present study aims to provide new data on the diet of the Common Wood Pigeon in Bulgaria, expanding our knowledge of its feeding habits in an area where such information is currently lacking. These findings could improve prediction about the species' potential responses to future habitat changes. Between September 2022 and December 2024, we analyzed the crops of 54 Wood Pigeons collected from nine hunting areas. All specimens were obtained during regular hunting trips in September 2022, September-December 2023, and January 2024. The contents of each crop were extracted, sorted by species, and air-dried for two weeks. Each fraction was then weighed using an electronic scale with an accuracy of one thousand grams. The dietary components were categorized into plant, animal, and inorganic matter. Plant material was identified using a LEICA EZ4 W trinocular stereoscope and a reference collection. The significance of each dietary component was calculated using the formula:

Significance = (%occurrence x % weight)/sum of (%occurrence x %weight), where: % occurrence – the percentage of crops containing the given dietary component; % weight – the mean weight of the given component relative to the average total crop content. In total, 21 taxa were identified – 17 of plant origin and 4 of animal origin. Sunflower seeds had the highest occurrence rate (47.7%), while corn seeds had the highest significance percentage (31.3%), followed by acorns from various white oak species (29.1%). The animal component of the Wood Pigeon's diet included several snail species, of which only two were identified: *Morlina glabra* Rossmässler, 1835 and *Pomatias rivularis* Eichwald, 1829. However, their contribution to the overall diet was minimal. The findings confirm that the Wood Pigeon primarily consumes the most abundant food sources available in its habitat. Notably, this study is the first to report the presence of these mollusks in the species' diet. Our results support the hypothesis that the Wood Pigeon exhibits high feeding plasticity and can utilize a wide range of food resources.

Key words: forage crops, Oak acorns, molluscs, degree of significance, prevalence

Results from monitoring of European Turtle Dove (*Streptopelia turtur*) in Bulgaria between 2022-2024 years

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Abstract

We conducted nationwide surveys from May 15 to July 31 between 2022 and 2024 to estimate the population size and habitat-specific density of singing male Turtle Doves (*Streptopelia turtur* Linnaeus, 1758). Point counts were carried out at survey stations systematically distributed across 20 plot locations throughout the country. Breeding density was assessed at 747 points, evenly spaced within these plots. Turtle Doves are primarily found in woodlands and shrublands, often surrounded by croplands, including cereal, forage and technical cultures. Therefore, we incorporated habitat type, adjacent cropland within a fixed radius, and tree and shrub height as covariates in our density modeling. To assess the impact of various environmental factors on the species' breeding distribution, we applied a generalized linear model with a Poisson error distribution. Model selection was based on the Akaike Information Criterion (AIC) to identify the best-fitting model for the data. The breeding density of the European Turtle Dove varies between 10.1 and 10.9 pairs per 100ha across the study years (2022:10.1; 2023: 10.9; 2024: 10.8). Additionally, average breeding density peaks in June before declining in July (May: 9.3; June: 12.02; July: 10.9 pairs per 100 ha). Breeding density also varies across different habitats, consistently reaching its highest levels in riparian forests throughout all three study years (mean density: 18.2 pairs per 100ha). The best-fitting model includes all four covariates: tree and shrub height, nesting site availability, and the cultures in open areas within the fixed radius. The model with the lowest AIC value indicates that Turtle Dove abundance is influenced by the height of woody and shrub vegetation, as well as by three types open areas within the fixed radius. The number of singing males is positively correlated with tree height but negatively correlated with shrub height. Additionally, it is positively associated with the presence of forage, cereal, and technical crops in open areas adjacent to nesting sites. Three years of surveys on the species indicate an average density of approximately 10-11 pairs per 100 hectares. The breeding peak occurs in June, though density varies depending on habitat type. Riparian forests are likely among the most preferred nesting sites. The presence of Turtle Doves is closely linked to various types of open areas that provide food. This suggests that conservation efforts should focus on enhancing food availability in territories near breeding sites.

Key words: breeding density, habitat, habitat associations, singing activity

Hunting tourism in Bulgaria: a hunters' profile

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Abstract

Bulgaria is an asserting leading hunting destination. Red Deer (*Cervus elaphus* Linnaeus, 1758) and Wild Boar (*Sus scrofa* Linnaeus, 1758) world records prove that some of the strongest populations of these game species are managed here. Every year between 3000–4000 local and foreign guest hunting in Bulgaria. The aim of the present study is to determine the hunter's profile and his preferences for hunting tourism products in Bulgaria.

A total of 128 hunters from 12 hunting districts offering hunting tourism services were surveyed. According to the data obtained from the study, 73.4% of all hunters have many years (more than 11) of experience in hunting several types of game. Almost half of those who filled in the questionnaire (48.4%) have no preferences for big/small game hunting, but the other 49.3% are only interested in big game hunting. The services of hunting tourism are used by 64.8% of the hunters surveyed, while the rest hunt in hunting clubs' districts, too. The results of the study cannot identify preferences regarding the method of hunting – 67.2% of respondents hunt both methods – individually and in groups but trophy hunters (27.3%) indicate individual hunting as preferred.

Hunting destinations in Europe are popular among 62.5% of hunters in our country, and 42.9% of them hunt mainly in Bulgaria. Some of the respondents (32.8%) hunt on more than one continent, visiting also Africa, Asia and North America. Only 10.9% of the participants are interested in just one species and 38.3% preferred big game hunting. The rest of the people that filled in the questionnaire were hunting both small and big games. The hunters in Bulgaria are most interested in Red Deer (43.7%), Wild boar (23.4%) and Fallow Deer (*Dama dama* L., 1758) (21.9%), while the remaining respondents' preferences are divided between Western capercaillie, Chamois (*Rupicapra rupicapra* Linnaeus, 1758), Mouflon (*Ovis aries musimon* Pallas, 1811) and predators. According to the study results, 40.6% of the small game hunter's Common quail as the preferred hunting species, the remaining respondents indicate European Turtle Dove (*Streptopelia turtur* Linnaeus, 1758), Eurasian woodcock (*Scolopax rusticola* Linnaeus, 1758) and waterfowl hunting as their favorite.

Hunting is accepted as a hobby and social activity for 65.6% of hunters and only for 17.2% is a way to obtain meat. That's why, for the biggest group (80.5%), shooting an animal is not at any cost. The hunters also would try additional activities while hunting tourism – 54.6% indicated spa services as the leading option, 49.2% would benefit from fishing as an additional service, 18% from observing wildlife with a guide. The remaining respondents have different preferences among visiting historical landmarks, horseback riding, off-roading and shooting.

Hunters' profile represents men, mainly aged between 36-50, hunting in Europe, both individually and in groups, mainly on big game. Red deer is the most preferred big game species, and Common quail is the most preferred small game species. Hunting is perceived as an opportunity for nature contact and a good time with friends, with the shooting of game not being a priority.

Key words: tourism, big game, small game, Red Deer, Wild Boar

Immobilization of game – conditions and opportunities

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Abstract

Immobilization of wild animals compared to domestic ones is an extremely complex event, requiring numerous preliminary activities, preparatory work, perseverance, patience and, last but not least, veterinary medical knowledge and skills. Knowledge of the ecology and biology of wild animals is essential for the proper planning and accurate implementation of the intended activities.

The cooperation and perseverance of the employees in a given hunting farm plays an extremely important role in achieving the set scientific research goals and objectives. The creation and maintenance of permanent shelters, the conduct of targeted observations and the year-round feeding of red deer in pre-selected habitats create opportunities to immobilize red deer of the correct sex and age.

The correct choice of devices, tools, and anesthetic medications allows deer to be put to sleep in the most humane way, to perform the planned activities, then to be awakened, and to continue their natural biological rhythm and life in their habitats with as little stress as possible.

Key words: immobilization, anesthetics, antisedation, anesthesia devices

New Data on the Distribution, Bioecology, and Phenology of the Big Bellied Glandular Bush-cricket (*Bradyporus macrogaster* (Lefebvre, 1831) in Bulgaria

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Abstract

Bradyporus (Callimenus) macrogaster macrogaster (Lefebvre, 1831), commonly known as the Big Bellied Glandular Bush-cricket, is an extremely rare steppe species. It's listed as "Endangered" in the IUCN Red List of Threatened Species and in the European Red List of *Orthoptera*. In the Red Data Book of Bulgaria, it's classified as "Critically Endangered". During a study on the distribution and status of conservation-important and protected steppe species such as the Hungarian ground beetle, conducted between 2021 and 2023 using 252 pitfall traps across 42 test plots in Western Bulgaria, the Big Bellied Glandular Bush-cricket (*Bradyporus macrogaster*) was recorded in four of the plots. Three of the locations fall within the Tri Ushi mountain range (near the villages of Bezden, Ponor, and Aldomirovtsi). The fourth location is in the Western Fore-Balkan, near the village of Reselets, on August 24, 2022 (near Bresté).

This marks the first official record of the species in Northwestern Bulgaria. The species had been previously recorded in this area by N. Kodzhabashev – in July 1989 and July 1995 – but those findings remained unpublished. The new locality represents a local karst-steppe refugium, located on the edge of the Reselets Canyon, which constitutes the northwesternmost limit of the species' range. The Iskar River and its gorge are the only natural ecological corridor crossing the Balkan mountain chain, along which steppe species like *Bradyporus macrogaster*, the Hungarian and the Bessarabian ground beetles, the common spadefoot toad and the pygmy field mouse have established populations in the Sofia Plain – the southernmost area of the entire Eurasian steppe biome.

The amount of material collected and the extended sampling period, allowed for the identification of phenological traits, larval stage sizes, and adult sizes, as well as the specific diapause phases the species undergoes throughout the year. For the first time, a significant portion of the steppe biota of these habitats has been mapped, along with their obligatory indicator species, which serve as bioindicators of suitable conditions for *Bradyporus macrogaster*.

Thanks to citizen science, individuals have been reported throughout the species' range in Bulgaria, allowing for broader monitoring and the discovery of new populations. The identified populations fall within two protected Natura 2000 zones, but the conservation of stenobiontic and stenotopic steppe species requires the introduction of strict protection measures, achievable only through formal proposals and the designation of two strictly protected reserve areas under Bulgarian national legislation. Preventing the extinction of rare steppe species like *Bradyporus macrogaster* is possible only through consolidated conservation efforts by the entire European community and the development of a joint strategy for urgent conservation actions that ensure the full preservation of steppe habitats and their entire biota.

Key words: *Bradyporus (Callimenus) macrogaster*, southern steppe refugium, Tri Ushi Mountain, Sofia Plain, Natura 2000, bioindicators, protection, phenology, conservation

New Data on the Distribution and Phenology of the Common Spadefoot Toad (*Pelobates fuscus* (Laurenti, 1786) in the Sofia Plain – a Southern Refugium at the Edge of the Species' Range

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Abstract

The Common Spadefoot Toad (*Pelobates fuscus*) is a rare, protected, and poorly studied amphibian species in Bulgaria's herpetofauna. Over the past few decades, its feeding and breeding habitats have undergone significant degradation.

Between 2021 and 2023, during research on the karst steppe fauna in the Sofia Plain, newly metamorphosed toadlets were recorded along the shoreline of the Aldomirovtsi Marsh. The localities in this region mark the southernmost range limit of the species, and no recent data has confirmed successful reproduction in this area. Over the past 70 years, most of its breeding wetlands have been drained or severely polluted, increasing the conservation importance of the Aldomirovtsi Marsh for the survival of the species at the southern edge of its distribution.

Parallel surveys in the nearby Dragoman Marsh, conducted in the same period, did not confirm the species' presence or breeding activity. It is likely that prolonged desiccation and frequent fires in the area have led to the partial or complete destruction of its breeding habitats.

The biological material collected from Aldomirovtsi provides valuable data on the timing of breeding and metamorphosis, as well as the importance of the marsh as the only known reproductive site of the species south of the Balkan Mountains. The Iskar River and its gorge serve as the only natural ecological corridor crossing the Stara Planina (Balkan) range, through which species from the Danubian Plain, including the Common Spadefoot, have colonized the Sofia region.

For the first time, the abundant collected material enabled observations on the phenology, post-metamorphic body size, and weight of the species. Additionally, a direct link was established between the species and potential food sources, captured in the same pitfall traps where the young toadlets were found feeding.

The identified breeding site of the species lies within a Natura 2000 protected area, but the conservation of this highly specialized amphibian requires the implementation of strict protective measures, including the designation of a strictly protected nature reserve under Bulgarian national law. Furthermore, year-round water retention and management activities are urgently needed to ensure successful reproduction and metamorphosis, which depend on permanent, non-drying water bodies.

Key words: *Palobates fuscus*, southern steppe refugium, Sofia Plain, Aldomirovci marsh, Natura 2000, Bulgaria's herpetofauna, protection, phenology, conservation

Contribution to the Study of the Contemporary Ichthyofauna and Ichthyocoenosis of the Provadiyska River

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Abstract

The ichthyofauna of the Provadiyska River has never been the subject of a comprehensive ichthyological study, and the available data on this part of its biota are incidental and incomplete. Scientific collections conducted in 2024 and early 2025, along with literature reviews, indicate a rich and distinctive ichthyofauna, including approximately 30 confirmed species and over 15 probable ones. More than half of the identified species have a high conservation status and significant ecological importance.

Of particular scientific interest is the discovery of the crucian carp (*Carassius carassius*), a species that has nearly disappeared from all of Europe and currently has only a few known locations in Bulgaria. Another noteworthy find is a caught specimen of bleak (*Alburnus sp.*) with morphological characteristics that distinguish it from previously known Bulgarian species, closely resembling the Danube bleak (*Alburnus danubicus Antipa*, 1909), which is considered extinct.

This study also provides the first and only records of the occurrence of the moderlieschen (*Leucaspius delineatus*), the three-spined stickleback (*Gasterosteus aculeatus*), the tubenose goby (*Neogobius gymnotrachelus*), and the Caucasian goby (*Knipowitschia caucasica*). The scientific interest in the ichthyofauna of this relatively small but zoologically and faunistically unique river dates back to 1937 when Professor Chichkov described a new species of gudgeon, *Gobio kovatschevi* Chichkov, 1937, naming it after the river.

The Provadiyska River, which flows into Lake Beloslav and is part of the Black Sea watershed, has also been influenced by its relative proximity to the Danube River. As a result, its ichthyocoenosis includes species characteristic of both Black Sea and Danube basins. The presence of several endemic and region-specific forms necessitates further in-depth research using modern phylogenetic methods to clarify their species identity and assess the river's importance for the conservation of its unique biodiversity.

The study of the ichthyofauna and ichthyocoenosis of the Provadiyska River aims to develop a comprehensive management and conservation strategy, which has never before been scientifically analyzed. Severe alterations to the riverbed, destruction of riparian habitats, and significant anthropogenic pollution have led to drastic changes and complete degradation. Without restoration measures and strict control over their implementation, the river's biodiversity and the river itself could face complete destruction.

These changes have already had a devastating impact on commercially valuable fish species, which once sustained the entire population along the river and provided livelihoods for professional fishermen—now irreversibly lost. We believe the time has come for responsible human intervention to restore both the natural conditions of the river and the ecological resources that sustained generations in the past.

Key words: ichthyofauna, ichrhyocenosis, Provadyiska river, protection, endemic fish, conservation, *Alburnus danubicus*, Gobio kovatcshevi, *Carssius carassius*

Contemporary landscape design for rehabilitation of University of Forestry Petrohan Arboretum

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Abstract

The Arboretum of the University of Forestry, located within the „Petrohan“ Training and Experimental Forest Range, was established in 1976 by a team of university experts. Spanning 3.1 hectares at an elevation of 540 meters above sea level, the arboretum serves primarily as an educational resource for the disciplines of Dendrology and Ornamental Dendrology. In addition, it plays a key role in research on tree species' responses to climate change and their adaptation to the local environment. The project aims to transform the University of Forestry Arboretum into both a functional hub for education and research, and an inspiring green space that enhances the landscape's aesthetic value while promoting biodiversity. The rehabilitation plan addresses several key challenges, including the deteriorated pathway network, limited accessibility, and the need to expand and enrich the plant collection. Key improvements to the alley network focus on creating logical and non-conflicting connections between the various sectors of the arboretum. One of the main challenges in developing the vertical planning model was the steep terrain, with slopes exceeding 12%. The redesign is grounded in a thorough assessment of the existing dendrological collection, which includes a detailed inventory of 118 species and infraspecific taxa, as well as mapping and phytosanitary evaluation of over 350 individual specimens. The results revealed that over 90% of the specimens exhibited normal growth and were in excellent overall condition. The diameter at breast height (DBH) of each specimen was measured and compared with data collected a decade earlier to assess species development over the 2014–2024 period. A graphical analysis of the arboretum's layout showed that the arrangement of the dendrological collection does not follow a systematic or geographical principle, nor does it adhere to any specific plan or methodology that would support easier study and interpretation. The primary goal is to preserve the arboretum's existing collection while enhancing accessibility and enriching the visitor experience through upgraded infrastructure and the introduction of new thematic zones. Key innovations include the creation of engaging educational exhibits focused on topics such as soil science, petrography, meteorology, dendrochronology, and ornithology. Additional features include a liana display on a pergola structure, a hedge exhibition, a collection of hygromesophytes near the lake, ground cover species, a spirarium, a rosarium, and a dedicated gymnosperm exhibit.

Highlights of the landscape architectural design include a welcoming decking platform at the arboretum entrance and a central gathering space composed of two adjoining squares, accommodating groups of 30–40 people. In the northwestern section, a uniquely designed outdoor classroom will support open-air learning.

The new dendrological plan incorporates 339 species and infraspecific taxa, carefully selected to align with local climate conditions and the academic curricula of Forestry, Landscape Architecture, Ecology, Agronomy, and Plant Protection programs. To enhance learning and engagement, interpretive signage will be supplemented by a mobile app featuring a QR code system, offering detailed information on plant species and their locations throughout the arboretum.

Key words: arboretum, University of Forestry, landscape design

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Results of Taxodiaceae species cultivation in urban green spaces in Bulgaria

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Abstract

Urban green spaces are vital for enhancing the quality of life in cities, offering ecological, social and aesthetic benefits. The selection of appropriate tree species is crucial for maximizing these avails. Species from the Taxodiaceae family, now part of the Cupressaceae family, have been historically introduced into Bulgarian urban landscapes due to their renowned ornamental value and potential. Such species are *Metasequoia glyptostroboides* Hu & W.C.Cheng. (dawn redwood), *Taxodium distichum* (L.) Rich (bald cypress), *Sequoiadendron giganteum* (Lindl.) J.Buchh. (giant sequoia), *Sequoia sempervirens* (D.Don) Endl. (coast redwood) and *Cryptomeria japonica* (L.f.) D.Don (Japanese cedar). Evaluating the results of their cultivation can facilitate future urban green infrastructure planning and biodiversity conservation efforts. Originating from various parts of the world, these species possess unique traits that affect their potential for adaptation in the climate and environmental conditions in Bulgaria. The introduction and performance of these species in urban green areas have been studied to a limited extent, which respectively provokes great research interest. The aim of this study was to analyse the results of cultivation of Taxodiaceae species in Bulgarian urban green spaces, focusing on their growth and development, ecological characteristics and contributions to urban aesthetics. A comparative characterization was made between the environmental conditions of the species' natural habitats and those of the different climate regions and environment in Bulgarian urban spaces. Biometric data for cultivated Taxodiaceae species and their distribution within public green areas was collected in major cities throughout the country. A phytosanitary examination and an assessment of the overall state of these species was also performed. Results show that *Sequoiadendron giganteum* and *Cryptomeria japonica* have been successfully grown in specific settings, their broader application in urban landscaping requires careful consideration of their ecological requirements and potential impact on local ecosystems. On the other hand, the preliminary results from the integration of *Metasequoia glyptostroboides* and *Taxodium distichum* has demonstrated promising outcomes, enhancing both ecological functions and ornamental effect. Cultivation of *Sequoia sempervirens* remains less explored, although opportunities may exist in specific microclimates. Thoughtful site selection, monitoring and management practices, including adequate plant protection measures, are essential to ensure the successful establishment and growth of these remarkable coniferous species in urban environments, while contributing to the enrichment of Bulgaria‘s urban biodiversity and landscape diversity. Public education about these species can also foster appreciation and support for their inclusion in urban green spaces. Further research and experimental plantings are necessary to fully assess their adaptability in the changing climate and benefits of these species.

Key words: introduction, redwood family, urban green infrastructure, urban vegetation

Influence of competitive strategy on dominant species composition inestablished perennial wildflower meadows under different sowing mulchtypes

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Abstract

Grime's CSR model, which categorizes plant species into competitors (C), stress-tolerators (S), and ruderals (R), is fundamental to understanding plant community assembly. Seed size is another crucial trait influencing germination success and species establishment. This study investigates how different types of sowing mulch influence the dominant competitive strategy of plant species and its interaction with seed size. An experimental study was conducted using two types of mulch – organic (compost) and mineral (sand) – and three different seed mixtures containing perennial herbaceous plants. Species cover was assessed in the third year after sowing. Additional data on seed weight, competitive strategy, and maximum species height were retrieved from electronic databases. Statistical analyses were performed using linear mixed models.The findings highlight the critical role of competitive strategy in determining species dominance. The type of mulch significantly influences which strategy prevails. Stress-tolerant (S) species were nearly absent in sandy mulch, where competitive (C) species dominated. In compost, ruderal (R) species were most prevalent, whereas in plots without mulch, a balance between C- and S-strategists was observed. Compost facilitated the rapid establishment of ruderals, which gained a competitive advantage over other species. Sandy mulch, on the other hand, restricted weed growth and promoted competitor species. Bare soil provided a more balanced environment, without a significant advantage for any specific strategy. Seed size also played a significant role, with its effect varying depending on the dominant strategy. These results have important implications for species selection in plant community design. Understanding the interaction between competitive strategy and mulch type can enhance the success of perennial plant communities by optimizing species composition on competitive strategy and the type of mulch used.

Key words: CSR strategy, dominant species, wildflower meadows, mulch, planting design

Small architectural forms of the rehabilitation garden at the Nationalchildren‘s specialized hospital of the Ministry of Health of Ukraine – OHMATDYT

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Abstract

Small architectural forms (SAFs) are essential in therapeutic spaces, aiding emotional, physical, and cognitive rehabilitation. Integrating natural and architectural elements reduces stress and enhances social interaction. SAFs in rehabilitation gardens create relaxation zones, sensory stimulation areas, and social spaces for children, military personnel, and medical staff. The OHMATDYT Rehabilitation Garden (970 m²) features benches (7units), contact sculptures (9 units), decorative stones (8 units), a metal sculpture of a girl with a dandelion, and trash bins (3 units). Benches, made of natural wood, provide comfort and have a vandal-resistant design for safety. Their strategic placement ensure seven visitor distribution and effective zoning of the space. Zoning helps regulate visitor flow, allowing rehabilitation activities in different areas without interference. This setup reduces anxiety and supports psychological stability. Contact sculptures stimulate sensory perception, which benefits patients with neurological disorders and PTSD. Specialized zones for therapeutic exercises and medical supervision enable physicians to monitor patient progress during therapy. Topiary sculptures (8 units) serve as visual focal points, promoting positive emotions and reducing stress. A metal frame sculpture supports an inclusive environment, aiding patients with cognitive impairments. One sculpture, covered in artificial turf, remains soft and decorative year-round, encouraging motor skill development and emotional engagement. Ergonomic decorative stones are designed for children and patients with limited mobility, creating safe resting spaces. Natural materials such as wood, stone, and metal ensure the garden‘s sustainability and durability. This rehabilitation garden is more than just a green space; it is a carefully designed therapeutic environment that fosters healing and well-being. Thus, SAFs play a crucial role in rehabilitation by enhancing physical, emotional, and cognitive recovery.

Key words: rehabilitation garden, garden therapy, therapeutic environment, SAF (Small Architectural Forms), SAF (Architectural Forms of the Site)

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