Rationale for the creation and planning organization of the national nature park within the boundaries of the Borzhava mountain range

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Abstract. To date, Transcarpathian region is where the conservation indicator in Ukraine is the highest (15.52%). However, the network of natural geosystems includes areas that – due to absence of well-established mechanisms of nature protection – are being harmed by excessive economic development and use of outmoded environmental management approaches. One such important natural complex requiring protection of its biotic and landscape diversity is the Borzhava range. In this paper, the authors provide a rationale for the creation of the National Nature Park (NNP) within the boundaries of the Borzhava mountain range, taking into account the landscape and biocological approaches, as well as accounting for the limiting factors of the existing management of natural resources. We determined the optimal location for the park, delineated its configuration, boundaries, and total area, and proposed a cartographic model of its functional zoning. We identified the NPP’s role in the regional econetwork and the main negative anthropogenic factors that must be regulated. In order to solve the aforesaid tasks, the authors clarified the boundaries of the Borzhava mountain range and high-landscape areas. We charted a schematic map and a supporting table «Existing environmental preservation territories within the Borzhava physical-geographical sub-district in the landscape areas» to the scale scale of 1: 500,000. To identify the functional and regime zones of the proposed park, we have compiled the «Species and age structure of forests, vegetation groups of meadows and other non-forest lands within the projected Borzhava NNP» map. In particular, it identifies species and age characteristics of forests, groups of shrubs and herbal phytocenoses in the meadows within the previously outlined NNP territory. To analyze the anthropogenic factors, economic and other functional zones influencing the park’s ecosystems, the authors charted the additional schematic maps of «Functional purposes and forms of ownership of land proposed to be included in the boundaries of the Borzhava NNP» and «Categories of land and forests suggested for inclusion in the Borzhava NNP». The authors believe that the research presented in this article gives ample reason for designing a Park’s project with further submission of necessary materials to be reviewed by the Department of ecology and natural resources of Transcarpathian region.

Keywords: national natural park, functional zoning, biodiversity, Emerald network, regional econetwork, key area of eco-network.

Obґрунтування створення та планувальної організації національного природного парку в межах Боржавського гірського масиву

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Анотація. На сьогодні Закарпатська область характеризується одним із найвищих показників заповідності в Україні (15.52%). Проте в межах природних геосистем, де відсутні механізми налагодження природоохоронного менеджменту, спостерігаються негативні процеси, зумовлені зокрема надмірним господарським освоєнням та застосуванням застарілих підходів до природокористування. Важливим природним комплексом у межах області, який потребує захисту біотичного та ландашафтного різноманіття, є Боржавський гірський масив. У даній публікації обґрунтовано створення національного природного парку (НПП) та його планувальної організації в межах Боржавського гірського масиву із врахуванням ландшафтних, біоценологічних підходів, а також враховуючи обмежуючі чинники сучасного природокористування у регіоні досліджень. Встановлено оптимальне місцеположення парку, окреслено його конфігурацію і межі, загальні правила, запропонована картографічна модель функціонального зонування парку. Визначена роль НПП у євромережі регіону та з’ясовані головні види антропогенного впливу, які потребують подальшого врегулювання. З метою вирішення вище вказаних завдань було уточнено межі Боржавського
Introduction

One of the five strategic goals of the Regional Strategy of the Development of Transcarpathian region during 2021-2027 (hereinafter – Strategy – 2027) is oriented at the «Provision of Environmental Protection, Ecologically Balanced and Rational Nature Use and Spatial Harmony» in the region. Achieving this purpose implies performing the following operative tasks: design of corresponding recommendations for preservation of the region’s biodiversity, broadening of the network of the Nature-Reserve Fund (NRF), preservation and restoration of wetlands in all the natural altitudinal zones of the region, development of an ecology-oriented multifunctional forestry that would be similar to a natural one, protection of forests from the impacts of climatic zones, advancement of the regional ecological network, etc.

We should note that in general, Transcarpathian region has the country’s highest indicator of nature protection (15.52%). At the same time, some negative processes occur in the region: the rates of water runoff from the mountain slopes have been increasing due to large-scale transformations of forest landscapes and massive illegal forest cutting; wastes are clogging the streambeds and are dumped on the banks of the Ukrainian part of the Tysa river basin, there emerge alien species of fish, animals and plants; water bodies are being polluted, landscapes are being fragmented, and some species of wild flora and fauna are vanishing.

Those negative processes mostly take place within natural ecosystems where nature-protection management has not put in place improvement mechanisms. As demonstrated by the international and domestic practices, one way to organize such a management would be creating a polyfunctional protection units – regional (Hammer et al., 2021) or national nature parks (Stevens, 2018), biosphere reserves (Purwanto, Nugroho, Achmadi & Munawaroh, 2020) with professional staff providing a complex preservation of biodiversity and ensuring ecosystem services (ES) of a certain nature-reserve territory (Garcia-Llorente et al., 2016; He, Gallagher, Su, Wang & Cheng, 2018; Hanna, Raudsepp-Hearne & Bennett, 2019; Xu et al., 2022).

In our opinion, an important natural complex of Transcarpathian region – which has a great potential of ecosystem services, but also requires the protection of its biological and landscape diversities – is the Borzhava Mountain Massif. Creating the Borzhava National Nature Park (NNP) would effectively preserve the landscape and biotic diversities of this mountain massif, regulate the touristic-recreational and agricultural activities in the area, and also prevent other anthropogenic threats coming from the projects of constructing a windmill power station (WPS) and large touristic complexes, aggravation of jeeping, gathering of excessive amounts of Vaccinium myrtillus berries, spread of man-caused fires, etc.

The history of projecting a polyfunctional territory in the Borzhava started in 2007. Already back then, the Program of Promising Development of the Nature Protection and the Ecological Network of Transcarpathian region for 2006-2020 contained a plan of creating the Zhdyymyr National Nature Park, with 21.6 thou ha total area. In 2007, the researchers of the Uzhhorod National University have scientifically substantiated the necessity of creating the Zhdyymyr NPP (on 6,116 ha area). This NPP would have included the part of the Borzhava range between Velykyi Verh and Stii mountains, and also its northwest and west slopes down to the Vycha river, the upper parts of the southeast slopes (Fig.1a) (Kovalchuk, Kovalchuk, Feliba-Klushina & Piashechnik, 2007.).

During 2016-2020, the Standing Committee of the Bern Convention substantiated and approved the object of the Emerald Network within the upper parts of the ranges of the Borzhava Mountain Massif – the Borzhava Polonyna (UA0000263). We should also note that a major part of this object is included in the Zhdyymyr key area [key area refers to already existing conservation lands of the Nature-Reserve Fund of Ukraine – Translator’s note], which is a component of...
the ecological network of Transcarpathian region, in accordance with the Project of the Regional Econetwork Scheme (Teslovych & Krychevska, 2021).

In 2020, the specialists of the Institute of Ecology of the Carpathians of the National Academy of Sciences of Ukraine submitted an application to the Ecology Department of the Transcarpathian region Administration, proposing a Borzhava Polonynas landscape park of local significance. The suggested object should have included the upper parts of the Borzhava range, presented by a landscape of convex peneplained alpine-subalpine (polonyna-type) high mountainous area. The objectives of creating the object were preserving the biotic diversity of the polonynas and regulation of tourism and traditional ways of nature use (Fig.1b). The necessary rationale of the project was prepared by the scientists of the mentioned institution, and also the State Nature Museum of the National Academy of Sciences of Ukraine, Ivan Franko Lviv National University, Mykola Hryshko National Botanical Garden, and the Uzhhorod National University (Felbaba-Klushina, 2020).

As of 2022, none of the abovementioned projects have been implemented.

At the same time, our studies revealed 30 established objects of the Nature-Reserve Fund (NRF) within the Borzhava Mountain Massif, in particular, three nationally significant reserves and 27 objects of local significance (Fig.2, Table 1). Most of them were claimed between the late 1960s and early 1990s.

The objective of the study was analyzing the landscapes and bioclimatic grounds of creating a national nature park within the Borzhava Mountain Massif (MM) and putting forward a cartographic model of its optimal planning organization.

The rationale of optimal planning organization is considered to be solutions to the following tasks: identification of an optimal location of the park and its role in the region’s network, contouring its configuration and boundaries, identification of its general area, designation of functional and regime zones, determining their boundaries and areas. The practice of such a planning (Krychevska, 2004; Getman, & Movehan, 2020) shows that such tasks need to be performed using the landscape and bioecological approaches, and also account for limiting factors of the traditional nature use in a study region.

The landscape approach during planning of nature-reserve territories (NRT) implies long-term preservation of their nature complexes (Dmytrowski & Kicińska, 2022; La Rosa & Izakovičová, 2022; Lakovskis, & Ieviņa, 2022). In mountainous regions, those are first of all geocomplexes that are stable from the perspective of paragenetic autonomy, are distinct by landscape representativeness and compactness. Therefore, geochemically interrelated autonomous geocomplexes include hypsometrically highest landscapes and basins of river headwaters. The higher is the autonomy level of those geocomplexes, the higher is their stability, and therefore likelihood of pres-
ervation of valuable nature formations. Protection of those landscapes should prevent the intensification of subsidence, landslides, avalanches and erosion, and also intensification of floods and spring water in areas at lowest hypsometric level.

The bioecological approach is focused on interrelation between biotic and abiotic environments, first of all oriented at preserving especially valuable centers of biodiversity (Tandaric, 2015; Tolvanen et al., 2020; Zhang, Zhou, & Luo, 2023). Such centers are places identified by biologists, which contain rare species of flora and fauna, typical or disappeared phytocoenoses and natural environments.

A limiting factor in NPP planning is anthropogenic use of the territories: existing forestry, agricultural, transport, and recreational, etc uses of nature.

Materials and methods

To accomplish the abovementioned tasks, we elucidated the boundaries of the Borzhava MM and high-altitude landscapes using SRTM data for the study area. The borders of the massif and landscape areas were determined according to the studies by Melnyk (1999). Therefore, as the Borzhava MM, we understand the Borzhava physical-geographic subdistrict (landscape), where six types of landscape areas have been identified.

To identify bioecologically valuable nature ecosystems and form the protected park zone, we charted a schematic map and therefore the table «Existing Nature-Reserve areas within the Borzhava Physical-Geographical Subdistrict in the Context of Landscapes» to the scale of 1:500,000. To chart it, we used the data of the Department of Ecology and Natural Resources of Transcarpathian region, detailed plans of planted forests, large-scale schemes of NRF objects, and data of the public cadastre map of Ukraine, fund materials of the aforementioned forestry, decipherment of Google satellite images, and also the said studies. The maps were generated using QGIS 3.16.8 software.

The current condition of the nature complexes was assessed by reconnaissance observations on the routes within the areas proposed to be included in the Borzhava NPP. For the future, we recommend performing more detailed studies for distinct delimitation between the functional zones of the nature-reserve institution.

Results and Analysis

The Borzhava Mountain Massif is situated between the Vycha and Rika rivers in the east of Mukachevo and in the north of Hust districts of Transcarpathian region.

From a physical-geographical standpoint, it is represented by the Borzhava subdistrict of the Polonyna Range, belonging to the Seredniohiria-Polonyna area (Melnyk, 1999). This area is where the massif’s highest points are concentrated. In the northeast part, there is an over 40 km-long monolithic range, starting with Tomnatyk mountain (1,343.8 m) on the left bank of the Vycha river and ending by the Palenyi Hrun range (1,038.5 m) on the right bank of the Rika river. The highest mountains are in the northwest part of the Polonyna-Borzhava Range (Velykyi Verh, 1,598 m) and also the northwest ramification – Stii mountain (1,681.5 m). The range in this area is the widest, as well as the residuals of the oldest near-range flattened surface (300-400 m). (Kravchuk, 2008). Slopes of this massif are densely cut by the network of permanent and temporary water currents that supply the rivers Vycha (a tributary of the Latorytsia), Borzhava and Rika (a Tysa tributary). The Borzhava is one of the most avalanche-prone districts of the Ukrainian Carpathians. In the southwest sector, there are distinct avalanche geo-complexes on the northern-exposure slopes (areas of Stii (1,682 m) and Plai mountains). On average, during the avalanche period, around 20 avalanches fall in the area; the most avalanche-active territories – according to the conducted studies – are northern and northwest slopes in the area between Velykyi Verh and Stii mountains (Tykhanovych & Bilaniuk, 2013).

According to the «Landscape Map of the Ukrainian Carpathians» (Melnyk A., 1999), six moun-
taneous landscape complexes (types of high-altitude landscapes) are designated in this subdistrict (Fig. 2). They are mainly represented by the following types of landscapes: 1) convex peneplained alpine-subalpine (polonyna) high mountainous area with high montane meadows, heaths, green-alder krummholz on mountainous-meadow-wetland soils, composed of sandstones and sandstone flysch of the Duklianska zone (1,300 – 1,680 m above sea level); 2) steep-sloped erosion-denudation forest-covered average-height mountainous area with beech, pine-spruce-fir-beech forests on brown mountainous-forest thin highly skeletal soils, composed of sandstones and sandstone flysch of the Duklianska zone (1,200-1,600 m); 3) steep-sloped erosion-denudation forest-covered and secondary meadow low mountainous areas (300-1,200 m) with beech forests on average-skeletal soils, composed of coarse-rhythmic sandstone flysch of the Porkuletska zone; 4) gentle-sloped erosion-denudation forest-covered and secondary meadow low mountainous area with beech, pine-spruce-beech forests on brown mountainous forest-covered thick poorly skeletal soils, composed of argillites with thin layers of sandstones and aleurolites of the Krosnenska zone; 5) terraced beds of the river valleys (floodplain and lower terraces), composed of loamy and sandy pebble alluvium with pine-beech-alder forests and meadow vegetation on sod and meadow soils on large sandstone and sandstone flysch of the Duklianska, Porkuletska, and Krosnenska zones; 6) floodplains and mouths of rivers, composed of pebble, sand and loam with meadow and shrub vegetation on sod undeveloped soils.

According to the landscape principles of organization planning, the NPP territory should first of all contain convex peneplained alpine-subalpine (polonyna) high mountainous areas, and also basins of high stream orders of rivers that are mostly within the areas of steep-sloped erosion-denudation forest-covered average-height mountainous areas, partially within the area of steep-sloped erosion-denudation forest-covered and secondary meadow low-height mountainous areas. The rivers that form such basins are first of all considered to be the Vycha with the tributaries Osa and Zhdymyr, Svaliavka, the Borzhava with the Kushnytsia tributary, the Rika with the Shyrokyi tributary, and others.
### Table 1. List of nature-reserve territories in the Borzhava physical-geographic subdistrict
Source: the data of the Department of Ecology and Natural Resources of Transcarpathian region (2022).

<table>
<thead>
<tr>
<th>№</th>
<th>Name</th>
<th>Year of establishment</th>
<th>Area, ha</th>
<th>Nature-reserve significance</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td><strong>National Significance</strong></td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>Reserves</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Forests</td>
</tr>
<tr>
<td>1</td>
<td>Rosishnyi</td>
<td>1974</td>
<td>461</td>
<td>Area of virgin indigenous phytocoenoses, rare plants included in the Red Book of Ukraine – <em>Galanthus nivalis, Lilium martagon, Crocus heuffelianus, Listera ovate, Platanthera bifolia</em></td>
</tr>
<tr>
<td>2</td>
<td>Potik Osa</td>
<td>1998</td>
<td>500</td>
<td>Home for Salamandra salamandra, Ichthyosauro alpestris, Rana dalmatina, Sorex alpinis, Neomys anomalus, included in the Red Book of Ukraine. The stream is inhabited by a valuable fish <em>Salmo trutta</em>.</td>
</tr>
<tr>
<td>3</td>
<td>Richanskyi</td>
<td>1985</td>
<td>2,408</td>
<td>Protection is provided for a forest where valuable animals concentrate and reproduce, including <em>Ursus arctos, Lynx lynx, Felis silvestris</em>, included in the Red Book of Ukraine. Mountainous streams are tributaries of the Borzhava eiver and (partially) Rika are places of spawning and fattening of rare fishes.</td>
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<td></td>
<td></td>
<td><strong>Local-Significance</strong></td>
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<td></td>
<td>Reserves</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Forests</td>
</tr>
<tr>
<td>4</td>
<td>Pruborzhavskyi</td>
<td>2015</td>
<td>444.8</td>
<td>Unique hardly disturbed old-growth beech forests that play important soil-protective and water-regulating functions and maintain the hydrological regime of the basin of the Borzhava river.</td>
</tr>
<tr>
<td>5</td>
<td>Temnatyk</td>
<td>2009</td>
<td>1,456</td>
<td>Beech and beech-spruce forests that are structurally similar to virgin ecosystems in the basin of the Latorytsia river.</td>
</tr>
<tr>
<td>6</td>
<td>Rika</td>
<td>1972</td>
<td>394</td>
<td>Valuable Salmonidae fishes living in the Bronka river and its tributaries.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Protected tracts</td>
</tr>
<tr>
<td>7</td>
<td>Bereznyky Virgin Forests Protected Tract</td>
<td>2017</td>
<td>385.5</td>
<td>Valuable virgin beech forests that are home for rare animals of Transcarpathian region. Rare and endangered species, namely: <em>Asplenium scolopendrium, Eirenis medus, Convallaria majalis L., Symphytum cordatum, Phleum alpinum, Achillea gerberi M.</em>, and <em>Rhodiola rosea L.</em> In the territory of the protected tract, there were found rare animals included in the Red Book of Ukraine: <em>Ursus arctos, Felis silvestris, Lynx lynx</em>. In the natural conditions, the streams still contain valuable fishes, such as: <em>Thymallus thymallus, Oncorhynchus mykiss, and Salmo trutta</em>.</td>
</tr>
<tr>
<td>8</td>
<td>Borzhava Virgin Forests</td>
<td>2017</td>
<td>853.5</td>
<td>Up to 200 years-old pre-polonyna virgin beech forests are growing in the Polonyna Borzhava Mountain Massif. The herbaceous coverage contains rare plants included in the Red Book of Ukraine or having a special protection: <em>Phyllitis scolopendrium, Convallaria majalis L.</em>, <em>Symphytum cordatum, Phleum alpinum, and Rhodiola rosea L.</em> The fauna contains <em>Ursus arctos, Felis silvestris, Meles meles, Lynx lynx, Ciconia nigra</em>, and <em>Salamandra salamandra</em>.</td>
</tr>
<tr>
<td>9</td>
<td>Virgin Forests and Quasi-Virgin Forests of the Svaliava Forestry nature relic</td>
<td>2021</td>
<td>822.6</td>
<td>Virgin forests</td>
</tr>
<tr>
<td>10</td>
<td>Natural Forests of the Nyzhni Bystryi Forestry old-growth forest nature relic</td>
<td>2021</td>
<td>123.8</td>
<td>Valuable old-growth beech forests and old forests that are environments for rare biodiversity of Zakarpattia. The fauna includes <em>Ursus arctos, Felis silvestris, Meles meles, Lynx lynx, Ciconia nigra</em>, and <em>Salamandra salamandra</em>.</td>
</tr>
<tr>
<td>11</td>
<td>Natural Forests and Quasi-Virgin Forest of the Dusyno Forestry old-growth forest relic</td>
<td>2021</td>
<td>107.0</td>
<td>Nature relics</td>
</tr>
<tr>
<td>12</td>
<td>Virgin Forests of the Bereznyky Forestry</td>
<td>2021</td>
<td>75</td>
<td>Virgin forests</td>
</tr>
</tbody>
</table>
### Botanical

<table>
<thead>
<tr>
<th>#</th>
<th>Common oak</th>
<th>1969</th>
<th>0.01</th>
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<tr>
<td>13</td>
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Over 600 years-old common oak.

<table>
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<tr>
<th>Hydrological</th>
<th>14</th>
<th>Shypit Waterfall</th>
<th>1984</th>
<th>0.19</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
<td>Lake on the Borzhava Polonyna</td>
<td>1969</td>
<td>2.34</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Repynne Lake</td>
<td>1969</td>
<td>0.97</td>
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<tr>
<td>29</td>
<td>Chonok</td>
<td>1972</td>
<td>6.1</td>
<td></td>
<td></td>
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</tbody>
</table>

| Natural landscape, various species of trees and shrubs. | Garden-design park monument |

The Borzhava landscape is valuable from a bioclimatological perspective as well. There have been found 94 species of birds, including 8 assigned to the Red Book of Ukraine, 21 vascular plants included in the Red Book of Ukraine and 22 species of invertebrates. Across the Borzhava Polonyna run international migration routes taken by a number of birds, including rare, protected by the national and international laws, particularly: common crane (Grus grus), black stork (Ciconia nigra), western marsh harrier ( Circus aeruginosus), hen harrier (Circus cyaneus), osprey ( Pandion haliaetus), black kite ( Milvus migrans), lesser spotted eagle (Clanga pomarina), and greater spotted eagle (Clanga clanga) (Dubovyk, 2020). The most bioclimatological valuable areas of the mountain massif are currently protected within NRF objects. Our analysis of the network of those objects (Table 1, Fig. 2) shows their concentration in the northwest part. The protected ecosystems, first of all those with 50-100 ha areas, comprise the basis for creating the NPP. At the same time, in the southern part of the massif, in the Bronka river basin, there is a large forest that is protected within the Richanskyi Zoological Reserve (2,408 ha) and the Rika Ichthyological Reserve (394 ha). For the future, the NPP we propose can have a cluster structure and comprise two major constituents.

Taking into account the previous researches (Kovalchuk, Kovalchuk, Felbaba-Klushina & Piashechnik, 2007; Felbaba-Klushina, 2020), and also the approaches we described earlier, we suggest to outline the 20.15 thou ha National Nature Park as follows.

Besides the highest stratum with the Borzhava-range polonynas, we propose that the territory would include the pre-polonyna forest structures of steep-sloped erosion-denudation forested average-height mountainous areas and steep-sloped erosion-denudation forested low-height mountainous areas (in the southwest), which – other than nature protection – carry out an important anti-erosion function. A large part of those forests are already under protection (Fig. 3). West of the park, we suggest including the geocomplexes of the Hanivetskyi landscape (subdistrict) in the Latorytsia-Vycha interfluve, where there are the Pinava and Krasna Dolyna locally significant reserves, western part of the Temnatyk Reserve, the Virgin Forests and Quasi-Virgin Forests of the Hankovtsia Forestry, hydrological nature relics, represented by hydrogeological wells.

Such organization plan of the NNP would first of all provide a national-level protection of the Polonyna Borzhava (UA0000263). This object of the Emerald network was found to have 12 types of habitats included in the Resolution of the 4th Bern Convention, and also 20 species of flora and fauna from the list approved by the Resolution of the 6th Bern Convention. The commonest types of habitats in the area are E1.71. Group of Nardus stricta; E4.3 acidic alpine and subalpine herbaceous groups; E5.5 Subalpine wet and moist high-grass and Polytopodiopsis-covered areas; F4.2 Dry heaths; G1.6 Beech forests. There are mostly Vaccinium myrtillus with additions of Vaccinium vitis-idaea, covering the northern slopes of the altitudinal belt of natural forests, comprised of European spruce (1,000 – 1,300 m), currently destroyed. Other species of vascular plants are found singly, including regular components of mountain meadows and krummholzes, such as Nardus stricta, Festuca airoides, etc. At the same time, there occur species that are typical components of forest ecosystems (Felbaba-Klushina & Bizilia, 2016).

In order to identify the functional zones within the outlined territory of the proposed park, we studied the contemporary specifics of lands and forests that are in various forms of nature use and forms of property, and also spatial structure of the vegetation coverage.
In general, the dominating lands in the territory of the proposed NNP are those of the forest fund (76%) (Fig. 4). As of now, those forests are included in three forestries of the Svaliava Forestry State Enterprise (SE), two forestries the Volovets Forestry SE and one forestry of the Mizhiria Forestry SE. There prevail forest phytocoenoses with dominance of *Fagus sylvatica*. According to the age structure, there dominate mature (49%) and average-age (32%) tree stands, those maturing (8%) and young (3%) being much less represented. Small forest fragments along the southwest slopes of the range between Plai and Velykyi Verh mountains and the northern slopes between Velykyi Verh and Stii mountains were identified by researchers of the WWF of Ukraine to quasi-virgin (old-growth) (Fig. 5).

The nature complexes of polonynas, accounting approximately for about 24% of the proposed park, are mostly represented by herbaceous heaths comprising *Nardus stricta* and *Festuca airoides*, which are chiefly used as pastures. Northeast, northern and northwest slopes of the range are covered with shrub heaths comprised of blueberries. In places where cattle had been grazed for a long time, secondary vegetation grows: *Rumex alpinus*, *Deschampsia cespitosa*, and also *Urtica dioica*, *Taraxacum officinale*, etc near the upper forest margin.

As seen on the map we charted, most of the lands within the object of the Emerald network – the Polonyna Borzhava – by purpose are reserved and municipal forms of property, at the same time some areas are used in agriculture.

Based on the analysis of the schematic vegetation-coverage maps we developed, taking into account that those ecosystems belong to various types of nature use, and also the categorization of forest...
lands, we propose a preliminary functional zoning of the projected NNP, designating four functional zones: protected, regulated recreation, stationary recreation, and economic.

Within the protected zone, we suggest designating two subzones: strict and regulated protections, because the part of forest ecosystems that performs anti-erosion and water-regulation functions had undergone changes and needs forest-economic measures promoting biologically stable, high-quality and highly productive tree stands.

The strict-protection subzone would include the existing nature-reserve objects, and also virgin forests identified by WWF-Ukraine scientists and agreed upon with the forest users. We believe that this subzone should contain the protected banks along the mountain streams, which belong to the basin systems of currents of the Osa and Zhdymyr, tributaries of the Vycha river. In particular, the Osa tributary runs within the national zoological reserve of the same name, which is an environment for valuable and rare species Salamandra salamandra, Ichthyosaura alpestris, Rana dalmatina, Sorex alpinus and Neomys anomalus, included in the Red Book of Ukraine. The current is home for a valuable fish – brown trout (Salmo trutta). Furthermore, for the absolute-protection zone, we propose allocating Mala Hymba mountain (1,416 m) and rocky outcrops on mountains Stii (1,681.5 m), Velykyi Verh (1,598 m), Hymba (1,491 m), Hrab (1,347 m), covered with rocky vegetation.

At the same time, those areas account for 32.7% of general area of the proposed park, occupying over 40.2% of its forest part. We suggest that the regulated-protection zone would include forests that perform protective functions: anti-erosion, forests along railways and river banks and lake shores, –
Fig. 5. Species and ages structures of forests, groups of vegetation in polonynas and other non-forested lands in the projected Borzhava NPP
Source: based on the studies by Malynovskyi & Melnychuk (1955); Felbaba-Klushina & Guklyvska (2021), based on detailed plans of planted forests

...and also protected shore of the lake on the Borzhava polonyna, which would be 32.5%. In general, the protected zone would equal 13.14 thou ha – 65.2% of NNP area.

The planned zone of regulated recreation includes the forest-park and forest-economic parts of the green-zone forests, and also the municipal lands of the reserve, which are mostly northern slopes of the Borzhava polonynas and unregistered municipal lands on the southern slopes. In this part of the Borzhava polonynas, there are waymarked touristic routes and convenient places for camping. In the northeast part of Hymba mountain (1,491 m), various types of ski lifts operate, including chairlift and surface lifts. At the same time, the intensity of using those territories as pastures tends to decrease. The regulated-recreation zone would equal 18.2%.

The zone of stationary recreation is concentrated on the southwest of the projected territory (Vovchyi village), represented by constructions along the Vycha river and on the polonyna (ruins of a cheese factory, shepherds’ houses, the Plai meteostation), and a camping area. Together, they measure only 0.5% of the park’s territory.

The economic zone would first of all comprise forests for exploitation. In the polonynas, it would include southern and southwest slopes of the range between mountains Velykyi Verh (1,598 m) and Skalianka (1,278 m), Stii (1,681.5 m) and Kinska (1,255 m), northern slopes of the range between mountains Temnatyi (1,343 m) and Voskresenskyi Verh (1,219 m), fragments of pre-polonyna slopes of Hymba (1,491 m), Zhyd-Mahura (1,517 m), Hrab (1,347 m), which are municipal, but some areas are state-
owned, allocated for agricultural purposes; narrow near-summit fragmented strips along the range between mountains Plai (1,323 m), Velykyi Verh (1,598 m), Mala Hymba (1,416 m), some spurs of them, and also fragments between mountains Rovnyi (1,435 m) and Riapetska (1,210 m), privately owned, and of agricultural allocation as well; some areas on gentle slopes, terraces and plain areas near the upper margin of the forest, covered with grazing-site vegetation. In general, the economic zone contains 16.1% of the park’s territory (Fig. 6).

The presented functional zoning, where the main part comprises the protected area (65.2%), is for preservation of the most valuable nature complexes of the Borzhava. In the economic and recreational zones, there would be regulated development of traditional spheres of agriculture, recreation and tourism.

Currently, some state-owned areas on the Borzhava ranges are rented by the Atlas Volovets Energy Ltd that is planning to construct WPS (wind power station) windmills with general power measuring 120 MW. Creating artificial surfaces, soil compaction as a result of intense movement of heavy transport, network of water drainages would alter the surface runoff, which can significantly deteriorate the water balance and hydrological condition of mountain streams and currents, which are the environment for aquatic animals and moist-loving vegetation. Moreover, there are many important bird migration routes over the Borzhava range. The presence of windmills would also endanger people nearby, especially in winter because of high risk of ice chunks from the wind turbines hurting people. This would drastically decrease the potential of the Borzhava MM. The said facts suggest that the project can substantially harm the natural complexes and therefore must not be implemented.

As with the forestries, the examined territory first of all needs protection of valuable forest ecosystems and prohibition of clearcutting of forests that perform protective anti-erosion and water-regulating functions.

An additional study and regulation are needed for the traditional grazing of bovines and sheep in the Borzhava polonynas, which often leads to the formation of low-productive Deschampsia-Nardus groups.

A common phenomenon in the Borzhava is also large-scale burning of blueberry fields for expansion of pasture areas. There is a need of fragmentation and introduction of scientifically-substantiated and nature-protective forms of cattle grazing in highlands.
Conclusions

In the presented study, we have provided the rationale for the creation and planning organization of the National Nature Park (NNP) in the northwest part of the Borzhava Mountain Massif, based on landscape and bioecological principles, taking into account the modern types of nature use and anthropogenic threats in the region. Presence of such an NNP would increase the efficiency of protection of geosystems within the Zhdymyr key area of the regional ecosphere network of Transcarpathian region.

The projected territory of the NNP, measuring 20.15 thou ha, would include the northwest part of the Borzhava physical-geographic subdistrict. It is represented by the highest stratum with polonynas of the Borzhava range, forests in the areas of steep-sloped forest-covered average-height mountainous and partly the steep-sloped forest-covered low mountainous areas. Therefore, the park would include an object of the Emerald network – the Borzhava Polonyna (UA0000263), 16 objects of the nature-reserve fund, in particular nationally significant forest reserves – the Rosishnyi and Potik Osa, large (over 800 ha) locally significant reserve Temnatyk, Borzhava Virgin Forests Protected Tract, the Virgin Forests and Quasi-Virgin Forests of the Svaliavske Forestry old-growth-forest nature relic.

The project demonstrated in our article, describing the functional zoning of the park, designates the protected zone, comprising 65.2% (subzones of strict protection – 32.7% and regulated protection – 32.5%), zone of regulated recreation – 18.2%, zone of stationary recreation – 0.5%, and economic zone – 16.1%.

The strict-protection zone has been determined based on the most valuable sites of biotic and landscape diversities: protected nature objects, protected banks of mountain streams, rocky outcrops, etc. The zone of regulated protection includes forests that perform protective functions. There is a possibility of introducing close-to-nature measures of forestry, oriented at the formation of biologically stable tree stands. The list of appropriate measures should be mentioned in the projects of creation and organization of the Borzhava NNP. The zone of regulated recreation includes forests for recreation and health-improving purposes and municipal lands in polonynas with touristic routes. A construction is now underway in the polonynas and the Latorytsia and Vycha interfluve; the territory for camping belongs to the zone of stationary recreation. Those zones were designated for the regulation of development of recreation and tourism. The economic zone is divided based on forests for exploitation and lands of polonynas that are used for agricultural purposes. Its purpose is regulation of the development of forestry and agricultural nature uses.

Creation of poly-functional nature-protection national institutions in the Borzhava MM would regulate the conflicts arising between the interests of nature protection and development of the region’s traditional spheres of agriculture, recreation and tourism. Organizing such a NNP would prevent the industrial constructions in the area, namely the WPS in the polonynas, general power of which would be 120 MW.

Fig. 7. Impacts of jeeping in the Borzhava Mountain Massif

An important task is also partly restricting or completely banning jeeping in the territory of the Borzhava. This area is attractive for riding in off-road vehicles on steep slopes and polonynas, which ruins the soil-vegetation coverage and intensifies erosion. Because of absence of a single marked route, more territories are being destroyed (Fig. 7).
The study is a basis for designing a project of the Park with following provision of additional materials.

References


