



FEATURES OF BIODIVERSITY CONSERVATION IN EASTERN PODILLIA: THEORETICAL AND PRACTICAL APPROACHES

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Statement of the problem

Biotic diversity (BD) is the basis for the formation of a holistic, structured, unique, self-regulating and self-renewing biotic system that performs key planetary functions. In essence, it is the history of the endless development of diversity of forms at different levels of its organisation (genetic, population-species, coenotic, ecosystem) and life functions as a single, holistic, unique planetary phenomenon. The unity and continuity of forms and functions necessitate the preservation of BD. However, the entire process of human development has been aimed at disrupting this integrity, as it has taken place at its expense. This has been particularly evident in the current stage of the technological revolution, when the rate of anthropogenic changes in vegetation cover, ecosystems and landscapes has exceeded the rate of natural evolution, and a number of negative actions (the greenhouse effect, desertification, ozone holes, acid rain, smog, pollution with toxic compounds, anthropogenic transformation of natural landscapes, military conflicts) have taken on global significance. It has become clear that the catastrophic loss of biodiversity, which is the most important component of the biosphere, the sociosphere, the "ecosystem fund" and "natural capital", is the greatest threat to society. The reduction in biodiversity is a consequence of the increase in areas dominated by humans (urbicultural and agroecosystems), the decline in the productivity of natural ecosystems, the disruption of small-scale nutrient cycles, the breakdown of food chains and links between organisms, and the deterioration of the socio-economic living conditions of the population [14-15].

To preserve and restore biodiversity, the fifteenth Conference of the Parties to the UN Convention on Biological Diversity was held in Montreal,



Canada, in December 2022. During this meeting, the countries that signed the convention, including Ukraine, agreed on the Kunming-Montreal Framework Protocol. One of the goals of the agreement is that by 2030, 30% of all terrestrial, coastal and marine ecosystems in the world should be under effective protection and management in networks of interconnected protected areas. A similar goal – to protect 30% of land and water areas by 2030 – was set for EU countries back in May 2020 by the EU Biodiversity Strategy, which is an integral part of the European Green Deal (.). Therefore, in 2022, nature conservation areas established under national legislation in European Union countries, together with the areas of the pan-European Natura 2000 network (the equivalent of the Emerald Network for EU countries), covered 26.4% of the EU's land area and 12.1% of its marine waters. In individual countries, these figures range from 13.3% to 55.8% for land and from 2.3% to 45.4% for marine areas. In other words, the EU is much closer to its 30% target than Ukraine is to its 15% target, with nine EU countries already exceeding their 2030 target (Fig. 1-2) [28-29].

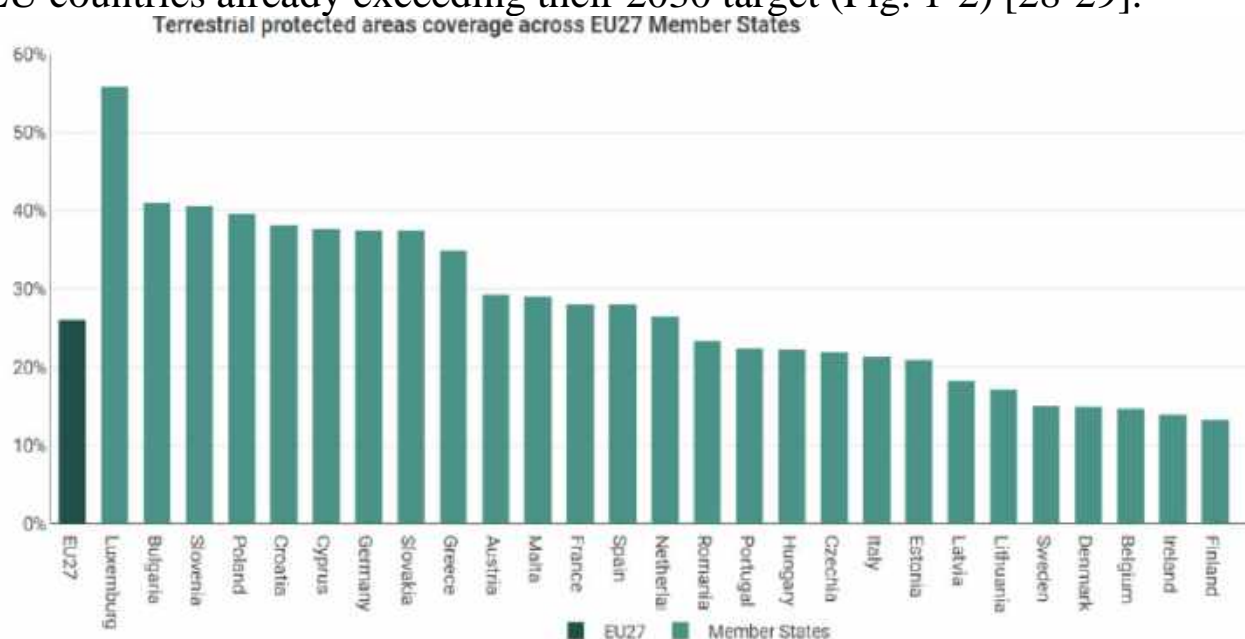


Fig. 1. Distribution of the proportion of land under protection in EU countries

Of course, Natura 2000 status does not always guarantee adequate protection of valuable natural sites in practice. Nevertheless, it provides real mechanisms for biodiversity conservation, such as the development of plans with clear measures that need to be implemented to achieve a good conservation status for protected species and habitats, i.e. the habitats of species. If we take into account only the nature conservation areas of EU countries created under national legislation (analogous to our nature reserve



fund, PZF), they cover an average of 18.27% of land area (almost three times higher than Ukraine), and in Poland, for example, 32.2% of the country's territory.

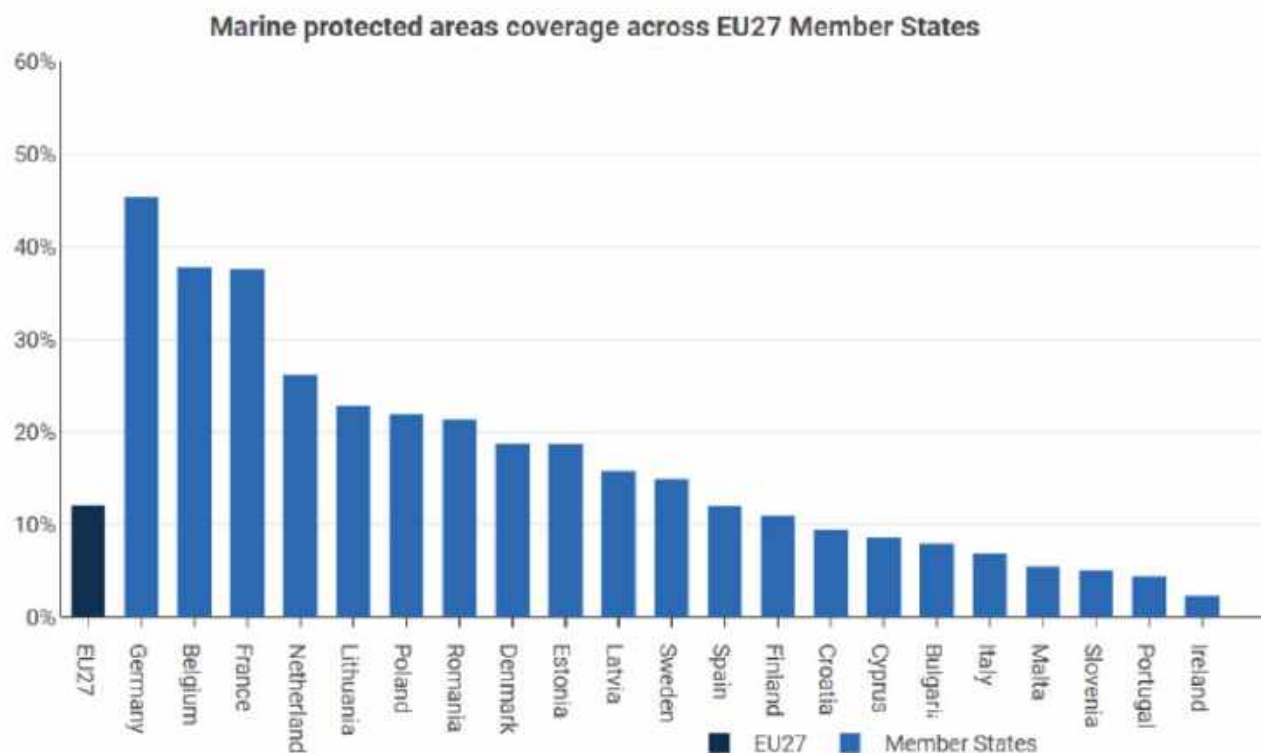


Fig. 2. Distribution of the share of marine areas under protection in EU countries

However, when comparing European analogues with our PZF, it should be borne in mind that the categories of nature conservation areas and the requirements for their protection vary greatly from country to country. Nevertheless, even the weakest protection status for a valuable area is better than no protection at all. Thus, Ukraine lags significantly behind the EU in terms of the area of protected areas, and recent trends do not predict a significant improvement in the situation. For example, between 2019 and 2023, the area of protected areas in Ukraine increased by only 189,000 hectares (0.3% of the country's area). At this rate, it will take more than 100 years to reach the 15% target. For comparison, in 2014-2018, the increase was 324,000 hectares (0.58%), and in 2009-2013, it was 677,400 hectares (1.1%). In recent years, the pace of expansion of the nature reserve fund has not only failed to increase, but has even slowed down significantly. And full-scale war does not seem to be a valid excuse, as the problems began long before it (Fig. 3) [28].

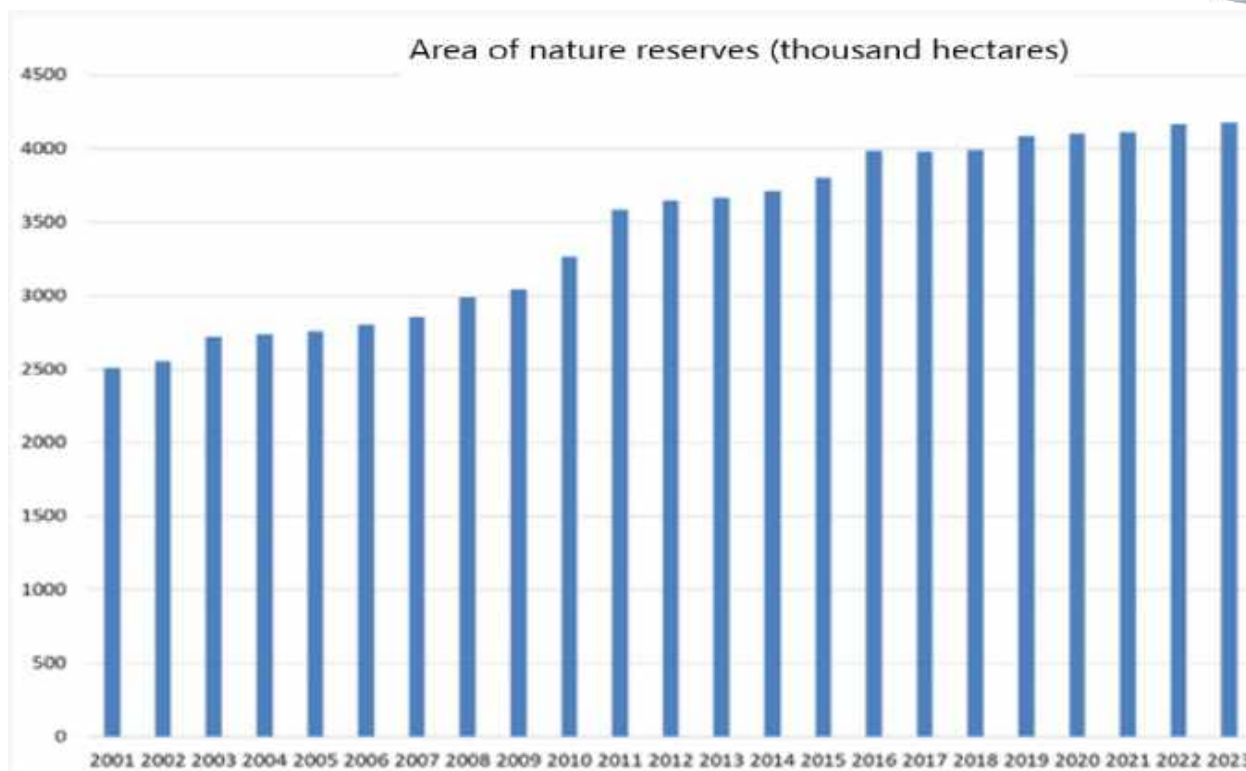


Fig. 3. Dynamics of changes in the area of the nature reserve fund of Ukraine during 2001-2023 (thousand hectares)

Of course, in order to preserve and restore biodiversity, it is necessary to establish a nature reserve fund. Currently, only 6.91% of Ukraine's territory is included in the nature reserve fund. Our legislation declares the goal to increase this figure to 15% by 2030. However, at the current rate of creation of new protected areas, it will take more than 100 years to achieve the target, as mentioned above [29]. Currently, expanding protected areas will help preserve clean water, clean air, and fertile soils, which directly affect our health and well-being. Without proper protection of natural resources, Ukraine will find it difficult to cope with environmental challenges and ensure quality of life for future generations. Therefore, the Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the Period until 2030" provides for achieving a share of protected areas at the level of 15% of the total territory of Ukraine by 2030 and 12.5% by 2025. The actual area of protected natural areas in 2024 was 4.181 million hectares, or only 6.91% of our country's territory [28].

In addition to the nature reserve fund, where biodiversity is preserved and restored, Ukraine has nature conservation areas of European importance (Emerald Network areas), which cover 13.7% of our country's territory and were created in accordance with the Bern Convention (Convention on the



Conservation of European Wildlife and Natural Habitats). However, this does not mean that more than 20% of Ukraine is under protection. The Emerald Network overlaps with the Nature Reserve Fund in a number of areas, for example, it includes almost all Ukrainian national nature parks and reserves. In addition, the mechanisms for protecting the Emerald Network areas are not yet enshrined in national legislation (no law has been passed), which makes it impossible to effectively prevent the destruction of valuable species and ecosystems (natural habitats) within these areas. We have a similar situation with other protected areas designated in accordance with international agreements, such as wetlands of international importance (Ramsar Convention) or biosphere reserves. They are only effectively protected where there are overlaps with previously established nature reserve fund sites, or where new nature reserve fund sites have been specifically created to protect internationally recognised valuable areas. Unfortunately, in Ukraine, biodiversity is only effectively protected when there are clear restrictions on land use within these areas. However, even there, violations often occur, such as the ploughing of grassland ecosystems in nature reserves, economic zones of national natural parks or regional landscape parks, coastal protection strips, and water protection zones. This is due to ineffective environmental control and the state's lack of attention to the conservation and restoration of biodiversity [14].

Eastern Podillia (Vinnytsia region) is an important agricultural region of our country, accounting for 4.4% of Ukraine's total area, where its share in the total agricultural production of the country is 12.3%. Agricultural landscapes account for 76.1% of its total area, and only 5% of natural biocenoses within agricultural land are characterised by high conservation value. In order to preserve and restore it, it is necessary to implement balanced management of agricultural landscapes, sustainable agricultural land use, and maintain the sustainability of agroecosystems, taking into account economic interests. The region is unique in its combination of distinctive landscapes, geological structure, and soil and climatic conditions, which has contributed to the spread of various types of forest, wetland, rock-steppe, shrub, meadow, and steppe vegetation, as well as a combination of typical, rare, and relict plant and animal communities, the spread of endemic, relict, disjunctive-areal species, and species on the edge of their range. The biotic diversity of the region accounts for 33.4% of the country's biodiversity, which requires significant protection [6, 16].



Analysis of recent research and publications

A significant contribution to the study of the biodiversity of Eastern Podillia has been made over the years by Gudzevich A.V. (2002), Didukh Ya.P., Korotchenko I.A. (2005-2010), Solomakha V.A. (2005), Yavorska O.G. (2005), Gordienko M.I., Bondar A.O., Krynytskyi H.T. (2006-2008), Kuziemko A.A. (2007-2020), Chorna H.A. (2007), Serebryakov V.V. (2010), Matviychuk O.A. (2010-2018), Mudrak O.V. (2012-2025), Pirhal A.B. (2015), Reminnyi V.Yu. (2015), Tkach Ye.D. (2016), Shavrina V.I. (2018), Ovchinnikova Yu.Yu. (2019-2022), Golunova L.A., Shevchuk O.A. (2019), Markivska L.V. (2019), Neiko I.S. (2020), Nakonechny I.V. (2025), Romanchuk O.P. (2020-2025) and others [2, 6, 9, 20, 23, 25, 27, 30].

However, the scientific, methodological and practical foundations for biodiversity conservation, the formation of the Emerald Network, the implementation of the ecological network, optimisation of the nature reserve fund, formation of a balanced territorial organisation, optimisation and formation of sustainable agricultural landscapes of Eastern Podillia in the modern system of balanced land use, and there is no comprehensive ecological and economic analysis of them.

The aim of the study

The aim of the study is a zoological assessment of the Eastern Podillia BR in the context of sustainable development of the region. The authors present the species diversity of the region's flora and fauna by taxa. The systematic structure of its flora of higher vascular plants (HVP) is characterised and its biomorphological analysis is presented. The ecological structure of VVP in relation to water and light regimes is determined. The ecological and coenotic structure of the phytobiota is established. Rare species of flora and fauna that require protection at the international, national and regional levels are considered. The conservation status of rare plant and animal species has been determined according to three levels of protection: adequately protected; inadequately protected; not protected.

Materials and methods of research

The object of the study was the biotic diversity of Eastern Podillia. During the study, general scientific and special research methods were used: *desk-based* (determination of taxonomic-typological, biomorphological, ecological-cenotic and adventive phytodiversity common in various ecotopes of the region); *complex, systematic, retrospective* and *comparative* analyses (to identify the cause-and-effect relationships of anthropogenic transformation of natural ecosystems and their species composition);



interdisciplinary (for zoological assessment of biodiversity); *detailed* routes (identifying the impact of negative factors on natural ecosystems and biodiversity in general); *field* (study of species and ecosystem diversity); *mathematical* (processing of obtained data); *statistical* (establishing, on the basis of regression, dispersion, and correlation analyses, the reliability of the obtained results and functional dependencies between various factors and processes).

To conduct research on the state of biodiversity in Eastern Podillia, data from the Department of Territorial Development and Infrastructure, the Department of Agricultural Development, the Forestry and Hunting Management of the Vinnytsia Regional Military Administration, the Main Department of Statistics in the Vinnytsia Region, the State Environmental Inspection in the Vinnytsia region, the Vinnytsia branch of the State Institution "Institute of Soil Protection of Ukraine", the Vinnytsia Regional Municipal Specialised Forestry Enterprise "Vinoblago", and the Southern Bug and Dniester Basin Water Resources Administrations [35].

Research on the biotic diversity of Eastern Podillia is associated with the widespread use of general theoretical and specific scientific approaches. Among them were used: *traditional* or classical (comparative, historical, genetic, evolutionary) and *specific* (constructive, socio-economic, systemic, ecological, landscape-typological, informational, sociological) research approaches [3-4, 6, 15-17, 37].

Presentation of the main material

The territory of Eastern Podillia (Vinnytsia region), according to the physical and geographical zoning of Ukraine (2005), belongs to the Eastern European flat landscape of the forest-steppe zone. It includes the Dniester-Dnipro forest-steppe region, which comprises part of the north-western and north-eastern Dnipro Upland, the Central Dnipro and Southern Podillia forest-steppe, the entire territory of the Dniester-Eastern Podillia and Middle Bug forest-steppe [12].

According to the geobotanical zoning of Ukraine (2003), the Vinnytsia region lies within the Eurasian steppe region, which belongs to the Holarctic dominion. It includes the forest-steppe subregion of the East European forest-steppe province of oak forests, steppe meadows and meadow steppes of the Ukrainian forest-steppe subprovince, which includes the central and northern parts of the Northern Podillia district of hornbeam-oak and oak forests, steppe meadows and grassy steppes, the north-eastern part of the Northern Right-Bank Dnieper District of hornbeam-oak and oak forests,



steppe meadows and grassy steppes, the eastern part of the Central Right-Bank Dnieper District of hornbeam-oak and oak forests and grassy steppes, the southern part of the Southern Podillia District of oak forests and meadow steppes, and the entire territory of the Central Podillia District of hornbeam-oak and oak forests and dry meadows [5].

Eastern Podillia is an agricultural region. In terms of soil and climate conditions, the area is quite favourable for growing crops. Therefore, land resources have a number of characteristics, among which it is necessary to note the high level of arable land, the high natural fertility of a significant part of the land, which requires scientific justification for their use and protection. As of 1 January 2025, the land resources of Eastern Podillia amounted to 2,649,200 hectares. More than three-quarters of the territory is occupied by agricultural land, of which 2,017.2 thousand hectares (76.1% of the total area) is agricultural land, including 1,727.9 thousand hectares (85.7% of the agricultural land area) of arable land, fallow land 0.9 thousand hectares (0.04%), perennial plantations 50.5 (1.9%), hayfields 50.7 (1.9%) and pastures 186.5 (7%). Forests and other wooded areas cover 379.1 thousand hectares (14.3% of the total area), built-up land 106.9 (4%), marshy land 28.9 (1.1%), open land without vegetation cover (sands, ravines, rocky areas) or with insignificant vegetation cover 28.9 (1.1%). The land area is 2,600 thousand hectares or 98.1%, water bodies are 49.2 thousand hectares or 1.9% of the total area of the region. Agricultural landscapes occupy a leading place in the region. The unsatisfactory state of the environment is currently manifested by an imbalance between agricultural land (62–87% of the total land area) and natural vegetation, as well as a significant degree of soil erosion (12–25%). The region is located in the temperate zone, with a temperate continental climate and average annual precipitation of 440–590 mm. Overall, the climate is favourable for the development of agriculture. The most common soils in the region are grey podzolic soils – 1,214,300 hectares, with black soils occupying 487,300 hectares [6, 35].

The biodiversity of Eastern Podillia is an important component of the region's environment, as it provides such ecosystem functions as climate regulation, maintenance of soil, air and water quality, and the circulation of substances and energy. However, in the current conditions of military pressure and intensive human economic activity, natural resources and the flora and fauna are being degraded, resulting in the impoverishment of the gene pool of living nature. The issue of biodiversity conservation and restoration is also important for the Eastern Podillia region, which covers



4.4% of Ukraine's territory. The region is unique in its combination of distinctive landscapes, geological structure, and soil and climatic conditions, which has contributed to the spread of forest, wetland, rock-steppe, shrub, meadow and steppe vegetation, as well as a combination of typical, rare and relict plant and animal communities, the spread of endemic, relict, disjunctive-areal species and species on the edge of their range. The biotic diversity of the region accounts for 33.4% of the country's biodiversity (Table 1) [6, 27].

Table 1

Species diversity of flora and fauna of Eastern Podillia

Taxonomic category	Number of flora species of Ukraine	Number of flora species in the region	Share of flora species of the region from the total number of flora species of Ukraine, %
<i>Species diversity of flora</i>			
<i>Streptophyta</i>	5310	1210	22,79
<i>Bryophyta</i>	763	160	20,9
<i>Algae</i>	4908	248	5,1
<i>Lichenes</i>	1322	188	14,2
<i>Fungi</i>	5227	269	5,1
Flora in general	17530	2075	11,83
<i>Species diversity of fauna</i>			
<i>Invertebrata</i>	33606	15000	46,1
<i>Cyclostomata</i>	2	1	50
<i>Actinopterygia</i>	176	30	17
<i>Caudata</i>	6	1	16,6
<i>Salientia</i>	13	9	69,2
<i>Testudinata</i>	1	1	100
<i>Lepidosauria</i>	20	6	30
<i>Aves</i>	422	194	45,9
<i>Mammalia</i>	132	70	53
<i>Vertebrata</i>	772	312	40,4
<i>In general fauna</i>	34378	15312	44,5
Biodiversity in general	51908	17387	33,4



During the field expeditions, we completed 123 field descriptions. As a result of research in Eastern Podillia, where various types of anthropogenically disturbed territories and natural phytocenoses were studied, 1,210 species of VSR were identified, belonging to 526 genera and 123 families. By studying the systematic structure of the flora of the studied territory, it was established that the species belong to 5 divisions (Table 2).

Table 2

Systematic structure of the flora of higher vascular plants of Eastern Podillia

Department	Number of families	Number of births	Number of species	Share of total, %		
				families	generations	species
<i>Lycopodiophyta</i>	1	1	1	0,8	0,2	0,1
<i>Equisetophyta</i>	1	1	9	0,8	0,2	0,7
<i>Polypodiophyta</i>	9	11	15	7,3	2,1	1,2
<i>Pinophyta</i>	1	1	2	0,8	0,2	0,2
<i>Magnoliophyta</i>	111	512	1183	90,2	97,3	97,8
Total	123	526	1210	-	-	-

The systematic structure of the flora is dominated by the *Magnoliophyta* division, which includes 1,183 species (97.2%) belonging to two classes, *Magnoliopsida* and *Liliopsida* (Fig. 4).

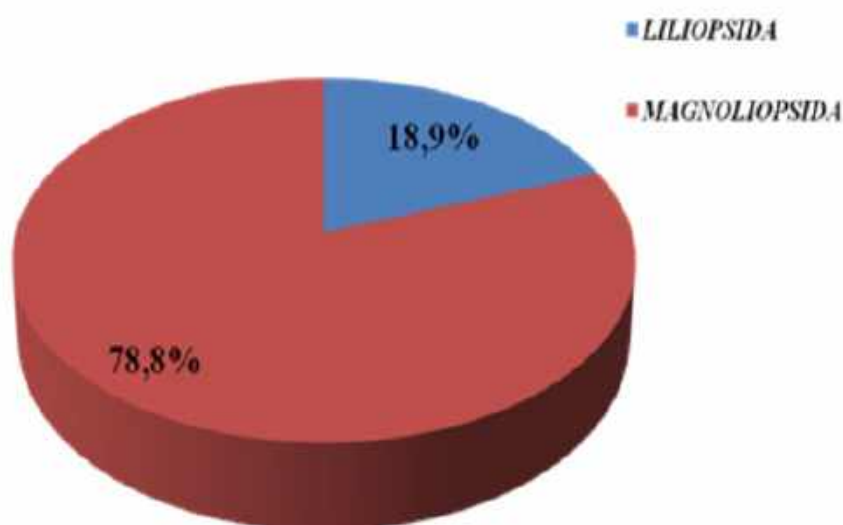


Fig. 4. Ratio of species in the *Magnoliophyta* and *Liliopsida* classes (of the total number)



The taxonomic (family-species) spectrum of phytobiota gives an idea of the composition and ratio of leading families, their ranks depending on the number of species that make up these families. The family spectrum of the leading families () of the phytobiota consists of 26 families, 15 of which reflect the main properties of the flora (Table 3).

Table 3

Spectrum of the leading families of the phytobiota of Eastern Podillia

Family	Rank	Number of births	Number of species	Share of total, %		Ratio in families, %
				generations	species	
<i>Asteraceae</i>	I	56	146	10,6	12,1	2,6
<i>Poaceae</i>	II	36	78	6,8	6,4	2,2
<i>Rosaceae</i>	III	23	73	4,4	6,0	3,2
<i>Fabaceae</i>	IV	21	69	4,0	5,7	3,3
<i>Lamiaceae</i>	V	28	68	5,3	5,6	2,4
<i>Brassicaceae</i>	VI	34	59	6,5	4,9	1,7
<i>Scrophylariaceae</i>	VII	16	51	3,0	4,2	3,2
<i>Apiaceae</i>	VII I	33	50	6,3	4,1	1,5
<i>Cyperaceae</i>	IX	8	47	1,5	3,9	5,9
<i>Caryophyllaceae</i>	X	26	45	4,9	3,7	1,7
<i>Ranunculaceae</i>	XI	19	41	3,6	3,4	2,2
<i>Chenopodiaceae</i>	XII	4	25	0,8	2,1	6,3
<i>Boraginaceae</i>	XII I	14	24	2,7	2,0	1,7
<i>Liliaceae</i>	XI V	10	20	1,9	1,7	2,0
<i>Euphorbiaceae</i>	XV	2	19	0,4	1,6	9,5
Total		330	815	62,7	67,4	2,5

Among the many methods of studying the region's biodiversity, a special place belongs to the typological assessment of biota, which considers biomorphological (indicators of life forms according to K. Raunkiaer), ecological-cenotic, ecological (relationship to water and light regime) structures, genesis and zoological affiliation of the species. The biomorphological spectrum of phytodiversity of the studied ecosystems shows that about 88.6% belong to herbaceous plants. Most species belong



to polycarpic plants 736 (60.8%). Monocarpic and annual plants account for 17.4% and 10.4%, respectively (Table 4).

Table 4

Biomorphological spectrum of vascular plants of Eastern Podillia

Life forms	Number of species	Percentage of total number of species, %
Tree (Ar)	4	4
Shrub (Fr)	6	5.1
Bush (Frt)	2	2.3
Annuals (Mkb)	126	10.4
Polycarpic trees (Pk)	73	60.8
Monocarpics (Mka)	210	17.4

When assessing the phytobiota according to K. Raunkiaer's ecobiomorph index, we found that the studied flora is dominated by hemicryptophytes and therophytes, which, according to , account for 47.9% and 22.2%, respectively. Cryptophytes, which are divided into geophytes, helophytes and hydrophytes, account for 17.6% of the studied flora. Phanerophytes and chamaephytes account for 12.3% (Fig. 5).

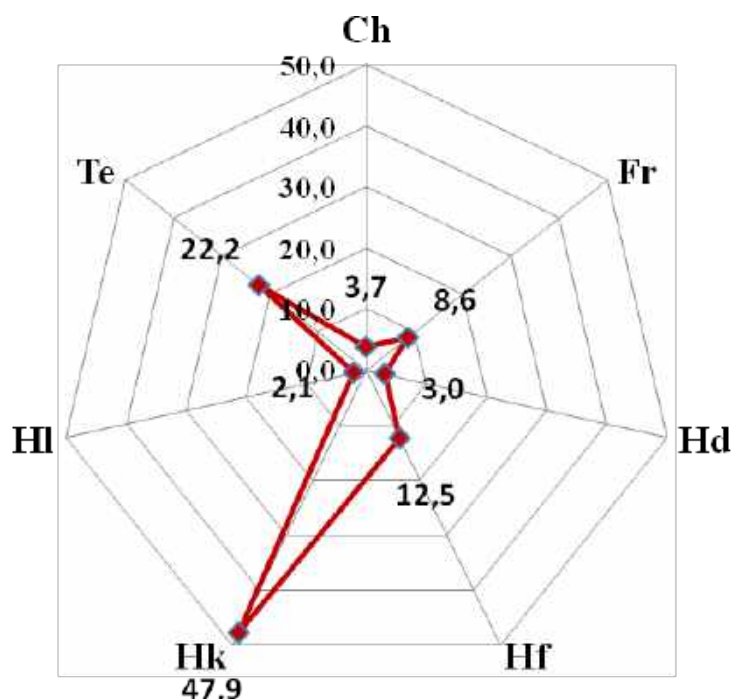


Fig. 5. Ecobiomorphs of the flora of Eastern Podillia according to K. Raunkiaer: Fr – phanerophyte; Ch – chamaephyte; Hk – hemicryptophyte; Hf – geophyte; Hl – helophyte; Hd – hydrophytic; Te – therophytic.



We analysed the state of vegetation in Eastern Podillia based on the relationship of species to water (Table 5) and light (Table 6) regimes.

Table 5

Ecological structure of higher vascular plants of Eastern Podillia in relation to the water regime

Ecological group of plants	Number of species	Percentage of total number of species, %
hygrophyt (H)	133	11
Hydrophytic (Hd)	42	3.5
xeromesophyte (Km)	432	35.7
xerophyte (Ks)	69	5.7
mesophyte (M)	221	18.3
mesoxerophyte (Mk)	313	25.9

Table 6

Ecological structure of higher vascular plants of Eastern Podillia in relation to light regime

Ecological group of plants	Number of species	Percentage of total number of species, %
Heliophytes (H)	386	31.9
Heliosciophytes (Hs)	390	32.2
Sciogeliofiti (S)	44	3.6
Sciophytes (Sh)	390	32.2

The ecological and coenotic structure of vegetation reflects the quantitative ratio of phytobiota species belonging to specific phytocenotypes. The following categories are distinguished according to the type of phytocenosis: psammophytic, halophytic, meadow, meadow-steppe, meadow-marsh, boreal forest, forest nemoral, forest-marsh, marsh, aquatic, coastal-aquatic, ruderal, segetal, species with a wide ecological amplitude, petrophytic, calcareous, chalky, and others (Table 7).

As a result of research in Eastern Podillia, where various types of anthropogenically disturbed areas and natural phytocenoses were studied, 1210 species of higher vascular plants (HVP) were identified, belonging to 526 genera and 123 families. The species of flora and fauna protected in Eastern Podillia are presented in tables 8 and 9 [6, 27].



Table 7

Ecological and coenotic structure of the phytobiota of Eastern Podillia

Ecological and coenotic structure	Number of species	Percentage of total number of species, %
Psammophytic	2	2
Halophytic	12	1
Meadow	185	15
Meadow-steppe	191	15.8
Meadow-marsh	126	10.4
Scrub	74	6
Forest coreal	41	3.4
Forest nemoral	183	15
Forest-marsh	3	2
Swamp	37	3
Aquatic	45	3.7
Coastal-water	27	2.2
Ruderal, Segetal	164	13.6
Species with a wide ecological amplitude	2	1.9
Petrophytic, calcareous, chalky and others	22	1.8
Cultural	19	1.6
Total	1210	100

Table 8

Flora species protected in the territory of Eastern Podillia

Total number of <i>flora</i> species in Eastern Podillia	1210
% of the total number of species in Ukraine	22
including those protected and included in:	22
IUCN Red List (2018)	4
ERL (1991)	5
Flora species listed in Appendix I of the Convention on the Conservation of European Wildlife and Natural Habitats	14
flora species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	27
Flora species listed in the Red Book of Ukraine (2009)	98
Plant communities listed in the ZKU (2009)	17
<i>grass and shrub steppe communities</i>	5
<i>forest communities</i>	6
<i>aquatic communities</i>	7
list of regionally rare species	123



Table 9

Fauna species protected in the territory of Eastern Podillia

Total number of <i>fauna</i> species protected in the region	1531
% of the total number of species in Ukraine	44
including those protected and included in:	340
IUCN Red List (2018)	30
ERL (1991)	35
Fauna species listed in the Red Book of Ukraine	99
Fauna species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	36
Fauna species listed in the appendices to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979), including the Emerald Network	183
Species listed in the appendices to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, CMS)	74
Species protected under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA, 1995)	31
Species protected under the Agreement on the Conservation of Bats in Europe (EUROBATS, 1979)	10
List of regionally rare species	59

The following types of vegetation are present in the region: 1) forest; 2) meadow; 3) steppe; 4) rocky steppe; 5) wetland. Rare communities listed in the Green Book of Ukraine (GBU, 2009) (Table 10) are also widespread [6].

Taking into account the ecosystem approach and the availability of detailed information on the current state of ecosystems, their composition, diversity, parameters, productivity, dynamics (spatial and temporal changes), boundaries, resistance to anthropogenic pressures, succession, etc., we have identified 39 types of ecosystems characteristic of the region, according to the classification scheme of ecosystems of Ukraine [15].

The current state of vegetation in Eastern Podillia is characterised by a significant increase in the role of anthropogenic influence. During synanthropisation, two main processes occur in parallel: on the one hand, the extinction and suppression of natural elements of the flora, and on the other, its enrichment with adventitious species and the formation of new types of plant communities with their participation. The number of adventitious plant species in the region is growing every year. There are 49 adventitious species with high invasive potential, accounting for 2.8% of their total number. In total, more than 100 species of adventitious plants grow in the region.



Table 10

Natural plant communities of the region listed in the ZKU (2009)

<i>Forest communities</i>
Communities of common oak forests (<i>Querceta roboris</i>) dominated by <i>Scopolia carniolica</i> in the herb layer
Groups of common oak forests (<i>Querceta roboris</i>) dominated by wild garlic (<i>Allium ursinum</i>) in the herbaceous layer
Communities of common oak forests (<i>Querceta (roboris) cornosa (maris)</i>) and field-maple-common oak forests (<i>Acereto (campestris)–Querceta (roboris) cornosa (maris)</i>)
Communities of common oak forests of blood-red oaks (<i>Querceta (roboris) swidosa (sanguineae)</i>) with a predominance of Parva sedge (<i>Carex brevicollis</i>) in the herb layer
Groupings of rock oak forests (<i>Querceta (petraeae) cornosa (maris)</i>)
Groupings of common oak forests with ivy (<i>Querceta roboris hederosa helix</i>)
<i>Grass and shrub steppe communities</i>
Formations of hairy feather grass (<i>Stipeta capillatae</i>)
Formations of the most beautiful feather grass (<i>Stipeta pulcherrimae</i>)
Formation of feather grass (<i>Stipeta pennatae</i>)
Low almond formation communities (<i>Amygdaleta nanae</i>)
Low sedge (<i>Cariceta humilis</i>) formation communities
<i>Aquatic groupings</i>
Floating water chestnut formation (<i>Trapeta natantis</i>)
Yellow water lily formation (<i>Nuphareta luteae</i>)
White water lily formation group (<i>Nymphaeeta albae</i>)
Snow-white water lily formation (<i>Nymphaeeta candidae</i>)
Formation of reed grass (<i>Glycerieta arundinaceae</i>)
Grouping of the <i>Nymphoideta peltatae</i> formation
<i>Salvinia natantis</i> formation group

About 20 species of adventive flora are in the expansion stage, including: *Galinsoga parviflora*, *Robinia pseudoacacia*, *Stenactis annua*, *Erigeron canadensis*, *Matricaria discoidea*, *Acer negundo*, *Amaranthus retroflexus*, *Bunias orientalis*, *Geranium sibiricum*, *Iva xanthiifolia*, *Fallopia sachalinensis*, *Impatiens parviflora*, *Conium maculatum*, *Bryonia alba*, *Solidago canadensis*, etc. Adventive plant species are divided into three groups according to the method of introduction: acolytofits – species accidentally introduced as a result of vegetation cover transformation,



ergaiofitofits – plants that have become feral, and xenofits – accidentally introduced as a result of human economic activity. A significant part of the adventive component consists of malicious and quarantine weeds. Among adventive plants, there are poisonous ones, the most dangerous *Conium maculatum*, *Iva xanthiifolia*, *Bryonia alba* and *Bryonia dioica*, *Phytolacca americana*, *Asclepias syriaca*, and others. Another group of plants are producers of allergens that cause persistent and difficult-to-treat hay fever in humans. The most well-known of these (*Ambrosia artemisiifolia*), which causes autumn hay fever and asthma attacks, *Heracleum sosnowskyi* and others [20].

The highest zoological assessment of the phytodiversity of Eastern Podillia is represented by rare plant species, which can be divided into the following groups for conservation purposes: 1) relicts; 2) endemics; 3) borderline species: a) species found on the eastern border of the range; b) species found on the southern border of the range; c) species found on the south-eastern border of the range; d) species located at the northern edge of the range; 4) species whose numbers are declining due to human disturbance of the habitats (habitats) in which they grow, or due to mass destruction (ornamental and medicinal species).

Rarities of the region's flora are included in the higher vascular plants, which are listed in: 1) IUCN Red List (Red List of the International Union for Conservation of Nature, 2018) – 4 species; 2) ERS (European Red List, 1991) – 5 species; 3) the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979) – 14 species; 4) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Washington, 1973) – 27 species; 5) Red Book of Ukraine (flora, 2009) – 98 species; 6) regionally rare species protected in the Vinnytsia region (decision of the 34th session of the 5th convocation of the Regional Council No. 1139 of 25 October 2010) – 123 species [6, 27].

Plant species on the IUCN Red List. There are a number of lists of plant species in the world that reflect the distribution of a species and threats to its existence on a scale larger than one country. Some lists are of global importance. One such list is the IUCN Red List. It has no official status in Ukraine, but is valuable for scientific work in the field of zoology. In Ukraine, there are 108 taxa (mainly species) of plants included in this list. In the Eastern Podillia region, four plant species listed in the IUCN Red List have been found in nature, accounting for 1.8% of the total number of rare species. All species on this list, namely *Astragalus dasyanthus*, *Carlina cirsioides*, *Chamaecytisus blockianus*, and *Chamaecytisus podolicus*, are also included in the Red Data Book of Ukraine [33].



Plant species listed in the European Red List. The ERL is a document prepared with the participation of the UN. There are 182 plant taxa from this list known in the natural flora of Ukraine. It is published as an appendix to the Red Data Book of Ukraine. Species from the ERL are predominantly endemic (with a small range) species. Since the species on the ERL are found exclusively in Europe, the threat to their existence is also a threat on a global scale, not just in Europe, as reflected in the full name of the list. Five plant species listed in the ERL have been found in the wild in the region, accounting for 2.3% of the total number of rare species. All species on this list, namely *Astragalus dasyanthus*, *Carlina cirsioides*, *Chamaecytisus blockianus*, *Chamaecytisus podolicus*, and *Schivereckia podolica*, are also included in the Red Data Book [33].

Plant species listed in Appendix I of the Bern Convention. Fourteen plant species subject to special protection under Appendix I of the Bern Convention have been identified in the region, accounting for 6.3% of the total number of rare species. All species on this list, namely *Aldrovanda vesiculosa*, *Carlina cirsioides*, *Trapa natans*, *Botrychium matricariifolium*, *Liparis loeselii*, *Dracocephalum austriacum*, *Cypripedium calceolus*, *Marsilea quadrifolia*, *Carex secalina*, thin-leaved peony (*Paeonia tenuifolia*), mountain fritillary (*Fritillaria montana*), floating salvinia (*Salvinia natans*), greater pasque flower (*Pulsatilla grandis*), and Podolian schivereckia (*Schivereckia podolica*) are also listed in the Red Data Book of Ukraine [33].

Plant species from the Red Book of Ukraine. The species under state protection listed in the Red Data Book (2009) include 98 plant species growing in Eastern Podillia, which accounts for 44.1% of the total number of rare species [33].

Regionally rare vascular plant species requiring protection in the Vinnytsia region. The flora of rare and endangered vascular plant species in the Vinnytsia region that require protection at the regional level includes 123 species, which is 55.4% of the total number of rare species belonging to 88 genera, 49 families and 5 divisions. A systematic analysis of regionally rare flora is presented in Table 11.

The unique relief, comfortable warm climate, large number of water bodies, and rich floristic diversity create special conditions for the preservation of numerous faunal complexes in the region, which differ in species composition. The qualitative and quantitative indicators of fauna are closely related to the floristic component of biocenoses. They are the result of the location of forest, steppe, meadow, wetland, agro- and urban ecosystems in the region. The composition of the region's zoocenoses is



quite diverse, with the interpenetration of forest and steppe species being a characteristic feature.

Table 11

Taxonomic structure of regionally rare flora

Division	Families		Genera		Species	
	number	%	number	%	number	%
<i>Lycopodiophyta</i>	1	2.0	1	1.1	1	0.8
<i>Equisetophyta</i>	1	2	1	1.1	3	2.4
<i>Polypodiophyta</i>	2	4.1	3	3	4	3
<i>Pinophyta</i>	1	2	1	1.1	1	0.8
<i>Magnoliophyta</i>	44	89.8	82	93.2	114	92.6
Including:						
<i>Liliopsida</i>	10	20.4	18	20.5	30	24.4
<i>Magnoliopsida</i>	34	69.4	64	72.7	93	75.6
Total	49	100	88	100	123	100

In general, the zoological assessment of the phytodiversity of Eastern Podillia is presented in Table 12 [8, 33].

Table 12

Flora species protected in the territory of Eastern Podillia

Total number of <i>flora</i> species in Eastern Podillia	1210
% of the total number of species in Ukraine	22.79
including protected species listed in:	222
IUCN Red List (2018)	4
ERL (1991)	5
Flora species listed in Appendix I of the Convention on the Conservation of European Wildlife and Natural Habitats	14
flora species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	27
RBU (2009)	98
Plant communities listed in the GBU (2009)	18
<i>Grass and shrub steppe communities</i>	5
<i>forest communities</i>	6
<i>aquatic communities</i>	7
list of regionally rare species	123



According to the zoogeographical zoning of Ukraine (2008) Eastern Podillia belongs to the Dniester-Dnipro (Right Bank) subregion of the Eastern European deciduous forest and forest-steppe zone of the mixed deciduous forest and forest-steppe zone of the Eastern European district of the Boreal European-Siberian subregion of the Palearctic region [24].

Over the past 100 years, due to significant anthropogenic pressure associated with human activity, the number of fauna species has decreased significantly, with 32 species becoming extinct. In general *Bos primigenius*, *Equus caballus ferrus*, *Saiga tatarica*, *Lynx lynx*, *Gulo gulo* and other species have disappeared from the region. However, during this period, attempts were made to acclimatise new species – *Ondatra zibethicus*, *Oryctolagus cuniculus*, *Lutra lutra*, *Marmota bobak*, *Bison bonasus*, *Cervus elaphus*, *Nyctereutes procyonoides*, *Ovis musimon* [23].

According to the ecological-typological principle, the following are distinguished in Eastern Podillia: 1) fauna of forest ecosystems; 2) fauna of agroecosystems (cultivated land, dry meadows and pastures); 3) fauna of wetland ecosystems; 4) synanthropic fauna. Despite the fact that natural biotopes (habitats) are not preserved everywhere and are located fragmentarily, their faunal composition remains relatively rich.

The highest zoological assessment of the biodiversity of Eastern Podillia is represented by rare animal species.

The rarities of the region's animal world include species listed in: 1) IUCN Red List (International Union for Conservation of Nature, 2018) – 30 ; 2) ERL (European Red List, 1991) – 35 species; 3) the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979) – 183 species; 4) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, Washington, 1973) – 36 species; 5) Red Data Book of Ukraine: Animal World (2009) – 99 species; 6) regionally rare species protected in the Vinnytsia region (decision of the 34th session of the 5th convocation of the Regional Council No. 1139 of 25 October 2010) – 59 species [6, 27]. In total, 340 animal species are included in the region's zoological lists (Table 13).

Animal species on the IUCN Red List. Despite the high level of economic development in the region, 30 animal species listed in the IUCN Red List can be found in the wild. These include 5 species of invertebrates (3 species of insects, 1 species of annelid worms and 1 species of crustaceans) and 25 species of vertebrates (1 species of cyclostome, 2 species of bony fish, 1 species of reptile, 12 species of birds, 9 species of mammals), which accounts for 8.8% of the total number of rare species. All species on this list are also listed in the Red Data Book of Ukraine.



Table 13

Fauna species protected in the territory of Eastern Podillia

Total number of protected <i>fauna</i> species in the region	15,3 12
% of the total number of species in Ukraine	44
including those protected and listed in:	34 0
IUCN Red List (2018)	30
ECS (1991)	35
Fauna species listed in the Red Book of Ukraine	99
Fauna species listed in the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	36
Fauna species listed in the appendices to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979), including the Emerald Network	18 3
Species listed in the appendices to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, CMS)	74
Species protected under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA, 1995)	31
Species protected under the Agreement on the Conservation of Bats in Europe (EUROBATS, 1979)	10
List of regionally rare species	59

These are representatives of 8 classes. Of these species, the following are relatively rare: *Proserpinus proserpina*, *Cerambyx cerdo*, *Osmoderma barnabita* – from insects; *Hirudo medicinalis* – from annelid worms; *Astacus astacus* – from crustaceans; *Eudontomyzon mariae* – from cyclostomes; *Acipenser ruthenus* and *Umbra krameri* – from bony fish; *Emys orbicularis* – from reptiles; *Haliaeetus albicilla*, *Falco cherrug*, *Falco naumanni*, *Gavia arctica*, *Limosa limosa*, *Falco vespertinus*, *Numenius arquata*, *Circus macrourus*, *Acrocephalus paludicola*, *Coracias garrulus*, *Aythya nyroca*, *Aythya marila*, *Milvus milvus* – birds; *Crocidura leucodon*, *Nyctalus lasiopterus*, *Lutra lutra*, *Bison bonasus*, *Myotis nattereri*, *Mustela lutreola*, *Spalax leucodon*, *Spalax zemni*, *Barbastella barbastellus* – among mammals [34].



Animal species on the European Red List. The ERL is a document prepared with the participation of the UN. It is published as an appendix to the CITES. The species on the ERL are predominantly endemic species. Since the species on the ERL are found exclusively in Europe, the threat to their existence is also a threat on a global scale, not just in Europe, as reflected in the full title of the list. In Europe, where nature has been transformed by humans more than in Ukraine, many species of animals are on the verge of extinction. Within Ukraine, they are not always rare, and in some areas they even cause damage to agriculture, for example, the grape snail, so such species have not been included in the Red Book. Within the region, 35 species of animals listed in the ECS have been observed in nature. These include 7 species of invertebrates (4 species of insects, 1 species of annelid worms, 1 species of molluscs, and 1 species of crustaceans) and 28 species of vertebrates (1 species of cyclostomes, 2 species of bony fish, 2 species of reptiles, 13 species of birds, and 10 species of mammals), which accounts for 10.3% of the total number of rare species. Almost all species on this list are listed in the Red Data Book of Ukraine. These are representatives of 9 classes. The following species of animals living in the region are included in the ERL: *Proserpinus proserpina*, *Cerambyx cerdo*, *Osmoderma barnabita*, *Calosoma sycophanta* – from insects; *Hirudo medicinalis* – from annelid worms; *Helix pomatia* – from molluscs; *Astacus astacus* – from crustaceans; *Eudontomyzon mariae* – from cyclostomes; *Umbra krameri*, *Zingel zingel* – from bony fish; *Vipera renardi*, *Emys orbicularis* – from reptiles; *Falco cherrug*, *Falco naumanni*, *Gavia arctica*, *Limosa limosa*, *Falco vespertinus*, *Perdix perdix*, *Circus macrourus*, *Acrocephalus paludicola*, *Coracias garrulus*, *Aythya nyroca*, *Aythya marila*, *Milvus milvus*, *Milvus migrans* – birds; *Nyctalus lasiopterus*, *Lutra lutra*, *Bison bonasus*, *Sicista subtilis*, *Spalax leucodon*, *Spalax zemni*, *Mustela lutreola*, *Myotis nattereri*, *Barbastella barbastellus*, *Rhinolophus hipposideros* – mammals [34].

Animal species protected under the Bern Convention. Within the region, 183 animal species protected under the Bern Convention have been identified in the wild. These include 12 species of invertebrates (9 species of insects, 1 species of annelid worms, 1 species of molluscs, and 1 species of crustaceans) and 171 species of vertebrates (1 species of cyclostomes, 5 bony fish, 6 amphibians, 9 reptiles, 118 birds, 32 mammals). 61 species on this list are also included in the Red Data Book of Ukraine [34]. These are representatives of 7 classes, accounting for 53.8% of the total number of rare species.



Bonn Convention. Eastern Podillia is located at the intersection of the migration routes of many birds and other animals. Bird species migrating through the region form the so-called "Polissya migration route", which partly passes through the north. This area plays a key role in sustaining bird life by providing them with food and serving as a resting place. It is particularly important for sandpipers, loons, storks, geese, ducks, teals, waders, martins, terns, mute swans and others that winter in Western and Central Europe. Some birds fly into the region along the North-South and North-East-South-West migration routes. They migrate in these directions, moving in a wide front and forming micro-flows in certain areas. The region is home to 74 species from 3 classes (ray-finned fish – 1, birds – 63, mammals – 10) that are protected under the Bonn Convention, accounting for 21.7% of the total number of rare species. The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) protects 31 species here, accounting for 9.1% of the total number of rare species, and the Agreement on the Conservation of Bats in Europe (EUROBATS) protects 10 species, accounting for 2.9% of the total number of rare species [6].

Washington Convention. The region is home to 36 species of animals from 4 classes (annelids – 1, ray-finned fish – 1, birds – 31, mammals – 3) that are protected under the Washington Convention (CITES), accounting for 10.6% of the total number of rare species [6].

IBA programme. Seven sites in the region have the status of international IBAs (important bird areas), covering an area of 8,495 hectares, which are included in the Emerald Network [6].

Red Book of Ukraine. When describing the diversity of the animal world, it is worth noting that of the 297 species of invertebrates listed in the Red Book of Ukraine (2009), 42 (12.4%) are found within the region, including 41 species of insects and 1 species of annelid worms. Of the 245 species of vertebrates listed in the Red Book of Ukraine, 57 (16.7%) are found in the region, including 1 species of cyclostomes, 6 species of fish, 4 species of reptiles, 26 species of birds and 20 species of mammals [33]. The total number of Red Book animal species is 99, which is 29.1% of the total number of rare species.

Regionally rare species. The number of animals that need protection at the regional level is 59 species, which is 17.4% of the total number of rare species. These are representatives of 6 classes: insects – 5 species, ray-finned fish – 2, amphibians – 2, reptiles – 4, birds – 35, mammals – 11 [6].



The conservation status of rare plant and animal species in Eastern Podillia is assessed according to three levels of protection:

1) *sufficiently protected*: plants – 81 species (including forest plants – 23, meadow-steppe plants – 51, wetland plants – 7); animals – 72 species (including 31 forest species, 24 meadow-steppe species, and 17 wetland species);

2) *insufficiently protected*: plants – 48 species (including 13 forest species, 23 meadow-steppe species, and 12 wetland species); animals – 54 species (including 15 forest species, 21 meadow-steppe species, and 18 wetland species);

3) *not protected*: plants – 32 species (including 6 forest species, 19 meadow-steppe species, and 7 wetland species); animals – 31 species (including 7 forest species, 17 meadow-steppe species, and 7 wetland species).

The current state of biodiversity in Eastern Podillia requires conservation and protection, as evidenced by the significant anthropogenic pressure on natural ecosystems. They have been preserved in their least altered form on lands occupied by forests (355.1 thousand hectares, 13.36% of the territory), shrublands (12.4 thousand hectares, 0.46% of the territory), wetlands (29.7 thousand hectares, 1.1% of the territory) ecosystems and partly on pastures (187.7 thousand hectares, 7.08% of the territory), hayfields (50.2 thousand hectares, 1.89% of the territory), fallow land (0.93 thousand hectares, 0.04% of the territory), open land without vegetation cover or with insignificant vegetation cover (25.9 thousand hectares, 1.11% of the territory), and field protection forest strips (17.5 thousand hectares, 0.66%). Their total area is 25.7% of the region's territory. Agricultural landscapes with seasonal vegetation dominate 78% of the territory. Thus, of the 1,210 species of higher vascular plants in the region (22.79% of the total number in Ukraine), 80 species require protection. Of the 15,312 species of fauna (44.5% of the total number in Ukraine) in the region, 121 require protection (Table 14) [6].

In order to preserve biodiversity and improve the ecological situation in agricultural landscapes, the first step towards balanced development of the region is to balance the ratio of arable land and ecologically stabilising land. To improve the ecological and agrochemical condition of soils, it is necessary to introduce scientifically based crop rotations, anti-erosion soil cultivation measures, and resource-saving chemical reclamation technologies. transition to partial organic farming, using organic fertilisers, green manure, mulching, biological preparations for crop cultivation and soil fertility improvement; removal from cultivation and subsequent



conservation of heavily degraded and low-yield soils. Over the past twenty years, there has been a trend towards an increase in the area of agricultural land, in particular arable land, a decrease in the area of hayfields and pastures, and an increase in the area of perennial plantations and forested areas [32].

Table 14

Number of endangered species of flora and fauna

Animal world		Flora	
Class name	Number of species	Class name	Number of species
Vertebrates	56	Vascular plants	8
Mammals	14	Gymnosperms	6
Birds	32	Ferns	3
Reptiles	3	Lycopod-like plants	2
Amphibians	2	Bryophyta	3
Fish	4	Algae	5
Cyclostomes	1	Lichens	4
Invertebrates	65	Fungi	6
Total	121	Total	109

Forest ecosystems (field protection forest belts) occupy an important place in the structure of the region's agricultural landscapes. They act as a buffer, protecting agroecosystems from gusty winds in summer and preserving snow cover in winter, as well as ecologically stabilising land (meadows, hayfields and fallow land) and small reservoirs, which ensure the ecological minimum water supply in the agricultural landscape [25].

The ratio of rational use of cultivated land resources (arable land + perennial plantations) to the total area of agricultural land is: in the USA – 20.3%, Canada – 4.6, the Netherlands – 24.3%, Germany – 32.0%, France – 34.7%, i.e. the land use structure of these countries is optimised, since about 40.0–50.0% of the total land fund consists of nature conservation areas, i.e. meadows and forests. The main factor ensuring the sustainable development of agroecological systems in developed countries, such as the agrosphere and the biosphere in general, is the optimal ratio of arable land to the total area of agricultural land [36].

To reduce degradation processes, balance territorial organisation, optimise agricultural landscapes and preserve the biotic diversity of Eastern Podillia, the following theoretical and practical approaches are proposed, as presented in table 15 [6].



Table 15

Basic approaches to optimising land use in Eastern Podillia

Indicator	Value		Ways to achieve
	Real	Expert	
Change in natural vegetation structure, thousand hectares (%)			
Natural vegetation	714 (26.9%)	1063.6 (40.1%)	Afforestation and grassing of wasteland and arable land and restoration of landscape and cenotic diversity
Nature reserve fund	59.8 (2.27%)	274 (10.5%)	Preservation of biotic and landscape diversity, creation of new protected areas, formation and implementation of an ecological network
Arable land	1730 (75.2%)	1200 (45.3%)	Renaturalisation of natural vegetation, significant environmental, economic and social benefits
Forests and forested areas	376.7 (14.3%)	469.8 (17.8%)	Renaturalisation of forests, increasing productivity and social functions
Meadows (hayfields and pastures)	23 (8.9%)	371.7 (13.9%)	Renaturalisation of meadows, minimisation of erosion processes and significant economic effect
Wetlands land	72.4 (2.7%)	150.1 (5.6%)	Renaturalisation of wetlands, improvement of the hydrological regime, minimisation of soil droughts and losses from them
Open land without vegetation cover or with insignificant vegetation cover	26.9 (1.04%)	72 (2.71%)	Renaturalisation of biogeocenotic cover, improvement of composition and diversity (lands perform the functions of renewable areas of the ecological network)

Taking into account the specifics of land use based on ecological and agrochemical certification of land plots, it is proposed to implement a set of



zoological measures to optimise agricultural landscapes and preserve and restore agrobiodiversity in the Eastern Podillia region:

1) reduce the area of arable land to 42-45.3% of the region's territory by removing from cultivation slopes with a steepness of more than 3^0 , lands in water protection zones, degraded, low-productive and technogenically polluted agricultural lands. It is advisable to sow them with perennial grasses, plant trees, and in some cases create or restore natural vegetation. For the effective restoration of wild flora and fauna, it is necessary to allocate parts of fields to areas close to their natural state ("compensation areas") and leave areas of natural vegetation (habitats) covering an area of at least 200 m^2 (although the larger they are, the better). To assess the species diversity of arable land (where there are about 50 species of wild plants, 150 species of insects, including 50 species of spiders), it is necessary to: identify the existing species of flora (it is advisable to identify rare and harmless weed species in order to create a seed bank) and fauna, the value of the land and the types of agricultural activity on which it depends; consider the possible beneficial effects of changes in farming methods that will not cause significant damage to agricultural activity and will not significantly affect overall costs; identify fields whose removal from use could be most beneficial to wildlife (fields that have been converted from spring sowing to autumn sowing); mark on the map the uncultivated parts of the agricultural landscape (parts of fields, roads, field boundaries, buffer strips, "insect banks", hedges, stone embankments and walls, drainage channels, ponds, ditches, individual trees, etc.) that may be the only valuable habitats for wild species within the farm as centres of biodiversity conservation requiring special nature conservation needs and management requirements; introduce special care for field boundaries (at least 1 m wide); develop a nature conservation plan for farms to help identify the best ways to maintain the natural value of arable land [7,10]. When reducing the area of arable land, it is advisable to:

- a) increase financial investment in production to \$150-200 per hectare;
- b) change land use regimes (converting arable land on which it is economically unfeasible to grow crops into natural forage land), which should be differentiated and adapted to local zonal and production characteristics;
- c) carry out grassing, taking into account the expansion of areas where the soil type is similar to natural;
- d) reduce the technogenic load on agroecosystems by 30%;
- e) recultivate disturbed land using landscape-ecological approaches;



f) prohibit the ploughing of any land that has not been ploughed for the last 10-15 years, converting individual fields into restoration areas of the regional ecological network (e.g. hunting grounds);

2) use as little mineral fertilisers as possible (apply them in such a way that they do not affect field boundaries and other biotopes), pesticides (maximise the proportion of highly specialised ones; use pesticides only when pest, weed and disease levels are critical); use chemicals with selective systemic action and insecticides in the morning and late evening to reduce the impact on bees and other beneficial and neutral insect species; prevent the wind from carrying chemicals during spraying, preferably spraying when the wind speed is no more than 2 points; do not spray pesticides on strips up to 20 m from the edge of the field), apply them at the optimal time, use biological methods of pest control (introduce and acclimatise entomophages from other territories; breed and release parasites into the fields; take measures to promote the reproduction and conservation of natural entomophages; infect harmful insects with bacterial and fungal pathogens, spray them with solutions of their cultures) and integrated pest control. Do not destroy all pests by excessive use of pesticides, as this is not only extremely harmful to wildlife, but also economically unfeasible. It is much more effective to keep their numbers low enough to prevent significant damage to crops. Use chemical pest control agents that cause the least harm to nature (decompose into harmless components, do not migrate from one organism to another through trophic links) and biological products. Do not treat forest belts (and other "islands" of wildlife) and their roadsides with pesticides, do not burn forest edges (this will cause great damage to succession processes). Use artificial and liquid organic fertilisers effectively so as not to harm wild species of flora and fauna [13,36];

3) avoid overgrazing and soil erosion, which causes water pollution, reduced water transparency, increased nutrient content, eutrophication, silting and the death of rivers and ponds – loss of biodiversity.

4) use organic fertilisers effectively. Incorrect and excessive application leads to eutrophication of water bodies, degradation of ecosystems, reduction in the number of aquatic organisms, fish kills, etc. Prevent liquid from silage pits from entering groundwater and surface water bodies;

5) leave bits of crops unharvested (stubble, fallen grain, weed seeds, etc.) to feed wild animals (especially birds), which will help increase the populations of many species (including game animals).

6) increase the proportion of extensively used agricultural land (hayfields, pastures) in accordance with scientifically based indicators



(taking into account local characteristics), keep part of the land under perennial grasses (those that form mounds, which are a wintering place for bees and spiders), giving preference to local (ecologically adapted) vegetation, expand the area of meadows near water bodies (these lands will help combat soil erosion, retain some of the agrochemicals on their way to water bodies, and maintain a high level of biodiversity). Sustainable management of meadows in accordance with the 50% use and 50% leave principle (the most appropriate use regime is mixed, with alternating grazing and haymaking) allows the natural grass cover to be maintained at a level of 40-50 species per 100 m². The use of meadows for haymaking creates conditions for the existence of greater diversity of tall plants compared to pastures (on low-productivity pastures in hilly areas, there are about 100 species of higher vascular plants, ferns, mosses, and lichens). Meadows where hay is harvested from early spring to mid-summer are biotopes for the reproduction of ground-nesting birds that require tall grass. Burning meadows reduces biodiversity (plants, invertebrates). Rolling destroys anthills and birds' nests, killing chicks. Harrowing restores neglected meadows but creates conditions for shrub invasion. Liming affects the plant composition of meadows but can destroy species that grow on acidic soils. It is important to maintain the existing haymaking regime in meadows with a high level of diversity. In meadows located in river valleys, it is appropriate to maintain or restore the flood regime and high groundwater levels. In peaty meadows, it is necessary to maintain high groundwater levels in spring and early summer by managing water levels in adjacent drainage channels and ponds. It is advisable to restore previous groundwater levels in drained areas through surface moistening (flooding). It is not advisable to cultivate and sow natural meadows and allocate areas for additional feeding of livestock. To control weeds, it is important to mow meadows with rich floral diversity. It is advisable to leave a small amount of weeds on the edges of meadows, as they also have a certain natural value. It is advisable to stop applying any fertilisers to restore semi-natural meadows with rich species composition. Where possible, it is necessary to fertilise meadows used for grazing waterfowl, clear meadows of trees and shrubs where they reduce the natural value of the land, and not create new meadows on land that has zoological value. Where possible, it is important to locate new meadows next to existing natural land. To restore the ecological value of wastelands, introduce livestock grazing where mowing is not possible (for grassy wastelands with a frequency of 1-5 years) or controlled burning (from mid-November to mid-February, creating firebreaks 10 m wide). In large fields, it is important to create additional grass strips ("insect embankments") that will become biotopes attracting



entomofauna, which will pollinate flowering plants and destroy aphids (the most important of which are hoverflies, staphylinids, and ladybirds). All pesticides and mineral fertilisers should be kept away from the boundaries or "insect embankments" (these are places where reptiles and birds nest). It is advisable to place seed crops of entomophilous plants next to the nesting sites of wild bees. Along existing grass phytocenoses, it is advisable to legislate for the allocation of buffer zones, restoration areas and the creation of ecological corridors in order to preserve their biodiversity and reduce the "island effect" [31];

7) preserve and increase the number of bushes (shrubs) and other vegetation near agricultural fields (they provide shelter for many species of birds that are natural enemies of agricultural pests);

8) preserve existing ponds, streams, and swamps on agricultural land that are used for irrigation, fish breeding, watering livestock, as a place of recreation for the local population, and as a valuable reservoir of wetland ecosystems. On the southern shores of water bodies, it is advisable to create alternating low-stemmed planted and open areas, while broad-leaved trees and shrubs should be preserved or additionally planted along the northern shore (small rivers and ponds should be cleared of tall trees along the southern shore). Existing willows and alders growing in marshy areas should not be destroyed. Constructed islands (including floating ones) or rafts will be a place for birds to nest and mammals to burrow (it is best to create them in shallow standing water bodies). Shallow areas for feeding birds, with an area of at least 1 ha and a maximum depth of 50 cm, should be open and located at least 100 m from any hedges or trees. In order not to disturb nesting or wintering birds, it is advisable to introduce periods of rest on water bodies used for fishing. Intensive grazing of grass on the banks of water bodies should be prevented, and livestock access to the shoreline should be kept under control. Where reed beds dry out, the accumulation of dead debris can be prevented by mowing once every two years (while controlling the invasion of trees and shrubs). Small areas of reeds can be easily created by transplanting rhizomes. It is necessary to prohibit the regulation and straightening of river channels, not to deepen the bottom of watercourses during dredging works, not to destroy such objects as backwaters, rapids, and shoals, and to maintain and restore meanders, islands, and eddies in the watercourse. The construction of artificial rapids and the cutting of ice holes in winter will reduce oxygen starvation in fish (prohibit the introduction of non-native fish species into water bodies, equip dams with fish lifts for the migration of migratory fish). It is advisable to



leave or restore marshy banks or steep slopes. It is necessary to impose a moratorium on drainage improvements, prohibit draining ponds without extreme necessity during the nesting period, and declare some water bodies as hunting reserves with a ban on staying there during the nesting period [21, 36];

9) restore and preserve forests (different types of forest structures support different species of fauna) in agricultural landscapes, the optimal area of which for Vinnytsia region should be 15-17% (this will prevent soil erosion, maintain soil fertility, and preserve biodiversity). When implementing this measure, it is important to: create new forests near existing ones; plant areas of up to 5 hectares or more; not plant trees on open land that is already of natural value; increase the length of forest edges; leave up to 20% of the area unplanted, creating glades and clearings there; plant native species of different ages in one group of trees; plant trees with wide row spacing in several areas; minimise clear-cutting of main use areas by using selective cutting methods; minimise the impact of timber harvesting activities for a longer period of time; give preference to natural regeneration (root sprouting) of forests, stimulate it for nature conservation purposes (cut down and plant areas no larger than 0,3 га); if tree planting is necessary, especially in old forest areas, use local planting material (native tree species); maintain glades and forest edges, mow them during a certain rotation period and maintain areas of vegetation of varying heights, and in some places – dense thickets of shrubs; in forests where there are no glades, expand the area at the intersection of forest roads, create winding edges along roads, leave gaps formed by windfall or create glades by cutting out small areas; clear bushes and trees on the southern and western edges of the forest or do not plant them right up to the edge; maintain bushes and trees on the edges of the forest in the same way as along the forest aisles; leave self-sown native broad-leaved species that are regenerating on the edges of the forest; in commercially important forests where there is an urgent need to restore tree cover, grazing should be stopped for 15 years or individual areas should be fenced off (0,5 га); use measures to enhance the "edge effect", in particular by maintaining clearings, felled areas, glades, sparse forests, etc.; allocate space for additional bird feeding where there are the fewest wild plant and invertebrate species; prohibit afforestation of steppe areas [1, 11]. To create optimal forest cover in the region, it is necessary to plant about 30,000 hectares of forest land (each year, the region's forest cover increases by an average of 1,500 hectares);



10) preserve individual old and fallen trees (dead wood), which will increase biodiversity – lichens, fungi, invertebrates, reptiles, birds. It is advisable to cut only the tops of trees, not to cut trees lying on the ground that show signs of rot or damage (if they do not threaten surrounding trees). If there is a shortage of natural hollows and cavities in tree trunks, artificial nesting sites for birds and bats should be constructed (local schoolchildren can be involved in these activities);

11) minimise the impact on irrigation channels (prevent agrochemicals from entering them), which are home to many wild species. Create a 2-metre permanent grass border to prevent mineral fertilisers from entering the channel (mow every 2-3 years). Cleaning the canals of silt and vegetation should be carried out cyclically, alternating between different areas. If the canals dry up at certain times of the year, they need to be deepened in some places to retain water. It is important to carry out proper weed control in areas around deep oxbows during the first 5 years. It is advisable to plant bare areas with alder, willow and low-growing shrubs (viburnum, grey willow, dog rose), and cut down old diseased trees;

12) place "filter strips" of perennial grasses across field slopes to retain soil during rainfall, prevent erosion and promote agrobiodiversity.

13) limit the number of livestock (in autumn and early spring) grazing per unit of pasture area (overgrazing leads to trampling and loss of diverse vegetation, degradation of vegetation cover, reduction in the species composition of pastures and existing invertebrates, trampling of nests and birds, and soil erosion. Additional feeding sites should be located on pastures no closer than 30 m from water bodies or springs to avoid destruction of the soil cover of the banks and water pollution. Feeders should be moved from one place to another as often as possible to prevent trampling of vegetation and degradation of pastures). Domestic animals should not be allowed in the buffer zones of protected areas and water protection zones around water bodies (the latter by means of fencing). Maintain the optimal load of farm animals per unit of land area (1 ra s of natural grassland, with free grazing, should account for 0.24-0.3 conventional livestock units or 1 sheep), which perform the function of regenerative areas of the agrosphere in the structure of the regional ecological network. It is necessary to revive sheep and horse breeding (export potential) with mandatory control over grazing standards;

14) do not place salt for cattle near water bodies or on the soil surface, but equip special places so that the salt does not get into the water body or



seep into the soil (it is advisable to create equipped watering places away from natural water bodies with tap water supply).

15) introduce organic (biodynamic) agriculture, which will not only preserve the biological diversity of the agrosphere, but also produce "environmentally friendly" products (for children, medicinal, preventive) and sell them at higher prices (by 30-70%);

16) introduce various nature-friendly crop rotations (this will reduce fertilizer application rates and prevent excessive pest reproduction), use biological nitrogen in the agroecosystem (from 7-10% to 35-40%) by growing cover legumes using nitrogen-fixing bacteria preparations (introducing up to 20% of perennial legumes into the crop structure). It is advisable to introduce anti-erosion crop rotations and grassing of steep slopes;

17) introduce no-till farming techniques (plough only where necessary) and soil mulching (leave crop residues on the soil surface, which will help combat soil erosion, provide feed for some animal species and save on fuel). Implement contour farming (ploughing fields at right angles to slopes is one of the easiest ways to prevent erosion and minimise runoff from fields into water bodies). In combination with contour farming, use strip farming (alternating cover crops such as wheat, barley, oats, ryegrass, timothy grass and others with row crops such as corn, beets and potatoes). Cover crops retain rainwater and allow it to penetrate deep into the soil. The type of soil, slope steepness and length determine the width of the strips and the practicality of this method. Create soil protection structures such as terraces and drainage ditches covered with perennial grasses to drain excess water during heavy rainfall. Try not to turn the soil during ploughing onto adjacent grass strips, as this will create ideal conditions for the germination of annual weeds. It is necessary to use techniques with minimal load per unit area (compaction occurs), prohibit ploughing of virgin land and old fallow land, burning straw, stubble and riparian vegetation [26];

18) set aside part of the fields for fallow, which will allow the land to "rest" and provide temporary habitats for many species of wild fauna and flora, including biotopes for breeding birds that build nests. For natural renewal of the land, it is not necessary to mow, plough or treat it with herbicides from March to July;

19) introduce "precision farming" technology, which allows agrochemicals to be applied and other agrotechnical measures to be carried out in different quantities on different areas of land depending on the needs of agricultural crops and the chemical composition of the soil;



20) use crop rotation technology, which allows for reduced fertiliser application thanks to more complete utilisation of soil nutrients;

21) harvest grain crops or mow grass from the middle of the field and continue mowing towards the edges (this will allow wild animals in the field to escape). Use deterrents that can be attached to agricultural machinery (especially during silage harvesting). Leave a 2-metre strip around the field unmowed to preserve insects, birds and small mammals;

22) apply the amount of fertiliser (in terms of active ingredient) necessary to maintain stable yields, regularly checking the nutrient content of the soil. Apply manure to agrocenoses as evenly as possible, avoiding the formation of "hot spots" (areas of excessive fertiliser application). When determining fertilizer application rates, it is important to consider all factors that affect the nutrient content in the agroecosystem, including organic fertilizers, legumes, and crop rotations;

23) store mineral and organic fertilizers in a way that prevents nutrients from entering wetlands. Do not apply fertilizers to frozen or snow-covered land, as this will wash them into water bodies and threaten wetland biodiversity. Do not apply fertilizers if there is a possibility of heavy rain or downpours in the next two days. Avoid applying fertilizers on steep hills where the slopes face wetlands. Do not apply fertilizers closer than 10 m from streams and small rivers, 20 m from ponds, medium and large rivers, 50 m from domestic water sources, 300 m from public water sources;

24) plant and maintain forest belts. The creation of a network of field shelterbelts up to 50 m wide (according to forest typological zoning and local characteristics) will allow to combat water and wind erosion of soils (to tame "dust" storms), retain moisture, diversify the structure of the agrolandscape, preserve its biodiversity (habitat, feeding and recreation environments of many species), use them as ecological corridors for animal migration. In new (existing) field shelterbelts, bushes should be planted (in some shrub lands, hunting reserves should be created), artificial nesting sites should be established, and feral cats and dogs should be combated. It is necessary to create and maintain existing riverside and streamside forest belts;

25) preserve agricultural buildings and stone walls (the older they are, the higher their value to nature), which are the habitat of a large number of specialised species (lichens, ferns, bats, bats). Warm stone walls (built without mortar) are a favourable environment for insects, spiders, lizards and snakes. Building elements (roof overhangs, holes in roofs, attics, etc.) are an important habitat for birds and bats. Do not use toxic types of coatings



for surfaces or roofs. When restoring stone walls or embankments, it is important to use local stone, encourage the growth of tall vegetation around them, and limit the transfer of agrochemicals from fields that may affect their flora and fauna;

26) any fuel spills during field cultivation should be removed (buried);

27) create new and expand existing protected areas within the agricultural sphere, establishing the status and degree of threat to populations of rare plant and animal species in accordance with the international criteria of the International Union for Conservation of Nature (IUCN): distribution of the species in the agricultural landscape and overall distribution; number of localities; population size, their status in relation to species listed in the Red Book of Ukraine (RBU), the European Red List (ERL), the Appendices to the Bern Convention, the IUCN Red List, and regionally rare species. Particular attention should be paid to the conservation of species diversity in meadows, wetlands, entomofauna (wild plant pollinators), and their habitats (groves, glades, roadsides, slopes of ravines, gullies, fallow lands), granting these biotopes the status of micro-reserves. It is important to create or restore biotopes that best suit the type of soil, terrain, and farm (the scale of the work should be determined by the cost, practicality, and interest of the landowner or land user) [18-21];

28) determine indicators of the region's flora and fauna in relation to agricultural activities, establish monitoring of populations of various rare species with the compilation of a passport (inform the owner about the optimal land use regime and types of liability for the deterioration or disappearance of these populations), strengthen control over poaching. On 31 January 2016, 19 individuals of the bison (*Bison bonasus*) population were killed near the village of Trybukhy. The tragedy occurred on the territory of the Khmilnytskyi State Forestry Enterprise on the border of the Khmilnytskyi city and Litinskyi settlement territorial communities, where the largest population of bison, listed in the IUCN Red List, the European Red List, the Bern Convention, the Red Book of Ukraine, and the damage was estimated at that time at 2,470,000 hryvnias (19 x 130,000 hryvnias). It is worth noting that of the 580 bison living in Ukraine, 132 individuals have their habitats in Eastern Podillia (Ulanivska and Khmilnytskyi estates) as the largest population;

29) ensure the implementation of legal norms and integrated ecological and economic mechanisms for the protection, reproduction and use of hunting animal resources, in accordance with the requirements of EU directives and agreements. Thus, in the Republic of Poland, the Hunting



Law requires: the implementation of economic activities in accordance with the main directions of agricultural land use, subject to the sustainable improvement of animal habitats; the safe use of chemical plant protection products in agriculture and forestry; the use of agricultural methods and technologies that do not threaten the existence of animals in these areas; the maintenance of ecological corridors (routes) in good condition. According to the Hungarian Law on the Protection of Wildlife and Hunting, in order to prevent and eliminate damage caused to game animals, the main land users are obliged to maintain the peace and well-being of game using appropriate agricultural production methods, to participate in the elimination or minimisation of damage caused, and to pay compensation to co-users of the land (hunting farms). The Law of the Slovak Republic "On Hunting and Amendments to Certain Laws" states the following: primary users must inform co-users of the location and time of agricultural work at night, feed harvesting and the use of chemicals that are harmful to wild animals, no later than three days before the start of the specified work; when mowing permanent pastures, harvesting grain and fodder crops, and mowing their green mass, it is necessary to perform agricultural work in such a way that animals move from the centre of the field contour to its periphery; the main users must cover the losses caused to co-users of land resulting from the cultivation of land in ways that do not comply with this law or other rules governing the use of plant protection products in the country. This comparative analysis of environmental and agricultural policies for the protection of wildlife in the modern agricultural landscapes of EU countries shows that the key means of preserving wildlife on their arable land is the creation of numerous state and public funds to financially encourage farmers to voluntarily green their farming practices. This policy continues to gain confidence in stimulating similar measures to preserve the fauna of local agrocenoses [36];

30) create conditions to ensure the continuity of natural areas within the agricultural landscape that will serve as ecological corridors (these may be hedgerows, steppe, forest or valley-river areas);

31) develop and implement zonal models of household farming based on the principles of greening agricultural technologies and sustainable use of local resources to maintain the ecological balance of rural settlements;

32) develop and implement legal norms for economic incentives for landowners and land users to preserve and restore the region's biological diversity, develop organic farming, and conduct ecologically balanced agricultural activities. It is necessary to make appropriate changes and additions to regulatory and legal documents aimed at improving the



economic mechanism related to the protection and restoration of natural landscapes, the preservation of biological diversity, the optimisation of agricultural land areas, and the support of the formation of an ecological network [22];

33) introduce an environmental management system (stimulation, financing, lending for environmental protection measures) in the region's agriculture based on comprehensive environmental monitoring and certification of agricultural objects (land, forest and water areas, protected objects, rural settlement areas, tourist objects, hazardous objects, phenomena) in the region [19].

For the rational organisation and optimisation of agricultural landscapes and the preservation of agrobiodiversity in Eastern Podillia, we have proposed recommendations for the use of land by type of locality. According to these recommendations:

- it is advisable to use the plain and inter-river undrained types of terrain for fields with the creation of field protection strips, and the depressions for haymaking;

- slope type of terrain: a) sloping ($3-5^{\circ}$) near-bank and near-valley slopes with the preservation of the area of arable land and forest should be used for haymaking and planting field protection strips; b) sloping ($5-10^{\circ}$) near-bank slopes should be used as meadow and pasture lands with the preservation of forests and the creation of anti-erosion forest strips. Plowed areas are subject to grassing; c) steep (more than 10°) near-bank and near-valley slopes should be used as pastures, as well as for afforestation, the creation of anti-erosion forest strips; d) the bottoms of the gullies should be used for haymaking with the preservation of forest and pasture lands [36];

- floodplain types of areas with preserved forest ecosystems and pastures are the main meadow phytogene pool of the region.

In improving and restoring the structure of agricultural landscapes, optimising them and preserving the agrobiodiversity of Eastern Podillia, it is advisable to take measures to create a fund of protected lands and restoration areas, which are structural elements of the local and regional ecological network and act as restoration areas.

The agricultural landscape complexes in Eastern Podillia are background ones, their landscape structure is quite altered, but among them there are unique ones that require rational use and protection. These include original field plots, valuable meadows and pastures, and unique orchards within agricultural landscapes.



The natural conditions of the Eastern Podillia region are distinguished by their uniqueness: the development of south-facing terraced complexes in meanders and, thus, their protection from the winds and the specificity of the microclimate (due to the warming of the sloping terraces, the average annual temperature here is 2°C higher than in the surrounding areas). This is particularly conducive to the development of horticulture and viticulture. Fruit orchards are an integral and characteristic feature of the region. There is an urgent need to create protected orchard landscapes where native varieties of apples, pears, plums, cherries, quinces, apricots, and cherry plums, which are often irretrievably lost, will be preserved. There are a significant number of orchard landscapes within the region that have been preserved in the villages of Shevchenkove, Yagidne, Derezhova, Vynohradne, Svidova, Zhvan, Nadnistrianske, Petrymany, Kozliv, Sadky, and the towns of Mohyliv-Podilskyi and Yampil. Currently, some of the orchard landscapes have been lost, while others require significant reconstruction. Therefore, it would be advisable to create new orchard landscapes. Gradually, they are being restored in the private sector, but the pace is rather slow. The variety composition is also changing. Previously, early and mid-season varieties predominated in collective gardens. Now the trend is shifting towards the cultivation of late varieties that are suitable for long-term storage. Stone fruit trees also predominate in the region [4].

Taking into account the altitude differentiation of the region's landscapes, terraced and sloping areas near the villages of Severynivka, Mykhailivka, Yaruga, Kozliv, Bronnytsia, Kopayhorod, and Shevchenkove are suitable for the formation of garden landscapes.

Eroded lands in the region can be used for horticulture. At the same time, it is necessary to apply tree care technologies that provide for the presence of permanent grass vegetation within garden landscapes and limit the use of mechanical tillage to prevent erosion and deflation. An important agrotechnical measure to improve soil quality and protect it from erosion in garden landscapes is to sow low-growing honey plants between rows. This will attract a significant number of entomophagous insects, which is a safe biological method of pest control and will contribute to the preservation and restoration of the region's biotic diversity.

An important aspect of preserving and restoring the biotic diversity of Eastern Podillia is increasing and expanding the territories of the nature reserve fund. Today, the level of conservation in the region is the lowest in Ukraine, accounting for only 2.52% of its total area. Therefore, the key problem in the functioning of the nature reserve network is the chronic lag



in the expansion of the nature reserve fund area from the declared goals, which is the result of a combination of several key factors:

1) ***the need for agreement with landowners.*** In order to create or expand any nature reserve, it is necessary to obtain the consent of all landowners (or land users) on whose land it is planned to be created (or expanded). Protected status entails a number of restrictions, the list and severity of which depend on the category of the relevant PFA, but there are restrictions that are common to all categories: it is not permitted to clear-cut forests, plough up steppes and meadows, drain swamps, or build on valuable natural areas. Under these conditions, landowners and land users are usually not interested in agreeing to the designation of their lands as protected areas, particularly due to financial factors. Arguments about the importance of nature conservation for the sustainable development of 63 territorial communities in Eastern Podillia and the possibility of generating income from other activities, such as tourism development, which is welcomed in protected areas, do not always work. The need for consent even applies to state-owned land, in which case it is granted (but in practice refused) by permanent land users who have been assigned the relevant plots, such as state forestry enterprises. This seems somewhat paradoxical. On the one hand, the state has declared goals to expand the PZF, and responsible civil servants are working on this, but on the other hand, state-owned enterprises are deliberately hindering the achievement of these goals.

2) ***Insufficient funding for protected areas from state and local budgets.*** Employees of protected area institutions usually receive low salaries and are often unable to perform their work effectively due to insufficient technical support. This leads to a reduction in the number of dedicated employees and shapes the image of protected area institutions among local residents as ineffective institutions that only hinder the development of the region. The lack of funding also makes it impossible to provide compensation to landowners whose land is being designated as protected, which could help to secure their consent.

3) ***bureaucracy and unjustified delays.*** The processing of documents and decision-making for the creation of new protected areas is often delayed (or even blocked) due to personal disagreements between officials and scientists and a lack of trained and motivated specialists to deal with issues related to the creation of protected areas at the national and regional levels (very often, regional councils do not even have environmental commissions that could consider these issues and bring them to regional council meetings).



There are no simple and effective solutions to such complex problems, but several proposed changes could significantly improve the environmental situation:

1) simplifying the procedure for creating new protected areas and preventing delays in the approval of protected areas by state and municipal landowners;

2) increasing the priority of biodiversity conservation and restoration in the work of the Ministry of Environment and regional departments of ecology and natural resources (incidentally, there is no such department in the Vinnytsia Regional State Administration), which should be accompanied by an increase in the number of officials who will deal exclusively with the creation and proper functioning of protected areas;

3) increasing state funding for nature conservation areas, which will enable them to implement projects to restore degraded areas, develop ecotourism and build a reputation as centres of sustainable community development;

4) making it more difficult to abolish existing protected areas as a mechanism to prevent the "carve-up" of valuable natural areas, for example for development.

Conclusions

The measures proposed above will optimise agricultural landscapes and preserve and restore the biotic diversity of the region's agrosphere. To this end, it is necessary to develop and implement legal norms for economic incentives for landowners and land users to preserve and restore biodiversity, develop organic farming, and conduct environmentally balanced agricultural activities. This requires appropriate amendments and additions to the Land, Water and Forest Codes, certain laws of Ukraine, the Strategy for Balanced Regional Development of Vinnytsia Region for the period up to 2030, regional programmes, and decisions of the regional council aimed at improving the financial, economic, organisational, administrative and management mechanisms related to the optimisation of agricultural land areas, the protection and restoration of natural landscapes, the preservation of biotic diversity, and the creation and expansion of new related to the optimisation of agricultural land areas, the protection and restoration of natural landscapes, the preservation of biotic diversity, the creation of new and expansion of existing protected areas, the improvement of the scheme and support for the implementation of the regional ecological network of Eastern Podillia.



In order to preserve the biodiversity of Eastern Podillia, it is necessary to implement a set of measures (regulatory, environmental, organisational, economic) by introducing EU Directives in the field of nature conservation and a schedule for their implementation. To this end, it is necessary to implement Ukraine's regulatory and legal framework in the EU Directives, introducing economic incentives for landowners and land users, developing organic farming, implementing environmentally safe economic activities, balanced nature use, and education for sustainable development, especially for the rural population. It is advisable to consider many nature conservation issues at the sessions of the Vinnytsia Regional Council related to the conservation and restoration of biological diversity, optimisation of agricultural land areas, support for issues related to increasing the area of nature reserve fund (NRF) objects and territories, and implementation of regional ecological and emerald networks.

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