

COMPARATIVE ANALYSIS OF REGIONAL PARK DENDROFLORAS OF UKRAINE IN THE ZONAL ASPECT

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Abstract

The paper provides the results of the comparative analysis of similarity of the model dendrofloras of protected parks-monuments of landscape art of Rivne, Vinnytsia and Zaporizhzhia administrative regions of Ukraine, the natural conditions of which represent three geographical zones - mixed forests, forest-steppe and steppe. The basis for the comparison was the park dendrofloras of Rivne region inventoried by the authors, which includes 127 species of woody plants. The species composition of plants of park dendrofloras of the other two regions has been analyzed by literary sources, from which it is known that the park dendroflora of Zaporizhzhia region has 348 and Vinnytsia region - 487 species of woody plants. As a result of the pairwise comparison of dendrofloras the greatest similarity of species composition of woody plants of parks of Vinnytsia and Zaporizhzhia regions ($K_{sc} = 0.47$, $K_j = 0.30$) has been established, which is a natural phenomenon, since the richness of forest steppe and steppe soils also determines the richness of dendrodiversity. As a result of the comparative analysis of taxonomic structures of all three park regional dendrofloras, the predominance of Magnoliophyta and Rosaceae species has been established. In their biomorphological structure, a subset of mesophanerophytes with a dominance of the first magnitude trees and tall shrubs has a key place. In the ecological structure of these three dendrofloras there are more light-demanding, mesophytic and frost-resistant plant species. As for the soil nutrient requirements, a share of common species for the pair of park dendrofloras of Rivne and Zaporizhzhia regions dominates. It is explained geographically and edaphically by less optimal conditions for plant growth and development than in the forest-steppe zone. Also, there are more dendroexotic plants in this pair of compared dendrofloras.

Key words: woody plants, floral structure, similarity coefficient, natural-geographical zones.

INTRODUCTION

According to the International Environmental Law, biodiversity conservation is an extremely pressing global issue, as evidenced by a number of conventions and other international instruments. In this aspect, for the conservation of flora, international special purpose policy papers have been developed and implemented, including the European Plant Conservation Strategy, prepared jointly by the Council of Europe and Planta Europa (Pruhonice, 2001), Global Strategy (Global..., 2004) for Plant Conservation (The Hague, 2002), International Agenda for Botanic in Conservation prepared by the Botanic Gardens Conservation International during 1998-2000, and others.

Among the means of implementing the abovementioned documented decisions is the formation by the States of a network of conservation areas for preservation of flora *in situ* and *ex situ*. The legislation of Ukraine on the Nature Reserve Fund (1992), which

identifies 11 categories of territories and objects, is also used to accomplish this task. Of these, there are four categories of artificial conservation parks (botanical gardens, dendrological parks, zoological parks, parks - monuments of landscape art). There is the biggest number of parks-monuments of landscape art in Ukraine (89 sites of nationwide and about 460 sites of local importance). Of the nationwide objects network, about 60% of ancient parks, which largely combine autochthonous and introduced dendroflora, formed over the centuries as a separate phytosystem.

Successful scientifically balanced conservation of park dendrofloras requires comprehensive research, including comparative studies to determine the degree of botanical value of the conservation objects, the enrichment of the species composition of plants and their humane use, in particular in the social sphere. Comparative studies are also needed to develop the science of woody plants, the practices of

their introduction and conservation. In this regard, the geographical space of Ukraine allows interzonal comparative studies of local protected dendrofloras of different regions. According to the results of the research, the process of replenishing the collections of dendrofloras of artificial protected parks can be adjusted.

As known, dendrological studies are among the priorities, as evidenced by numerous publications (Loeb, 2006; Hassan et al., 2019; Kolodziejczyk et al., 2019). Therefore, the study of dendrofloras of the parks in different regions and the comparison of their species composition of plants are now relevant and important for science and practice. Similar studies are particularly common to European scientists. Amongst other things, dendroflora of different parks has been studied by the European scientists, for example in Romania – Onete et al. (2010), Croatia - Tafra et al. (2012), Poland - Dudkiewicz et al. (2015), Bulgaria - Tashev and Tsavkov (2016) and many others.

Over the last decade, in Ukraine, various aspects of dendroflora of the protected parks or individual regions have been studied in the Steppe zone - Popova et al. (2007), Chonhova (2013), Vlasenko (2016), in the Carpathians - Mykhailovych (2014), in Polissia - Kurdyuk et al. (2015), Markov (2015), Savoskina (2016), Pokotylova (2018), Forest-Steppe - Syplyva (2014), zone of Deciduous Forests - Kotsun (2007), Miskevych (2018) and many other scientists.

At the same time, an integral scientific direction in the conservation of dendrodiversity (dendrosozology), the objects of which are all groups of rare species of woody plants (autochthonous and introduced of protected and unprotected soil) and protected dendrocenoses, has been distinguished in Ukraine. The priority chosen to investigate this category of the rare dendrodiversity for its *in situ* inventory within the natural reserve fund was natural and necessary, as the dendrorarities are, for the most part, a determining component of the intensively degrading in Ukraine and in Europe in general (*Quercion roboris*, *Quercus robur* L.: IUCN Red List) and (*Pinion*

sylvestris, *Pinus sylvestris* L.: IUCN Red List) forest and steppe shrub phytocoenoses, as well as oligotrophic marshes listed in the Berne Convention. On the other hand, a tendency is observed *ex situ* to impoverishment of collections of rare dendroexotics of artificial protected parks of Ukraine. Therefore, it was important for the Ukrainian scientists to know the current state of preservation of these dendrorarities. As a result of the development of this line of research, a number of scientific works have been published, primarily monographs (Popovych et al., 2010, 2013, 2017, 2019; The dendrosozological the catalogue of natural-reserved fund of the Forest-steppe of Ukraine, 2011; The dendrosozological the catalogue of natural-reserved fund of the Steppe of Ukraine, 2014; The dendrosozological the catalogue of natural-reserved fund of Ukrainian Polissya, 2017 etc.) and educational publications (Popovych et al., 2009, 2011), which testify to the results of the initial inventory of the protected rare dendrodiversity of the Forest-Steppe, Steppe and Polissia of Ukraine.

MATERIALS AND METHODS

Objective: to carry out a comparative analysis in the zonal aspect of the degree of similarity of structures of regional dendroflora of parks-monuments of landscape art in Rivne region (zone of mixed forests) with south-facing similarly structured dendrofloras of the same category of the nature reserve fund of model-selected Vinnytsia (Forest-Steppe) and Zaporizhzhia (Steppe) regions (Figure 1).

The object of research: structures of regional (representatively selected) dendrofloras of parks-monuments of landscape art of Rivne, Vinnytsia and Zaporizhzhia regions of Ukraine. The research was based on the published lists of dendroflora species.

In a course of the route-field researches for parks-monuments of landscape art of Rivne region we compiled separately for each of these objects and a general regional list of plant species of dendroflora. It was used as the basis for floristic analysis (Pokotylova, 2018) made by the methods of Tolmachov (1986).

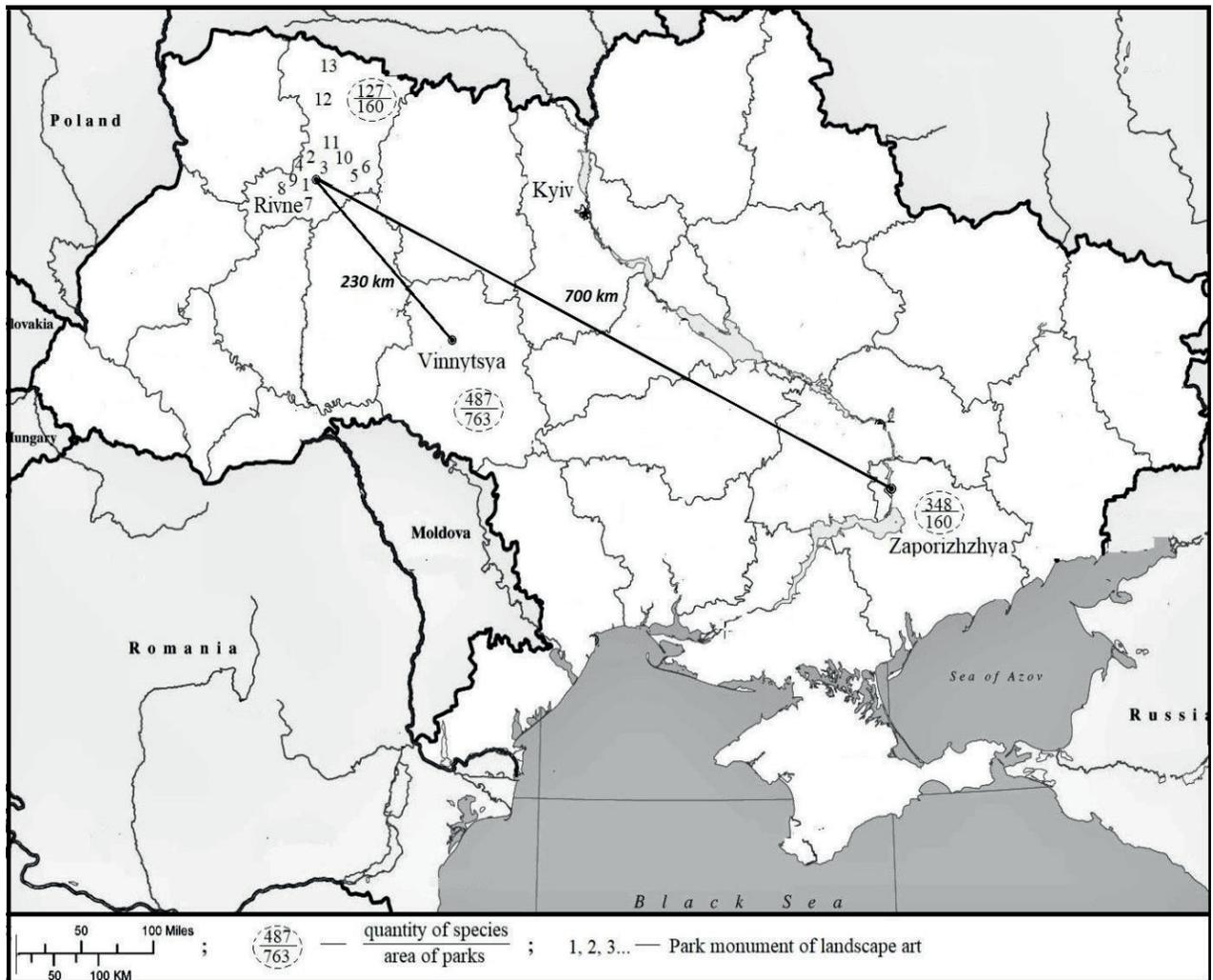


Figure 1. Network of the objects of research on the map of Ukraine

Note: park names: 1 - Rivne Park, 2 - Klevansky Park, 3 - Horodotskyi Park, 4 - Novostavskyi Dendropark, 5 - Hoshchanskyi Park, 6 - Velykomezhyrskyi Park, 7 - Mizotskyi Park, 8 - Mlynivskyi Park, 9 - Ostrozhetskyi Park, 10 - Tuchynskyi Park, 11 - Oleksandrivskyi Park, 12 - Antonivka Park, 13 - Zirnenskyi Park.

We have used similar results for comparison from the studies of dendroflora of the parks-monuments of landscape art of Vinnytsya (Popovych et al., 2012; Syplyva, 2014) and Zaporizhzhia (Chonhova, 2013) regions.

The analysis of taxonomic and ecological structures of dendrofloras was performed on the basis of the methodology used in similar dendrofloristic studies (Popovych et al., 2010; 2011; 2013; 2017; 2019). Traditional environmental analysis of dendroflora was supplemented by the division of plant species into eco-groups relative to the selected ecofactor (Didukh, 1994; Didukh, Pliuta, 1994). The analysis of biomorphological structure was carried out according to the classifications of types of life forms (Raunkiaer, 1937; Serebryakov, 1962; Kalinichenko, 2003). To analyze the geographical structure, we used the

botanical-geographical zoning of the Earth for autochthonous plant species (Meusel et al., 1965, Meusel et al., 1978), and for dendroexotic plants we determined their belonging to the floral regions of the Earth (Takhtadzhan, 1978).

We performed a correlation analysis in three stages: 1) calculation of the Serensen-Chekanovsky Ksc coefficient of similarity, 2) calculation of the Jacquard similarity coefficient, 3) comparison of the obtained results (Schmidt, 1984).

Latin names of plant species have been verified with the taxonomic base The Plant List.

RESULTS AND DISCUSSIONS

There are 13 parks-monuments of landscape art (Figure 1) on the area of 160.4 hectares in the

territory of Rivne region, where 127 species of woody plants have been found. Of their total number, the vast majority are *Magnoliophyta* species - 81.10% (Table 1).

Table 1. Taxonomic structure of dendroflora of parks-monuments of landscape art in Rivne region

Division	Number of families		Number of genuses		Number of species	
	pcs	%	pcs	%	pcs	%
<i>Pino-phyta</i>	3	10.34	8	11.76	24	18.90
<i>Magnoliophyta</i>	26	89.66	60	88.24	103	81.10
Total	29	100	68	100	127	100

The number of species of dendroflora of the parks - monuments of landscape art of Zaporizhzhia region is much higher - 348 species of plants. They represent 155 genuses, 62 families, two divisions. *Magnoliophyta* species (81.32%) also prevail in Zaporizhzhia region (Chonhova, 2013). The studied parks of Vinnytsia region are filled with the largest number of taxons - 487 species of woody plants, and the main share belongs to *Magnoliophyta* (87.30%) as well (Popovych et al., 2012; Sypliva, 2014).

As a result of the correlation analysis it was established that the value of the Serensen-Chekanovsky similarity coefficient for the local park dendrofloras of the three administrative regions of Ukraine is within $0.36 \leq K_{sc} \leq 0.47$, the average value $\Delta K_{sc} = 0.42$. The closest correlation relationships are between the dendroflora of Vinnytsia and Zaporizhzhia Parks ($K_{sc} = 0.47$), which is a natural phenomenon, since the richness of soils and the similarity of climatic conditions of the Forest-Steppe and Steppe of Ukraine determine both quantitative and qualitative richness of the dendrodiversity. In addition to the similarity of the natural conditions of these regions, their parks, compared to northern Rivne, also have a significantly higher level of representativeness of dendroflora (Table 2).

To verify the validity of the obtained results in a pairwise comparison of similarity of regional park dendrofloras, the Jacquard similarity coefficient was additionally calculated (the variation was within $0.22 \leq K_j \leq 0.30$).

Table 2. Matrix of similarity coefficients of regional park dendrofloras of administrative regions

Indicator and the region name of park location		Rivne	Kj Vinnytsia	Zaporizhzhia
		K _{sc}	Rivne	1
	Vinnytsia	0.36	1	0.30
	Zaporizhzhia	0.44	0.47	1

Although much lower quantitative indicators were consequently obtained than when using the Serensen-Chekanovsky similarity coefficient ($\Delta K_j = 0.27$), however, the same pattern is generally observed: the highest similarity of dendroflora of the parks of Vinnytsia and Zaporizhzhia, then Rivne and Zaporizhzhia, Rivne and Vinnytsia regions. The reasons for some discrepancies in both cases of application of the similarity coefficients is a significant difference in the number of represented species of woody plants in the regional park dendrofloras of the compared regions. After all, the values of similarity coefficients depend not only on the ratio of the number of common and non-common species of woody plants, but also in direct proportion to the difference between the quantitative numerical values of the species compositions of the compared dendrofloras. However, when using the Serensen-Chekanovsky coefficient, unlike the Jacquard coefficient, the value of such difference is significantly leveled out. At the same time, the Jacquard coefficient requires handling multiple species floras. This feature actually convinced us that it is advisable to use these two similarity coefficients at the same time.

As dendroflora of the parks-monuments of landscape art of Zaporizhzhia and Vinnytsia regions have the highest degree of similarity, it was necessary to consider the common species composition of the parks of the two regions in the taxonomic, biomorphological, ecological and geographical section, as well as separately with the similar list of plant species of Rivne region. As a result of the comparison of the species composition of woody plants in the parks-monuments of landscape art of Vinnytsia and Zaporizhzhia regions, 195 common species were found. They belong to 99 genuses, 38 families and two divisions (*Pinophyta* 15.90% and *Magnoliophyta* 84.10%). *Rosaceae*

including 40 species (20.51% of the total) is the best represented among the families. By dividing the total number of species of woody plants by biomorphotypes, we found a significant predominance of mesophanerophytes (48.77%). Common species of plants in this pair of regions represent the following types of life forms: trees (121 species), shrubs (71) and woody vines (3). The height classes are dominated by trees of the first magnitude (53 species) and among the shrubs there is the biggest number of tall plants (32). The analysis of the spectrum of ecological features of common species of woody plants revealed the predominance of heliophytes (54.36%), mesophytes (41.03%), oligotrophs (34.36%) and frost-resistant (64.62%) species. Of the total number of the compared plant species, a significant proportion (68.72%) are plant species exotic for the territory of Ukraine. They originate from the Circumboreal (28 species), Atlantic North American (24), Eastern Asiatic (14), Irano-Turanian (9), Madrean (3), Rocky Mountains (3), and Mediterranean (1) floral regions. The natural habitat of the remaining 46 plant species covers two floral regions at a time, with six species naturally growing within the three floral regions. Instead, most autochthonous species are of the European habitat type and European Nemoral geoelement.

A comparative evaluation of the dendroflora of the parks-monuments of landscape art of Rivne and Zaporizhzhia regions showed that 105 common species of woody plants were found within them, belonging to 62 genera, 29 families and two divisions (*Pinophyta* 17.14% and *Magnoliophyta* 82.86%). *Rosaceae*, *Pinaceae* and *Salicaceae* (17, 11 and 7 species, respectively) were the most representative of the indicated number of families. Six species represent three families, five species only *Cupressaceae*, four species three families, three species four families, two species eight families and one species seven families. According to biomorphotypes 54.29% of 105 species belong to mesophanerophytes. The following types of life forms represent this species composition of woody plants: trees - 73 species (69.52%), shrubs - 29 species (27.62%), woody vines - three species (2.86%). According to the height

classes, the major number of species belong to the trees of the first magnitude - 52.05% (*Abies alba* Mill., *Aesculus hippocastanum* L., *Castanea sativa* Mill. etc.) and tall shrubs - 58.62% (*Juniperus communis* L., *Caragana arborescens* Lam., *Cornus alba* L. etc.). According to the analysis of the spectrum of ecological features in the common dendroflora, heliophytic (54.29%), mesophytic (40%), frost-resistant (64.76%) and oligotrophic (37.14%) plant species predominate. Of the total number of common plant species, 41.9% are autochthonous in Ukraine, and 58.1% are dendroexotic plants. Autochthonous plant species are of predominantly European habitat type and European Nemoral and Eastern European Nemoral geoelements. Of the total fraction of dendroexotic plants, only 54.10% naturally grow within one floral region. The largest number of them is the Circumboreal floral region - 15 species of plants. Instead, 23 species represent two floral regions at a time, and four plant species represent three floral regions of the Earth.

Table 3. Taxonomic structure of common species of park dendroflora of Rivne and Vinnytsia regions

Division	Number of families	Number of genera		Number of species		
	pcs	%	pcs	%	pcs	%
<i>Pino-phyta</i>	3	10.34	8	12.90	21	18.92
<i>Magnoliophyta</i>	26	89.66	54	87.10	90	81.08
Total	29	100	62	100	111	100

As the result of comparison of dendroflora of the parks-monuments of landscape art of Rivne and Vinnytsia regions, 111 common plant species were identified (Table 3). *Rosaceae*, *Pinaceae*, and *Salicaceae* represent the largest number of plant species (17, 15, and 8, respectively). *Betulaceae* has seven plant species, *Oleaceae* - six, *Cupressaceae* and *Sapindaceae* - five, *Fabaceae*, *Fagaceae* and *Adoxaceae* - four, five families cover three species, seven families - two, the other seven families - one species of plants each. As in the previous version, mesophanerophytic species of plants predominate by biomorphotype - 54.05%. According to the classification of types of life forms by I.H. Serebryakov (1962)

three types have been found: trees (79 species), shrubs (30) and woody vines (2). The height classes in the pair of these two regions are also dominated by species of the first magnitude trees and tall shrubs. As a result of ecological assessment of the composition of common species, the predominance of light-loving plants (54.95%) has been established, with respect to moisture - mesophytic (38.74%), to temperature - frost-resistant (67.57%), to soil trophicity - the proportion of oligotrophic and eutrophic plant species are almost identical (35.14% and 34.23%, respectively). Common species of plants also include dendroautochthons and dendroexotics. Usually a share of autochthonous plant species is 13.52% lower. The European type of habitat and the European Nemoral geoelement are the most well represented by dendroautochthons. Of all dendroexotic plants, 52.38% of plant species are represented by one floral region: Circumboreal - sixteen species, Atlantic North American - eight, Irano-Turanian - four, Eastern Asiatic and Rocky Mountains - two each, Madrean - one plants species.

The native habit of 25 plant species covers two floral regions at once: Circumboreal and Atlantic North American - nine species, Circumboreal and Irano-Turanian - six, Eastern Asiatic and Irano-Turanian - five, two species in pairs represent the Eastern Asiatic and Circumboreal, Mediterranean and Circumboreal floral regions. Four species of plants represent three floral regions: Circumboreal, Atlantic North American and Madrean - two species, Eastern Asiatic, Irano-Turanian and Mediterranean - one species, Rocky Mountains, Circumboreal and Atlantic North American - one species of plants as well. Finally, as a result of comparison of dendroflora of the parks-monuments of landscape art in Rivne, Vinnytsia and Zaporizhzhia regions, only 89 common plant species were identified, belonging to 56 genera, 26 families and two divisions. Of these, angiosperms account for a major proportion (80.90%). However, only two families of both divisions dominate by the largest number of plant species (*Rosaceae* and *Pinaceae* - 11 species each). Almost half (48.31%) of the composition of the compared plant species belong to the subtype of

mesophanerophytes. Of the three types of life forms, trees (62 species) prevail with slightly fewer shrubs (26). The type of woody vines is represented by only one species (*Parthenocissus quinquefolia* (L.) Planch.). Trees of the first magnitude and tall shrubs have a prominent place by the height classes. Of the eco-groups, heliophytes (53.93%), mesophytes (43.82%), oligotrophs (35.96%) and frost-resistant (61.80%) plants occupy a leading position among the common plant species in the three regions. Among genesis groups of common plant species, there are slightly more dendroexotics (55.06%) than dendroautochthons (44.94%).

Most dendroexotic plants grow naturally within a single floral region: in particular Circumboreal (12 species), Atlantic North American (8), Irano-Turanian (3), Eastern Asiatic (2), Rocky Mountains (2) and Madrean (1) regions. Another 17 plant species cover two floral regions at a time. The rest of the common species grow naturally within the three floral regions. Autochthonous species of woody plants mainly belong to the European type of habitat and the European Nemoral geoelement.

CONCLUSIONS

Despite some differences in the values of both coefficients (Jacquard and Serensen-Chekanovsky indicators), the general trend shows a higher level of similarity of the park dendrofloras, which are found in more similar natural conditions, albeit in different geographical zones (Forest-Steppe and Steppe). In general, most of the common plant species of the studied dendrofloras of the three regions are represented by *Magnoliophyta* and *Rosaceae*. They all belong to a subset of mesophanerophytes as well. A characteristic feature for all three compared pairs of dendroflora is the predominance of trees of the first magnitude, and tall plants among the shrubs. In terms of the range of eco features, most of the compared species are light-loving, mesophytic and frost-resistant plants. However, there are some differences in the requirements for trophic soils: most common species of park dendrofloras of Rivne and Zaporizhzhia regions have little demand for soil conditions, as they are outside the edaph-

geographical optimum of the plant growth and development, regardless of their origin (autochthonous or exotic). On the other hand, oligotrophs and eutrophs are equally common among the common plant species in Rivne and Vinnytsia regions. This difference is due to zonal soil-climatic features. Also, this pair of the compared dendrofloras is characterized by a greater proportion of dendroexotic plants, which indicates a more intensive introductory process in the parks over the historical time of their development. Therefore, an optimal natural-geographical region of Ukraine for park construction and introduction of dendroexotics is the forest-steppe zone. Hence the species of woody plants that are not part of the common species of the pairwise compared dendrofloras shall be introduced in the parks of some natural geographical region.

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