

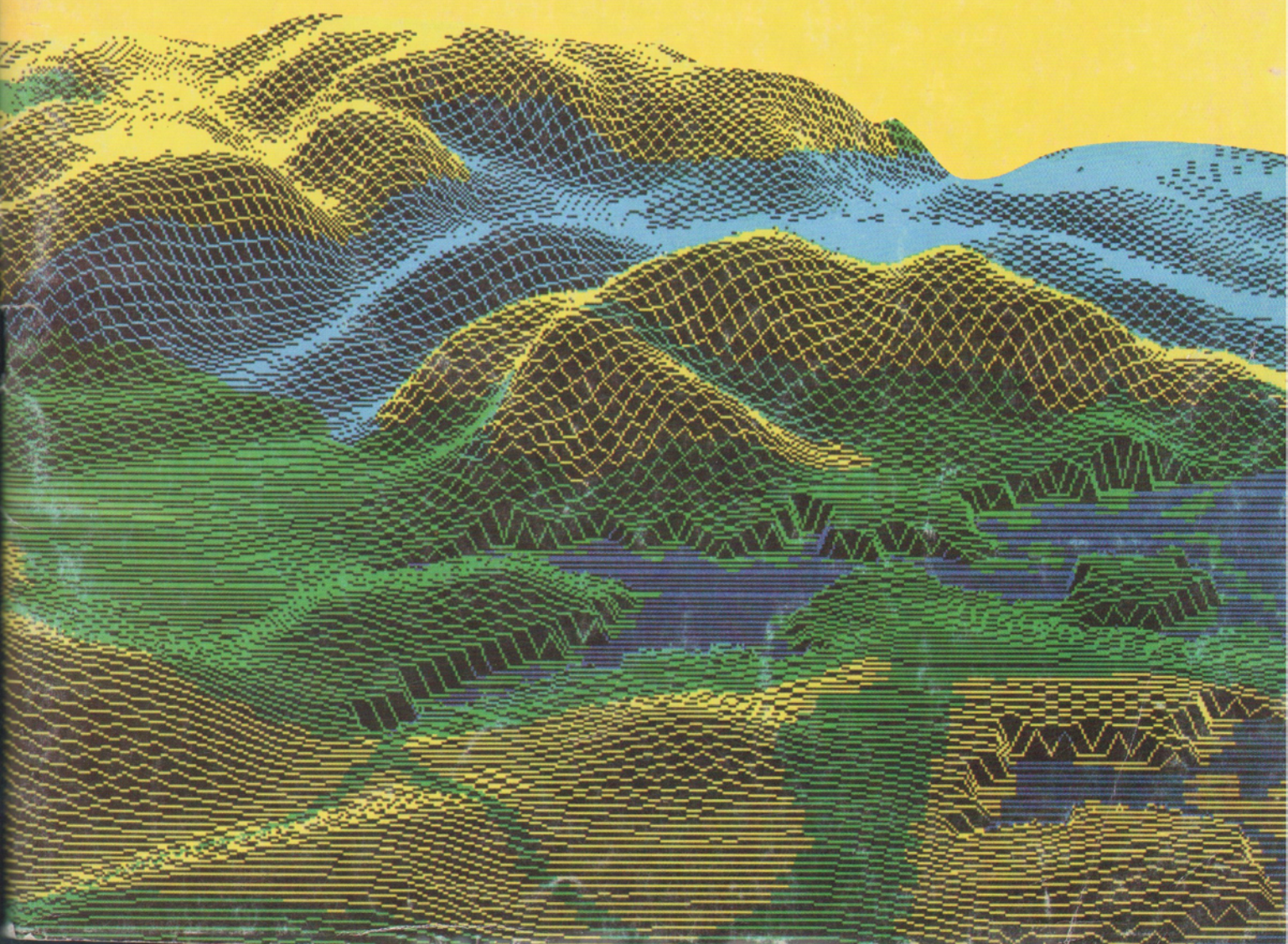
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THE SKELETON OF LANDSCAPE ECOLOGICAL STABILITY

Jan Lacina

Abstract

Ecological stability of the landscape, which depends mainly on the condition of biotic component, namely vegetation has been disturbed in vast territories by long-term intensification of anthropogenic activities. At present efforts directed to restoration of ecological stability the most important task consists in defining and registration of all natural and near-natural ecosystems which have been preserved in the cultural landscape. These ecologically significant landscape segments which are further divided into ecologically significant landscape elements, districts, regions and ecologically important line communities by spatial and structural criteria, form the skeleton of landscape ecological stability. Since the formations in question are often represented only by isolated isles of biodiversity, their present network should be completed and provided with proper interconnection. Thus, the skeleton of landscape ecological stability becomes a basis for creating functional regional systems of ecological stability of the landscape.

Shrnutí

Kostra ekologické stability

Dlouhodobou intenzifikací antropogenních aktivit byla na rozsáhlých územích narušena ekologická stabilita krajiny, která je závislá na stavu biotické složky, zejména vegetace. Při současných snahách o obnovu ekologické stability je prvořadým úkolem vymezit a registrovat všechny přirozené a přírodě blízké ekosystémy, které se v kulturní krajině zachovaly. Tyto ekologicky významné segmenty krajiny, které podle prostorově strukturních kritérií dělíme na ekologicky významné krajinné prvky, celky, oblasti a ekologicky významná liniová společenstva, tvoří kostru ekologické stability krajiny. Protože se často jedná jen o izolované ostrovy biodiverzity, je třeba jejich současnou síť doplnit a propojit. Kostra ekologické stability je tak základem pro vytváření fungujících územních systémů ekologické stability krajiny.

Key words: ecologically significant landscape segments, skeleton of landscape ecological stability, regional systems of ecological stability of the landscape

1. Introduction

Anthropogenic factors, significantly forming the landscape in Central Europe for many centuries, have led to gradual transformation and at many places even to devastation of natural ecosystems. Ecological stability of the landscape has thus been seriously disturbed, i.e. the ecological systems have lost their capacity to resist disturbing influences by means of self-regulation processes occurring in them. It is known that the ecological landscape stability depends on the condition of biotic component. It is therefore necessary that a certain proportion of natural biocoenoses remains preserved even within the cultural landscape, which would represent, if possible, complete diversity of species (biodiversity) of certain landscape. The natural ecosystems should be evenly distributed in the landscape, and form a really functional system.

The natural ecosystems in cultural landscape have been preserved mainly on extreme sites which cannot be subject to intensive utilization. Their network in the landscape is thus usually insufficient and unevenly distributed. This is why the ecological network must be artificially renewed in landscape types under strong anthropogenic impact.

An impuls for biogeographical research directed towards building of the landscape ecological network is the equilibrium theory of island biogeography (McARTHUR, WILSON - 1967). In the Czech Republic, the methodological procedure of landscape biogeographical differentiation has been worked out with using the interpretation of geobiocoenoses. Definition of the skeleton of landscape ecological stability has been set up as one of its major tasks (BUČEK, LACINA - 1977, 1979a, 1979b, 1984). A methodological

procedure of creation regional systems of landscape ecological stability (LÖW et al. – 1984) was developed at building a functioning ecological network in cooperation of a multidisciplinary team of natural scientists and planners, which is being discussed and precised in these days.

2. *Fundamental concepts and methodological procedure of defining the skeleton of landscape ecological stability*

The skeleton of ecological stability is a set of presently existing ecologically important landscape segments. Ecologically important are those segments of the landscape, which are either formed by ecosystems with relatively higher ecological stability or in which these play a dominant role. They are distinguished by permanent character of biota and by ecological conditions enabling existence of species appurtenant to landscape natural gene-pool.

The ecologically important landscape segments can be formed by natural biocoenoses which are typical of certain biogeographical areas, or by biocoenoses whose condition and development are conditioned by anthropogenic activities. The first group includes mostly remains of forest stands with natural forest tree species composition, the second group is composed of mainly various types of derelict lands, meadows with prevailing naturally growing species and ponds.

By spatial and structural criteria (size and shape, degree of homogeneity of ecological conditions, and present condition of biocoenoses) the ecologically important landscape segments divide into:

- ecologically important landscape elements,
- ecologically important landscape districts,
- ecologically important landscape regions,
- ecologically important line communities.

By their biogeographical significance (degree of biological diversity, representativeness and unique character of communities, incidence of rare and endangered species and communities) the ecologically important landscape segments further divide into those of:

- local importance
- regional importance
- supra-regional importance
- provincial importance
- biospherical importance.

Ecologically important element is a small area (usually of 100 m² up to 10 hectares) with homogeneous ecological conditions which usually include only one community type. Among elements we find for example a residual deciduous forest stand amongst pure coniferous stands, a wetland meadow with spring area amongst cultural meadows and fields, a small pond with riparian communities, an isolated rock with natural vegetation, a group of trees or even an isolated sizeable solitary tree amidst the rural landscape with no forests at all.

Ecologically important landscape district is a more extensive area (usually of 10 to 1000 hectares) where diverse ecological conditions facilitate existence of more community types. Characteristic complexes are for example incised valleys of upper and lower river reaches with forest, rock and wetland communities. Within the complex, there is a whole range of ecologically important elements. This appears useful namely in the cases when the individual elements differ from each other by methods and desirable intensity of protection and management.

Ecologically important landscape region is a large area (usually of above 1000 hectares), distinguished by diverse ecological conditions as well as by diversity of communities among which ecologically stable natural communities and near-natural communities are prevailing. The ecologically important landscape regions include not only the majority of protected landscape areas, but also a whole range of extensive areas with prevailing forests of natural composition of forest tree species and meadow communities rich in species. Very important are pond areas with typical mosaic of aquatic, wetland and terrestrial communities. Within the landscape region, it is always useful to define smaller territories with pronounced different communities as ecologically important landscape elements or complexes.

Ecologically important line communities are specific formations of the cultural landscape: they have a narrow and oblong shape and are characteristic by prevailing proportion of transition marginal biocoenoses (ecotones). They are formed by grass-herbaceous or woody vegetation, by breaking blocks of fields and meadows or forest monocultures. The densest network of line communities in our cultural landscape are formed by riparian stands in which continuous natural biocoenoses of alder, willow and ash with undergrowth of wetland and hydrophilous plant species reach in many a case the length of several kilometers. Shorter but no less important are the line

communities on remains of balks, agrarian terraces and stone walls. The important line communities include also alleys and tree avenues of autochthonous broadleaved trees (especially lime, maple, oak, rarely also beech, in some landscapes birch and European mountain ash). Ecologically less important are line communities formed by introduced tree species such as poplar provenances, horse chestnut, black locust, etc.

This spatial structural classification is used at assessing present condition of the landscape, at defining the skeleton of ecological stability. It has appeared that at least locally important landscape elements and line communities which request and deserve improved management and protection can be found and defined in practically any area.

The skeleton of ecological stability is defined on the basis of comparison between the natural (potential) and present condition of ecosystems in the landscape. It is first of all remains of natural communities with the highest ecological stability, which are to be defined. In the biogeographical province of Central European deciduous forests this applies mainly to remains of forest stands with species composition corresponding to the natural one. In agricultural landscape these include namely various types of derelict lands (both dry and wet) which are characteristic of high diversity of species. The intensively exploited rural and urbanized landscape usually lacks sufficient amount of residual ecosystems with high ecological stability. Therefore it is necessary to apply here a principle of relative choice. The skeleton of ecological stability in these cases includes also those parts of the landscape, which are less valuable in terms of ecological stability - such as locust grove amidst the field agricultural landscape, or park with a certain proportion of autochthonous tree species located in the middle of the town. Even these anthropogenically conditioned landscape segments enable existence of at least some species belonging to natural gene-pool of the landscape.

Definition of ecologically important landscape segments which form the skeleton of ecological stability is made by means of terrain biogeographical research. Biogeographical mapping of the present condition of biocoenoses can be either selective or full-area. At selective mapping the biogeographical research concentrates only to areas of ecological importance, of which many are well known from older literature such as materials documenting state nature protection. More suitable appears to be full-area mapping of current condition of the vegetation to detailed scales

(1:10 000 and greater). Advantage of the full-area mapping is the fact that the skeleton of ecological stability can be defined much more precisely and in more details.

Types of contemporary landscape can be defined by representation and distribution of current vegetation in the landscape. Attention is also being paid to relief types as well as to representation and arrangement of water streams and water areas. The types of contemporary landscape include areas with the same kind and intensity of anthropogenic activities which exhibit the same consequences within natural conditions of the given type. Basic types of the contemporary cultural landscape in Central Europe are as follows: urbanized landscape, agricultural landscape, agricultural-forest landscape and forest landscape. These general types are differentiated in more details by representation and distribution of actual types of current vegetation (e.g. in fields, meadows, vineyards, broadleaved forests, parks, etc.) into sub-types. The sub-types of contemporary landscape differ from each other by their functional importance, and also by their relative degree of ecological stability. The individual sub-types of contemporary landscape differ also in representation and distribution of ecologically important landscape segments. Thus the full-area definition of types and sub-types of contemporary landscape provides a good knowledge of specific places where the ecological network must be primarily renewed.

3. *Map contents and its assessment*

Example for defining the skeleton of ecological stability in maps of medium scales (1:50 000) was found in an area which includes northern part of BRNO and its surroundings. This area is markedly differentiated both by natural conditions and by intensity of anthropogenic influence.

The map illustrates 4 types of contemporary landscape with 16 sub-types, the types being distinguished by colours and their sub-types by figures. The greatest representation in the mapped area is that of agricultural-forest landscape, the second place is being occupied by forest landscape and the third one by urban landscape. The least representation is that of agricultural landscape. In a table, the landscape sub-types are allocated to altitudinal vegetation zones as well as to trophic and hydric series. A scale is applied to assess their anthropogenic load, relative degree of ecological stability and functional importance in terms of production, water-management, soil

preservation, recreation and biosphere protection. Aesthetic qualities are differentiated in a similar way.

There are altogether 133 ecologically important landscape segments defined on this full-area base, which can be distinguished by colours used to illustrate types of existing communities (water, wetland, grass, xeromorphile, forest deciduous, parks, etc.). Their biogeographical significance (local, regional and supra-regional) is expressed by thickness of the demarcation line. Shortening in front of the name designates the spatio-structural category of ecologically important landscape segment (element, district, region, line community) or the type of protected landscape area. It is apparent from the map that the highest number of ecologically important landscape segments in the given territory can be defined within forest ecosystems, lesser number in meadow ecosystems and only exceptionally in wetland and water ecosystems. The urban area of BRNO can boast of a significant representation of ecologically important park segments. The majority of defined segments is of local and regional biogeographical importance, only some of them are of supra-regional significance. Quite striking is the fact that in the time when the map was made (1990) only 30 of the mentioned 133 ecologically important landscape segments were provided legislative protection.

4. Conclusion

The map of the above conception is expected to provide sufficient knowledge about differentiation of the contemporary landscape by rep-

resentation and distribution of current vegetation types, which also indicate a certain intensity of anthropogenic influence as well as a certain relative degree of landscape ecological stability. The map should demarcate all parts of the landscape, which are of primary significance for preservation of biodiversity and landscape ecological stability. This means that it would not be enough to only illustrate-as it seems a rule in similar maps-exclusively the areas protected by legislation. Distribution of the existing skeleton of landscape ecological stability in the area under study indicates that there will be differences in demands imposed on creation functional territorial systems of ecological stability within various subtypes of contemporary landscape. It follows from the map also that some parts of the landscape will have to be preferably eliminated from considerations on intensive anthropogenic exploitation (urbanization, intensive forest management, intensive agricultural production, mining of mineral resources and parent rocks, etc.). These are the reasons which should make the map of "The Skeleton of Ecological Stability", one of important basic documents for any decision-making concerning regional developments.

Since 1990, when the described map was designed, both the methodology of defining the skeleton of ecological stability and actual knowledge of illustrated area have been improved with tens of other ecologically important landscape segments having been defined on the basis of full-area mapping procedures. The new Act on protection of nature and landscape, issued in 1992, defines new categories of particularly protected areas. In this sense, the map calls for integration of topical changes.

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RNDr. Jaroslav Vašátko, CSc.

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Explanations to the map - Appendix No. 2

The map reflects types and sub-types of the contemporary landscape. The tables provide an overall view of the types and characteristics of their functions, ecological stability, anthropogenic effects and aesthetic qualities. All these items constitute the skeleton of ecological stability. The ecological stability is a complex of all important current ecological segments of the landscape. They are distinguished by phytocoenoses and biogeographic significance.

Types of the present landscape:

1 – Urban landscape: 1.1 Residential landscape in depressions and uplands, 1.2 Residential and industrial landscape in depressions, 1.3 Residential and forest landscape in uplands, 1.4 Recreational and forest landscape in river valleys. 2 – Agricultural landscape: 2.1 Cropland in depressions, 2.2 Cropland on flat ridges of uplands and highlands, 2.3 Cropland with riparian stands in broad river and stream floodplains. 3 – Agricultural-Forest landscape: 3.1 Combined cropland and forest with prevailing deciduous forests (oak, hornbeam) and with upland orchards, 3.2 Combined cropland and forest with prevailing coniferous forests (pine, Norway spruce) and orchards in broken uplands and highlands, 3.3 Combined cropland and forest with pine and mixed forest stands and steppe derelict land in the uplands devastated by limestone mining, 3.4 Combined cropland and forest with Norway spruce stands and upland meadows, 3.5 Combined cropland and forest with mixed forest stands in the flat karst uplands. 4 – Forest landscape: 4.1 Deciduous forests (oak, hornbeam, beech) in broken uplands and highlands, 4.2 Mixed forests (pine, Norway spruce, larch, oak, hornbeam, beech) in uplands and highlands, 4.3 pine forests in broken uplands and highlands, 4.4 Norway spruce forests in broken uplands and highlands. 5 – Landscape type limits, 6 – Landscape sub-type limits, 7 – numerical designation of landscape sub-types.

Ecologically important landscape segments:

8 – Boundaries of ecologically important landscape elements and districts of local biogeographic significance, 9 – ditto of regional importance, 10 – ditto of supra-regional importance, 11 – Boundaries of ecologically important landscape regions of local biogeographic significance, 12 – ditto of regional importance, 13 – ditto of supra-regional importance, 14 – Ecologically important line communities of local biogeographic significance, 15 – ditto of regional importance, 16 – ditto of supra-regional importance.

Community types in ecologically important landscape segments:

17 – Aquatic, 18 – Wetland, 19 – Mesophyte grasslands, 20 – Hydrophilous grasslands, 21 – Xerophylic and thermophylic grasslands, 22 – Saxicolous, 23 – Forest deciduous, 24 – Forest floodplain, 25 – Forest coniferous-deciduous, 26 – Forest coniferous, 27 – Forest-steppe, 28 – Parks.

Used abbreviations:

EVKP – Ecologically important landscape element,
EVKC – Ecologically important landscape district,
EVKO – Ecologically important landscape region,
EVLS – Ecologically important line community,
CHKO – Protected landscape area,
KO – Rest area,
SPR – National nature preserve,
CHPV – Protected natural formation,
CHPZ – Protected parks and gardens.

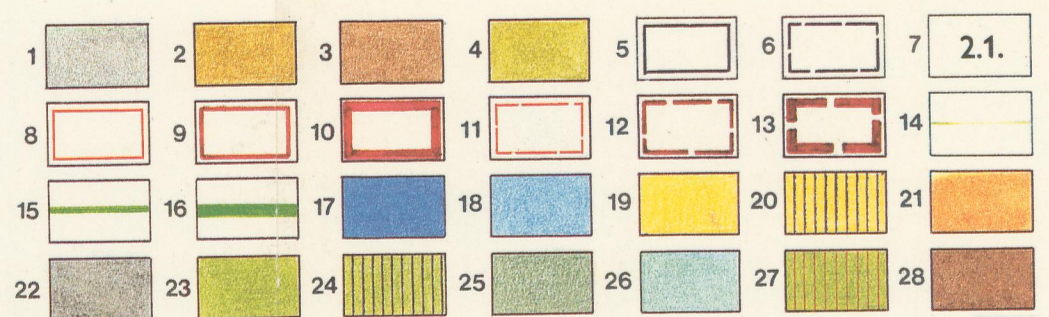
Explanations to the table assessment of present landscape types:

STK – Number of landscape sub-type, VS – Altitudinal vegetation zone: 1 - oak, 2 - beech, 3 - oak-beech, 4 - beech, 5 - fir-beech, TR – Trophic series: A/B Oligotrophic-mesotrophic, B Mesotrophic, B/C Mesotrophic-Nitrophilic, B/D Mesotrophic-Calciophilous, HR – Hydric series: n - normal, o - restricted, z - water logged, AO – Intensity of anthropogenic impacts, ES – Degree of ecological stability. Evaluation of functions: PZ – Agricultural production, PL – Forest production, V – Water management, P – Soil protection, R – Recreation, BO – Biological protection, EK – Aesthetic qualities.

The scale expresses the following meaning or condition:

0 - none (not evaluated), 1 – very low, 2 – low, 3 – medium, 4 – high, 5 – very high.





Kostra ekologické stability krajiny je soustava v současnosti existujících přírodě blízkých částí krajiny, vyznačujících se vyšší ekologickou stabilitou a ekologickými podmínkami vhodnými pro existenci druhů přirozeného genofondu. Tyto ekologicky významné segmenty krajiny (ekologicky významné krajinné prvky, celky, oblasti a liniová společenstva) mají funkci biocenter a biokoridorů různého biogeografického významu. Jejich zastoupení a rozložení je různé v různých krajinných typech. Typy současné krajiny jsou vymezeny především na základě současného stavu vegetace, v níž se nejzřetelněji projevuje intenzita antropogenních aktivit.

TYPY SOUČASNÉ KRAJINY:
1 - krajina urbanizovaná: 1.1. sídelní ve sníženinách a pahorkatinách, 1.2. sídelně-průmyslová ve sníženinách, 1.3. sídelně-lesní v pahorkatinách, 1.4. rekreačně-lesní v údolích řek; 2 - krajina zemědělská: 2.1. polní ve sníženinách, 2.2. polní na širokých hřbtech pahorkatin a vrchovin, 2.3. polní s břehovými porosty v širokých říčních a potočních nivách; 3 - krajina zemědělsko-lesní: 3.1. polně-lesní převážně s listnatými lesy (dub, habr) a se sady v pahorkatinách, 3.2. polně-lesní s převážně jehličnatými lesy (borovice, smrk) a se sady v členitých pahorkatinách a vrchovinách, 3.3. polně-lesní s borovými a smrkovými lesy a se stepními lody v pahorkatině devastované těžbou vápence, 3.4. polně-lesní se smrkovými lesy a loukami ve vrchovinách, 3.5. polně-lesní se smíšenými lesy v ploché krásové vrchovině; 4 - krajina lesní: 4.1. listnaté lesy (dub, dub, habr, buk) v členitých pahorkatinách a vrchovinách, 4.2. smíšené lesy (borovice, smrk, modřín, dub, habr, buk) v pahorkatinách a vrchovinách, 4.3. borové lesy v členitých pahorkatinách a vrchovinách, 4.4. smrkové lesy v členitých pahorkatinách a vrchovinách; 5 - hranice typů krajiny; 6 - hranice subtypů krajiny; 7 - sídelně označení subtypů krajiny;

EKOLOGICKY VÝZNAMNÉ SEGMENTY KRAJINY: 8 - hranice ekologicky významných krajinných prvků a celků lokálního biogeografického významu; 9 - dtto regionálního významu; 10 - dtto nadregionálního významu; 11 - hranice ekologicky významných krajinných oblastí lokálního biogeografického významu; 12 - dtto regionálního významu; 13 - dtto nadregionálního významu; 14 - ekologicky významná liniová společenstva lokálního biogeografického významu; 15 - dtto regionálního významu; 16 - dtto nadregionálního významu;
TYPY SPOLEČENSTEV V EKOLOGICKY VÝZNAMNÝCH SEGMENTECH KRAJINY: 17 - vodní; 18 - mokřadní; 19 - travinná mezofytita; 20 - travinná vlhkofilní; 21 - travinná suchá- a teplomilná; 22 - skální; 23 - lesní listnatá; 24 - lesní lužní; 25 - lesní jehličnatá-listnatá; 26 - lesní jehličnatá; 27 - lesostepní; 28 - parky;
Použité zkratky: EVKP - ekologicky významný krajinný prvek; EVKC - ekologicky významný krajinný celek; EVKO - ekologicky významná krajinná oblast; EVLS - ekologicky významné liniové společenstvo; CHKO - chráněná krajinná oblast; KO - kládová oblast; SPR - státní přírodní rezervace; CHPV - chráněný přírodní výtvar; CHPZ - chráněné parky a zahrady.

HODNOCENÍ TYPŮ SOUČASNÉ KRAJINY													
STK	VS	TR	HR	AO	ES	Hodnocení funkcí							
						PZ	PL	V	P	R	BO	EK	
1.1.	1.-3.	B,B/C	n	5	1	1	0	0	0	1	1	2	
1.2.	1.-2.	B,B/C	n	5	0	0	0	0	0	0	0	1	
1.3.	2.-3.	B,B/C	n	3	3	0	1	2	2	4	2	3	
1.4.	2.-3.	B,B/C	n,z	3	3	0	2	2	3	5	2	4	
2.1.	2.-3.	B	n	5	1	4	0	1	1	1	1	2	
2.2.	3.	B	n	5	1	3	0	1	1	1	1	2	
2.3.	2.	B/C	n	4	2	4	1	2	2	2	3	3	
3.1.	2.-3.	B	n	3	3	3	3	3	4	4	4	4	
3.2.	2.-3.	B,A/B	n	3	2	3	3	2	3	3	3	4	
3.3.	2.-3.	B,B/D,D	n,o	4	2	3	2	1	2	2	5	3	
3.4.	3.-5.	B,A/B	n	3	2	2	4	4	3	3	3	4	
3.5.	2.-4.	B,B/D	n,o	3	3	3	3	2	4	4	4	4	
4.1.	2.-3.	B,B/C	n	1	5	0	3	3	5	4	4	4	
4.2.	2.-4.	B	n	2	4	0	4	3	4	4	4	4	
4.3.	2.-3.	B,A/B	n	3	3	0	4	3	4	3	3	3	
4.4.	3.-4.	B,A/B	n	3	3	0	5	4	3	3	2	3	

STK - číslo subtypu krajiny; VS - vegetační stupeň: 1. dubový, 2. bukový, 3. dubobukový, 4. bukový, 5. jedlobukový; TR - trojická řada: A/B oligotrofně-mezotrofní, B mezotrofní, B/C mezotrofně-nitrofilní, B/D mezotrofně-kalcifilní, D kalcifilní; HR - hydriická řada: n normální, o omezená, z zamokřená; AO - intenzita antropogenního ovlivnění; ES - stupeň ekologické stability; Hodnocení funkcí: PZ - produkční zemědělská, PL - produkční lesní, V - vodoohospodářská, P - půdochranná, R - rekreační, BO - biochranná; EK - hodnota estetických kvalit

Stupnice vyjadřuje význam resp. stav:
0 - žádný (nehodnoceno), 1 - velmi nízký, 2 - nízký, 3 - střední, 4 - vysoký, 5 - velmi vysoký.

SOUBOR GEOGRAFICKÝCH MAP ŽIVOTNÍHO PROSTŘEDÍ
KOSTRA EKOLOGICKÉ STABILITY ČR. List 24-32 Brno.
Měřítko 1 : 50 000. Zpracováno v rámci dílčího úkolu SPZV II-7-4-01.
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