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NATURALNESS-BASED HABITAT QUALITY OF THE HUNGARIAN (SEMI-)NATURAL HABITATS

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Effective conservation of (semi-)natural habitats needs knowledge on the naturalness, the actual quality of a habitat or vegetation patch. Nevertheless, there are only a few studies have been published in this topic so far. During the MÉTA project, between 2002–2005, we have surveyed the semi-natural vegetation of Hungary and assessed the naturalness of the predefined 86 habitat types. In this paper we present the country scale analysis on the naturalness of these habitat types. We compared the naturalness of the individual habitat types and also habitat groups, as well as the naturalness of the physical macroregions of Hungary. Euhydrophyte habitats and habitats deserving high abiotic stress are the most natural ones, while secondary shrublands, uncharacteristic forests and grasslands are the less natural. For the forest habitats we compared and discussed the naturalness values given by the MÉTA mappers and the values gained in the TERMERD (assessing forest naturalness in Hungary) project. In case of regions, Kisalföld has the lowest naturalness, and surprisingly the quality of the Alföld and the Középhegység is nearly equal if we consider only the remained vegetation.

Key words: habitat quality, Hungary, MÉTA survey, naturalness

INTRODUCTION

There is growing global concern for the quality or health status of landscapes (or specific vegetation types), since we now believe that the future human well-being depends upon the well functioning and wholeness of the habitats, ecosystems and landscapes (MEA 2003). Effective conservation of (semi-)natural habitats requires not only knowledge of where the remnant patches of the natural vegetation occur, to what extent and which factors explain their

compositional characteristics, but needs also knowledge on the naturalness, the actual quality of a habitat or vegetation patch (Németh and Seregélyes 1989, Parkes *et al.* 2003, Raatikainen *et al.* 2007).

However, determining the overall quality of a particular habitat patch or habitat type is not an easy task; there is no absolute standard measure, since naturalness – similarly to human health – is not quantifiable as a whole. Nevertheless, there are thoroughly field-tested empirical methods available (Dierschke 1984, Németh and Seregélyes 1989, Parkes *et al.* 2003, Molnár *et al.* 2007), which make it possible to estimate habitat quality.

Despite the fact that the survey of the state and naturalness of the vegetation is generally considered as an important task (Molnár *et al.* 2007), there are relatively few investigations (or few of them are published) that document naturalness of larger areas, countries or regions. To estimate the naturalness of certain preferential habitats – for example forests – several projects were implemented recently in Central Europe. These kind of forest surveys can be classified into two groups (1) hemeroby investigations (e.g. Austria: Grabherr *et al.* 1998), which evaluate the forests according to the strength of human impact; and (2) investigations that evaluate the forests according to their deviation from a natural reference (e.g. Germany: AFL 1996, Baden-Württemberg: Schirmer 1999, Brandenburg: Steinmeyer 2003; Switzerland: Brassel and Lischke 2001). Recently, in 2004–2005, there was a project on assessing the naturalness of Hungarian forests, which was carried out similarly to the latter type (TERMERD project – assessing forest naturalness in Hungary, Bartha *et al.* 2003, 2006, Bölöni *et al.* 2005, Kenderes *et al.* 2007, http://ramet.elte.hu/~ramet/project/termerd/index.htm). All of the above-mentioned surveys covered large areas, but evaluated only the forest habitats.

Surveys assessing the naturalness-based habitat quality of grasslands are usually very weakly documented. A country scale assessment on the state of grasslands was carried out in Estonia recently. In this evaluation geobotanical, floristical and aesthetical aspects were considered, using a scale ranging from 1 to 3 (Mägi and Lutsar 2001). Besides this, there is an assessment of nature conservation value of grassland habitats of Morava River floodplain meadows published (Stanová *et al.* 1999). This assessment has been done exclusively by the quantity of the red listed species in the individual map unit. However, these two published investigations deal only with grasslands or a floodplain.

We found only one example until now, where the mapping of the vegetation of a huge area – Victoria State in Australia – was demonstrated on the basis of a well-documented methodology. Habitats were scored according to pre-set criteria (e.g. presence of large trees, lack of weeds, size of the patch), and the habitat score was gained by the adding of the individual scores (Parkes *et al.* 2003). The main goal was to prepare a summarised value map for

Victoria State, which was partly elaborated by extrapolation methods (Newell *et al.* 2006, Higgins 2006). The comparative evaluation of different regions were also done (Newell *et al.* 2007), which is our aim also to do in Hungary on the basis of MÉTA database.

We suppose that several surveys could have been executed with similar aims to ours, but their result can hardly be found in scientific journals, since the majority of these surveys were carried out by civil organisations (NGOs) and governmental organisations, consequently, the end-product is a report (with a limited access) and not a scientific paper. For researchers, however, it would be essential to get to know about these surveys and to discuss and harmonise their methodology.

During the MÉTA project, between 2002–2005, we surveyed the semi-natural vegetation of Hungary. In this survey 86 pre-defined habitat types were mapped and assessed by several attributes, including naturalness among others. Based on the MÉTA survey in this paper we present the naturalness of the most important Hungarian habitats and the naturalness of the landscape macroregions of Hungary.

MATERIALS AND METHODS

All of our data was derived from the MÉTA database (Molnár *et al.* 2007, Horváth *et al.* 2008). The survey of the natural vegetation heritage of Hungary and of its actual state were set as our main goals at the beginning of the MÉTA program. The MÉTA method is a grid-based, landscape ecology oriented, satellite image supported, field vegetation mapping method (Molnár *et al.* 2007). In the field work of MÉTA we used a hexagon grid with cells of 35 hectares (267,813 cells cover Hungary). In the hexagons, habitat types were listed, then the area, naturalness-based habitat quality, spatial pattern in the hexagon, effect of the neighbouring vegetation and landscape items, connectedness, and threats were recorded for each habitat type. For standardisation of mapping, three different pre-printed data sheets and two different kinds of guides have been composed (Mapping guide and Habitat guide) and field trainings were organised.

We used the naturalness-based habitat quality to estimate the state of the natural vegetation heritage in Hungary. For the estimation of naturalness-based habitat quality, the so-called Németh–Seregélyes naturalness system was used (Németh and Seregélyes 1989, Molnár *et al.* 2007): 1 = totally degraded state; 2 = heavily degraded state; 3 = moderately degraded state; 4 = semi-natural state; 5 = natural state, or a state that can be considered as natural. This system is essentially compatible with the European systems (e.g.

Dierschke 1984, Bastian 1996, Ružičková *et al.* 1996, Grabherr *et al.* 1998, Mägi and Lutsar 2001). Naturalness-based habitat quality is a synthetic value that integrates the structural and species pool variables into one value, e.g. distance from a theoretical natural state and the measure of human impact; species richness, ratio of the dominant species groups (weeds, uncharacteristic species, dominant and subordinate species of the original community), structure of the vegetation, site conditions and the size of the vegetation patch. Though this evaluation holds subjective elements, we have strongly endeavoured to standardise the method during the MÉTA project (Molnár *et al.* 2007). For example, the selection of the proper category of naturalness-based habitat quality was supported by a large set of examples in the Habitat guide (Bölöni *et al.* 2003, 2007).

Naturalness-based habitat quality was recorded separately for each habitat type in the hexagon. The values of different patches of the same habitat type in the same hexagon had to be merged into one (or two) value(s). If for up to 10% of the stands a higher category was relevant, it had to be indicated (e.g. coding 5r4 means: 4 dominates, but with less than 10% of the total area of a habitat type in the hexagon reaches the requirements of category 5).

Data of the naturalness-based habitat quality and the area of the habitat in the hexagon were gained by the SQL expert information service from the MÉTA database (Horváth and Polgár 2008). Since naturalness-based habitat quality is collected and interpreted in an ordinal scale, we compared the proportion of high quality stands. The stands are high quality if the naturalness is not lower, than category 4. Some rare habitats (total area in Hungary is below 20 hectares, e.g. "A4" = euhydrophyte communities of fens, "C1" = soft and hard water flushes, "C23" = transition mires and raised bogs, "J1b" = birch mire woodlands, "E5" = *Calluna* heaths) were excluded from the evaluation. Forests containing more than 50% invasive species were also omitted ("RD"), since the perception of this category is rather heterogeneous among the surveyors, and this habitat is usually not part of the natural heritage.

Naturalness-based habitat quality was summed also by habitat groups (Table 2). In case of the forests, the aggregation of the different habitats was carried out such a way that the comparison with the results of the TERMERD program (Bartha *et al.* 2005) is enabled.

To be able to compare the results of the two surveys, here we briefly summarise the method applied in TERMERD, since differences of the results can partly originate from the differences of the survey methods. In the TERMERD project a stratified random sampling was used (3,000 forest subcompartments) based on 56 indicators. The indicators were grouped into criteria (e.g. composition and structure of the tree, shrub and herb layer, dead wood, effect of

games, site degradation, etc.). Total naturalness value of a stand was gained a posteriori by the integration of the individual criteria.

Finally, for the comparison of the naturalness-based habitat quality of the physical geographical macroregions of Hungary (Marosi and Somogyi 1990), firstly the total area of the habitats in the given macroregion with naturalness-based habitat quality 4 and 5 was calculated and compared to the total area of all habitats ("area covered by vegetation"), and then to the total area of the whole region (including the non-vegetated areas, e.g. arable fields, roads, settlements, etc.).

RESULTS AND DISCUSSION

General evaluation of the habitats

The most natural habitat types in Hungary (Table 1) are the habitats connected to water and to extreme site conditions: euhydrophyte habitats ("A23" = euhydrophyte communities with *Nymphaea*, *Nuphar*, *Utricularia* and *Stratiotes*; "A3a" = communities of slowly running waters with *Potamogeton* and *Nymphoides*), marshes ("B2" = *Glyceria*, *Sparganium* and *Schoenoplectus* beds; "B3" = water-fringing helophyte beds with *Butomus*, *Eleocharis* and *Alisma*; "B6" = salt marshes), halophytic habitats ("F4" = dense and tall *Puccinellia* swards; "F5" = annual salt pioneer swards of steppes and lakes; "B6") and all rocky forest types ("LY1", "LY2", "LY3", "LY4"). The only exception is the beech forest ("K5"), which belongs to the mesic woodlands. Evidently, the so-called "uncharacteristic" habitat types ("OA", "OB", "OC", "RB", "RC") are the less natural. Closed steppes of the Alföld (Great Hungarian Plain) ("H5a" = closed steppes on loess, clay, tufa; "H5b" = closed sand steppes), the open loess

Table 1

Proportion of stands with high value of natural-based habitat quality (categories 4 and 5)

Proportion of semi-natural and natural stands	Code of habitats
> 2/3	LY3, F4, A23, B6, LY1, LY2, M7, LY4, K5, F5, B2, A3a, I4, B3, B1b
1/2 – 2/3	G2, M5, F1a, A1, M8↓, M1, M6, L1, D1, L4a, H1, D2, F2, B5, J1a, M4↓, J3, L4b, G3, A5, J6↓, B4, N13
1/3 – 1/2	K2, J2, J4, K7b, K7a, B1a, E2, P45, G1, H2↑, K1a, N2, J5, L2x↓, L2b, D6, L2a, D34, F3, F1b, M3, E34, L5↓, H3a↑, H4
1/4 – 1/3	I1, M2, D5↑, H5b, E1, P7, I2
< 1/4	Pa2, BA, H5a, P2b, RB, RA, OA, OB, OC, RC

Arrows show values, which are considered to be over- (↓), and underestimated (↑) by the authors

steppe oak woodlands ("M2") and certain mesic meadows ("E1" = *Arrhenatherum* hay meadows) also belong to the group of habitats with low naturalness value. We signed the habitats with up and down arrows in the table, where we assumed that the naturalness-based habitat quality was under- or overestimated by the MÉTA mappers.

Considering the habitat groups (Table 2), the euhydrophyte habitats, the few remained stands of fens and the halophytic habitats are the most natural ones among the treeless habitats. Mesic meadows and dry grasslands have the lowest habitat quality. The naturalness of wet meadows and tall herb communities is not much higher. Habitat quality of dry shrub habitats with natural origin is prominently high. Wet shrub habitats are also in a relatively good state.

Table 2

Naturalness-based habitat quality of the habitat groups according to the MÉTA database

Habitat groups	Á-NÉR 2003 habitat types	Percentage area of naturalness categories					Total area [ha]
		2	3	4	5	4 + 5	
Euhydrophyte habitats	A1, A23, A3a, A5	4	28	33	35	68	8,302
Fens	D1, D2, B4, B1b	8	30	51	11	62	13,385
Halophytic habitats	F1a, F1b, F2, F3, F4, F5, B6	6	38	46	11	57	177,848
Marshes	B1a, B2, B3	7	43	42	8	50	63,432
Rocky grasslands	G2, G3, H1, H2, I4	3	50	43	4	47	6,767
Open sand steppes	G1	18	37	35	10	45	9,524
Wet meadows	B5, D34	10	50	35	5	40	84,063
Wet tall herb habitats	D5, D6	12	51	35	1	37	2,983
Mesic meadows	E1, E2, E34	10	62	28	1	29	25,042
Steppes	H3a, H4, H5a, H5b	16	58	25	2	27	77,917
Dry shrubs	M6, M7, M8	3	29	38	31	69	616
Wet shrubs	J1a, J3	5	38	45	12	57	2,814
Pioneer shrubs	P2a, P2b	16	67	15	1	17	56,704
Rocky woods	LY1, LY2, LY3, LY4	2	18	72	9	81	7,423
Beech woodlands	K5	1	24	73	2	75	97,414
Calcifrequent oak woodlands	L1, M1	2	33	60	4	64	23,260
Acidofrequent woods	L4a, L4b, K7a, K7b	3	43	50	4	53	6,803
Coniferous woods	N13, N2	1	49	45	4	50	1,168
Swamp woods	J2	6	44	45	4	50	3,505
Oak-hornbeam woodlands	K1a, K2	4	47	47	1	49	193,714
Riverine woods	J4, J5, J6	4	49	43	4	47	52,226
Steppe woods	L2x, L5, M2, M3, M4, M5	11	49	34	6	40	17,698
Turkey oak woodlands	L2a, L2b	5	57	38	1	38	142,557

Secondary shrub habitats that develop after disturbance or abandonment have the lowest habitat quality. Among the forests, the rocky woodlands, the calcifrequent forests and beech woodlands are in the best state. Open and closed steppe oak woodlands, turkey oak-sessile oak and turkey oak-pedunculate oak woodlands are the furthest from their natural state.

After all, it is not surprising that the wetland habitats have the highest habitat quality. These habitats (mainly the euhydrophyte habitats, but partly the marshes, too) can be characterised by very fast regeneration after disturbance (Seregélyes *et al.* 2008). It is also understandable that the saline habitats are in good state, since their sites are unsuitable for arable farming. Low habitat quality of wet, mesic and dry grasslands can also be explained by historical causes. Part of these habitats were formerly sustained by the traditional agriculture (grazing and mowing). Abandonment often caused serious degradation, and their regeneration is often also slow.

Comparison with the TERMERD forest naturalness database

Comparison with the results of the TERMERD and MÉTA programs is shown in Table 3. The rank of the zonal, mainly colline and montane forest types that had undergone intensive management, is similar according to the two surveys. The mesic types are more natural than the drier ones (the order: beech woodlands, oak-hornbeam woodlands, closed dry Turkey oak woodlands). Beech woodlands are relatively the most natural forests of Hungary according to both analyses. Rocky forests and calcifrequent oak woodlands that are less influenced by management belong to the most natural habitats. On the other hand, the habitat quality is low in case of the larger, intensively managed

Table 3

Order of rank of the aggregated forest types based on the naturalness values of the TERMERD and MÉTA programs

Forest type	Order of rank	
	According to the MÉTA	According to TERMERD
Calcifrequent oak woodlands	3	1
Beech woodlands	2	2
Rocky woods	1	3
Oak-hornbeam woodlands	6	4
Turkey oak woodlands	9	5
Acidofrequent woods	4	6
Riverine woods	7	7
Swamp woods	5	8
Steppe woods	8	9

forests of the lowlands, independently of their site conditions (floodplain forests, forest steppe woodlands). Consequently, among the forests – similarly to the dry grasslands – particularly those types are the less natural, which are rare or absent westward from Hungary, therefore Hungary has a high responsibility in Europe to save these habitats. Though it is partly possible to regenerate the destroyed stands, the protection of the existing stands is an incomparably simpler (and cheaper) solution – and also the result is more satisfactory. These steppe woodlands are not only the less natural habitats among all semi-natural habitat types, but the most threatened ones, as it is revealed also by the MÉTA project (Molnár *et al.* 2008).

Besides the similarities of the results of the two surveys, there are significant differences, partly caused by the differences in the methodologies. The MÉTA survey focused mostly on the species pool, whilst TERMERD both on the species pool and the structure. E.g. rocky forests, beech woodlands and calcifrequent oak woodlands are reported as the most natural ones according to both surveys, though not in the same order. If we equally consider species pool and vegetation structure (TERMERD), than calcifrequent oak forests seem to be the most natural ones, since these habitats characteristically have heterogeneous structure and contain dead wood in great quantity. If we emphasise species pool, then rocky forests come to the first place, since they are rich in species and usually contain relic and specialist species. The same reasons can explain that the swamp woodlands came ahead in the list according to the MÉTA survey.

Evaluation of the naturalness-based habitat quality of the turkey oak dominated woodlands strikingly differ in the two surveys. It can be explained by the different interpretation of these woodlands in the MÉTA and TERMERD programs. Several stands that were classified as plantation of native tree species (and thus not parts of the natural vegetation heritage) in the TERMERD project, were classified as turkey oak dominated woodlands in the MÉTA survey. Since these stands are poor in forest species, their naturalness-based habitat quality is evidently worse. This could strongly (and negatively) influence the evaluation of the habitat quality of the turkey oak dominated woodlands in the MÉTA survey.

Assessment of the naturalness-based habitat quality of the macroregions of Hungary

Based on the existing vegetation, the naturalness of the Hungarian macroregions is similar, the proportion of habitats with habitat quality 4 and 5 is between 35 and 38%, only the Kisalföld region has strikingly low values (23%) (Table 4). The proportion of habitats with the highest naturalness category (5)

Table 4

Proportion of naturalness categories in the geographical macroregions of Hungary

Regions of Hungary	Percentage area of naturalness categories					Total area of (semi-) natural [ha]	Total % of (semi-)natural habitats
	2	3	4	5	4 + 5		
Alföld	20.9	43.3	29.3	6.5	35.8	583,332	12.8
Kisalföld	23.0	53.9	21.6	1.5	23.1	47,694	9.5
Nyugat-Dunántúl	12.2	50.8	35.4	1.5	36.9	125,564	18.3
Dunántúli-dombság	20.0	44.9	34.0	1.1	35.1	186,659	16.7
Dunántúli-középhegység	12.1	49.6	37.0	1.3	38.3	179,804	30.6
Északi-középhegység	13.6	49.8	35.6	1.0	36.6	332,008	35.2
Total	17.3	46.8	32.6	3.3	35.9	1,455,061	17.3

is far the highest in Alföld – 6.5%, and does not reach 2% anywhere else. But at the same time, the extension of the habitats with the worst naturalness-based habitat quality (category 2) is the largest in the lowlands (Alföld, Kisalföld) as well and in Dunántúli-dombság (20–23%).

Considering the proportion of the remained (semi-)natural vegetation in the macroregions provides a more complex picture (Table 4). While in Kisalföld the area of the natural habitats does not reach 10%, it is more than 30% in the mountains (Északi-középhegység and Dunántúli-középhegység). Among the macroregions in Hungary, the less (semi-)natural vegetation remained in Kisalföld. This region is also the most affected area by invasive species (Botta-Dukát 2008). Historical and environmental factors may jointly explain the state of this region; due to the formerly dominating large-estate system this is one of the mostly exploited agricultural regions of the country. At the same time, because of the more moderate and more humid climate, the proportion of the ecologically strongly stressed vegetation types (e.g. alkali, and sand steppes) should have been originally smaller than in Alföld. The other macroregions differ essentially only in the area of the remained (semi)-natural vegetation.

We should note that the naturalness-based habitat quality of the remained – though small amount – (semi)-natural vegetation of Alföld is on the same level as that of the remained – though more extended – (semi)-natural vegetation of colline-montane regions. It can be explained by two main reasons. Firstly, within the remained habitats the heavily stressed ones (mainly the alkali habitats) have great proportion. These sites avoided the drastic transformation, like ploughing or afforestation. Secondly, among the remained vegetation of Alföld, there are several habitats with good regeneration potential (e.g. marshes and euhydrophyte vegetation) that recovered after past disturbances.

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