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A contribution to the application of some numerical indices in the evaluation of recreational impact on vegetation

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The increasing demands on recreation and an indiferent relation to nature threaten the quality of vegetation and the recreational environment as a whole. The article discusses the possibility of using several numerical indices for the evaluation of recreational impact on the environment on examples of several plant communities disturbed and more or less undisturbed by recreation.

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The increasing demands on recreation result in expanding pressure on many a place of natural beauty and conservationists' interest. People being given more free time, with growing possibilities of mobility, search for peace, quietness and beauty in nature not considering the fact that they can be a potential danger of destruction of what they are looking for.

Therefore one great task emerges before ecologists, conservationists and managers — to study and to understand processes connected with the recreational impact to preserve nature at least as it is for the future.

One of the most difficult tasks now is the collection and quantification of data that could be interpreted and used in practice. There is practically no place that would not be disturbed by some human activity either directly or indirectly and these influences are very hard to distinguish.

In this article I would like to show one method of evaluating a decline in diversity and complexity of vegetation and the degree of anthropogenization first used by Kostrowicki (1970).

METHODS

I have applied Kostrowicki's method on the basis of vegetation relevés comprising various natural plant communities from the lowlands to the mountains. Relevés were sampled in areas relatively undisturbed and disturbed by recreation, but comparable with the former ones. The habitats were predominantly damaged by trampling and eutrophization. The taxonomic nomenclature (where the authors' names are not given) follows Rothmaler (1976). Relevés were recorded by means of ten-numbered scale by Domin, modified by Hadač.

Kostrowicki (l.c.) suggests the following equation for the evaluation of the degree of diversity and complexity of vegetation:

$$I = \frac{(1000\ p.g)^{a1} + (700\ p.g)^{a2} + (500\ p.g)^{a3} + (100\ p.g)^{b} + (p.g)^{c}}{100},$$

where a^1, a^2, a^3, b, c = vegetation layers, p = total coverage of a given layer, g = total number of species forming a given layer. The multipliers 1000, 700 etc. mark differences in the increment

Tab. 1. — *Plantagini medii-Festucetum rupicolae* HADAČ et RAMBOUSKOVÁ 1981 — slightly disturbed (a) near the road Srbsko—Hostim almost against the branch to the quarry of the Chlum hill and very strongly disturbed (b) on the central strip of the path of Zlatý kůň, both in the Bohemian Karst (anthropophytes A)

Relevé	a		b		
Exposition	NW		—		
Slope (°)	10		0		
Area (m^2)	8		6		
Number of species E_1	22		24		
E_0	2		0		
Coverage E_1 (%)	95		75		
E°	5		0		
E_1		T (%)		T (%)	
Achillea millefolium	—	—	1	1	
Agrostis stolonifera	—	—	1	1	A
Alyssum alyssoides	1	1	3	3.5	
Arenaria serpyllifolia	—	—	2	2	
Arrhenatherum elatius	2	2	4	10	
Asperula cynanchica	3	3.5	—	—	
Carduus acanthoides	1	1	—	—	A
Carduus nutans	—	—	1	1	
Centaurea scabiosa	3	3.5	—	—	
Cerastium arvense	1	1	—	—	A
Convolvulus arvensis	1	1	—	—	A
Crepis biennis	—	—	1	1	A
Dactylis glomerata	—	—	2	2	A
Echium vulgare	—	—	2	2	
Euphorbia cyparissias	2	2	—	—	
Festuca rupicola	8	62.5	5	20	
Fragaria vesca	3	3.5	—	—	
Galium glaucum	5	20	—	—	
Helianthemum nummularium	1	1	1	1	
Hieracium pilosella	1	1	—	—	
Hypericum perforatum	—	—	1	1	
Knautia arvensis	3	3.5	—	—	
Lolium perenne	—	—	2	2	A
Matricaria maritima subsp. *inodora*	—	—	1	1	A
Medicago lupulina	—	—	3	3.5	A
Pimpinella saxifraga	4	10	—	—	
Plantago lanceolata	1	1	5	20	A
Plantago major	—	—	3	3.5	A
Plantago media	2	2	1	1	A
Poa annua	—	—	4	10	A
Polygonum aviculare	—	—	1	1	A
Potentilla arenaria	—	—	1	1	
Potentilla heptaphylla	2	2	—	—	
Salvia verticillata	2	2	—	—	
Sanguisorba minor	4	10	5	20	
Scabiosa ochroleuca	—	—	1	1	
Taraxacum officinale	—	—	2	2	A
Teucrium chamaedrys	2	2	—	—	
Thymus pulegioides	4	10	—	—	

Tab. 1. (contd.)

E_0		
Syntrichia ruralis	4	—
Thuidium abietinum	2	—
ΣT_{E1}	145.5	111.5
I	$\frac{145.5 \cdot 22}{100} = 32.0$	$\frac{111.5 \cdot 24}{100} = 26.8$
A	$\frac{6 \cdot 5}{100} = 0,3$	$\frac{48 \cdot 11}{100} = 5,8$
I_A (%)	$\frac{6 \cdot 5 \cdot 100}{145.5 \cdot 22} = 0.9$	$\frac{48 \cdot 11 \cdot 100}{111.5 \cdot 24} = 21.5$

of the organic mass between herbaceous vegetation and shrubs and trees growing at the slowest rate. The multipliers were taken from the work of BOYSEN-JENSEN (1932).

Further Kostrowicki suggests the degree of anthropogenization A as follows:

$A = \frac{g_A \cdot P_A}{100}$, where g_A = number of anthropophytes for a single layer, p_A = coverage

Tab. 2. — Untrampled (a) and trampled (b) community with *Festuca rupicola* on slopes of the Šárka gully — Prague (anthropophytes A)

Relevé	a	b
Exposition	S	—
Slope (°)	5	0
Area (m²)	10	9
Number of species	13	11
Coverage (%)	100	95 — 100

		T (%)		T (%)	
Achillea collina	—	—	1	1	
Agropyron intermedium	2	2	4	10	
Arrhenatherum elatius	3	3.5	—	—	
Centaurea stoebe	1	1	—	—	
Convolvulus arvensis	3	3.5	3	3.5	A
Dianthus carthusianorum	1	1	—	—	
Eryngium campestre	4	10	+	0.5	
Euphorbia cyparissias	4	10	—	—	
Festuca rupicola	7	41.5	8	62.5	
Galium verum	3	3.5	1	1	
Koeleria macrantha	1	1	—	—	
Lolium perenne	—	—	5	20	A
Medicago falcata	4	10	3	3.5	
Salvia nemorosa	1	1	—	—	
Stachys recta	1	1	—	—	
Taraxacum officinale	—	—	+	0.5	A
Thymus marschallianus DOM.	—	—	3	3.5	
Trifolium arvense	—	—	1	1	A
ΣT		89		107	
I		11.6		11.8	
A		0		1.0	
I_A		0		8.5	

Tab. 3. — Untrampled (a) and trampled (b) community *Cetrario-Festucetum supinae* JENÍK 1961 along the tourist path near the Sněžné jámy in the Krkonoše mountains

Relevé	a		b	
Exposition	S		S	
Slope (°)	1 — 3		1 — 2	
Area (m^2)	9		9	
Number of species E_1	6		4	
Coverage (%) E_1	80		50	
E_0	30		0 (not analysed)	
		T (%)		T (%)
Calluna vulgaris	8	62.5	3	3.5
Carex fyllae subsp. *nardeticola* HOLUB	4	10	—	—
Deschampsia flexuosa	6	29	—	—
Festuca supina	5	20	7	41.5
Hieracium alpinum	3	3.5	+	0.5
Nardus stricta	1	1	—	—
Vaccinium myrtillus	—	—	+	0.5
ΣT		126		46
I		7.6		1.8
A, I_A		0		0

of anthropophytes for a single layer, and the degree of diversity and complexity of anthropophytes I_A for each layer:

$I_A = \frac{g_A \cdot p_A}{(g \cdot p)^c} \cdot 100$ (%) for herb layer and similarly for other layers. Index I can reach 1—3 for open dune communities, 30—60 for steppes and meadows, 500—1000 for pine forests poor in species, 2500—5000 for various types of deciduous and mixed forests, 5500—6500 for flood plain meadows and forests rich in species, 14000—25000 for tropical rain forests according to Kostrowicki (l.c.).

Tab. 4. — *Lolio-Plantaginetum majoris* BEGER 1930 (anthropophytes A) — Zlíchov (Prague)

Exposition	—		
Slope (°)	0		
Area (m^2)	4		
Number of species	7		
Coverage (%)	55		
		T (%)	
Dactylis glomerata	3	3.5	A
Eryngium campestre	+	0.5	
Lolium perenne	7	41.5	A
Plantago lanceolata	4	10	A
Plantago media	1	1	A
Taraxacum officinale	1	1	A
Trifolium repens	3	3.5	A
ΣT		61	
I		4.3	
A		3.6	
I_A		85.0	

Tab. 5. — *Acereto-Fraxinetum* KLIKA 1932 (a) along road from the Karlštejn castle to Prague and "*Sambuco-Fraxinetum*" (b) changed by eutrophization just under the castle (anthropophytes A)

Relevé	a		b		
Exposition	E		E		
Slope (°)	30		35		
Area (m^2)	200		200		
Number of species	36		27		
Coverage (%) E_3	65		75		
E_2	20		40		
E_1	85		80		
E_0	0		0		
E_3		T (%)		T (%)	
Acer platanoides	4	10	7	41.5	
Carpinus betulus	5	20	—	—	
Fagus sylvatica	4	10	—	—	
Fraxinus excelsior	6	29	7	41.5	
Pinus sylvestris	—	—	1	1	A
Ulmus glabra	4	10	6	29	
E_2					
Acer campestre	5	20	4	10	
Acer platanoides	2	2	2	2	
Acer pseudoplatanus	2	2	2	2	
Carpinus betulus	3	3.5	—	—	
Cornus mas	4	10	—	—	
Corylus avellana	3	3.5	1	1	
Evonymus europaea	4	10	—	—	
Fraxinus excelsior	4	10	—	—	
Lonicera xylosteum	2	2	—	—	
Ribes uva-crispa	3	3.5	—	—	
Sambucus nigra	—	—	6	29	A
Ulmus glabra	4	10	2	2	
E_1					
Aegopodium podagraria	3	3.5	—	—	
Aesculus hippocastanum (juv.)	—	—	1	1	A
Alliaria officinalis	2	2	5	20	
Anthriscus sylvestris	1	1	7	41.5	A
Asarum europaeum	4	10	—	—	
Arctium lappa	—	—	1	1	A
Ballota nigra	—	—	2	2	A
Campanulla trachelium	2	2	—	—	
Clematis vitalba	—	—	2	2	A
Epilobium montanum	—	—	1	1	
Evonymus europaea	—	—	2	2	
Fagopyrum dumetorum SCHREB.	+	0.5	—	—	
Fragaria moschata	1	1	—	—	
Galium aparine	2	2	—	—	
Galium odoratum	4	10	—	—	
Galium sylvaticum	1	1	—	—	
Geranium robertianum	1	1	—	—	A
Geum urbanum	1	1	1	1	A
Hedera helix	—	—	1	1	
Hepatica nobilis	3	3.5	—	—	

Impatiens parviflora	—	—	6	29	A
Lamium galeobdolon L.	5	20	—	—	
Lamium maculatum	3	3.5	—	—	
Lathyrus vernus	2	2	—	—	
Mercurialis perennis	4	10	—	—	
Poa nemoralis	—	—	2	2	
Primula veris	—	—	1	1	
Pulmonaria obscura	2	2	—	—	
Ranunculus auricomus	2	2	—	—	
Ribes uva-crispa	—	—	2	2	
Sisymbrium strictissimum	—	—	2	2	A
Stellaria holostea	7	41.5	—	—	
Taraxacum officinale	—	—	2	2	A
Torilis japonica	2	2	1	1	A
Urtica dioica	—	—	2	2	A
Veronica chamaedrys	1	1	—	—	
Veronica hederifolia subsp. *hederifolia*	2	2	1	1	
Viola hirta	1	1	—	—	
ΣT_{E3}		79		113	
ΣT_{E2}		176.5		46	
ΣT_{E1}		125.5		114.5	
I		4821.6		4817.8	
I_{E3}		3950,0		4520.0	
I_{E2}		841.5		276.0	
I_{E1}		30.1		21.8	
A_{E3}		0		0	
A_{E2}		0		29.0	
A_{E1}		0.3		9.3	
I_{AE3}		0		0	
I_{AE2}		0		10.5	
I_{AE1}		0.8		42.7	

RESULTS AND DISCUSSION

The following tables give several examples of plant communities of different habitats, and the way of calculation of I, A and I_A.

The first example (Tab. 1) is the community *Plantagini medii-Festucetum rupicolae* HADAČ et RAMBOUSKOVÁ 1981 from the Bohemian Karst, represented by one community very slightly disturbed and another one influenced very heavily. The second example (Tab. 2) is trampled and untrampled community with *Festuca rupicola* in the Šárka gully. It is clear that in both cases index I is lower in the Šárka than in the Bohemian Karst, which seems to be caused by the substratum of the Šárka region poorer in nutrients. Comparing both relevés within one association the anthropogenic impact is obvious.

We must take into consideration that these communities are often developed on shallow soils in extreme habitats of so called rock steppes and therefore they are susceptible to any kind of disturbance. Even worse is the situation in alpine communities represented by one example (Tab. 3) which shows again trampled and untrampled communities of the *Cetrario-Festucetum supinae* JENÍK 1961. Extreme conditions of the mountain climate make it impossible for the common anthropophytes indicating trampling

Tab. 6. — *Tilieto-Aceretum* FABER 1933 untrampled (a) and trampled (b) undergrowth (tree layer not analysed) along the tourist path from the Punkva caves to the Macocha abyss (anthropophytes A)

Relevé	a		b		
Exposition	W		W		
Slope (°)	45		45		
Area (m^2)	8		8		
Coverage (%) E_2	25 — 30		0		
E_1	65 — 70		2		
E_2		T (%)		T (%)	
Acer campestre	1	1	—	—	
Acer platanoides	2	2	—	—	
Acer pseudoplatanus	4	10	—	—	
Carpinus betulus	3	3.5	—	—	
Evonymus verrucosa SCOP.	1	1.5	—	—	
Fagus sylvatica	1	1	—	—	
Fraxinus excelsior	1	1	—	—	
E_1					
Acer pseudoplatanus	—	—	1	1	
Brachypodium sylvaticum	3	3.5	—	—	
Carex digitata	3	3.5	—	—	
Epipactis helleborine	2	2	—	—	
Evonymus verrucosa SCOP.	—	—	+	0.5	
Fragaria moschata	1	1	—	—	
Galium sylvaticum	3	3.5	—	—	
Geranium robertianum	+	0.5	—	—	A
Knautia drymeja	6	29	—	—	
Lamium galeobdolon	3	3.5	—	—	
Mercurialis perennis	5	20	—	—	
Mycelis muralis	2	2	—	—	A
Pulmonaria obscura	4	10	—	—	
Viola reichenbachiana	1	1	+	0.5	
ΣT_{E2}		19.5		0	
ΣT_{E1}		79.5		2	
I_{E2}		136.5		0	
I_{E1}		9.5		0.1	
A_{E1}		0.1		0	
I_{AE1} (%)		0.5		0	

(e.g. *Poa annua*, *Plantago major*, *Lolium perenne* etc.) to grow, so that the destruction of the vegetation cover leads to a complete denudation of soil surface and its quick erosion.

Tab. 4 demonstrates one typical trampled community *Lolio-Plantaginetum majoris* BEGER 1930 from the Zlíchov slopes in Prague. The numerical indices indicate how poor in species the community is; all of them are anthropophytes.

Tables 5—9 concern forest communities, both more or less natural ones (*Acereto-Fraxinetum* near Karlštejn, *Tilieto-Aceretum* near the Punkva caves in the Moravian Karst, pine forest near Dvůr Králové and spruce forest near

Tab. 7. — Cultural spruce forest with pine on the habitat of an autochthonous *Querco-Carpinion* Klika 1957 — undisturbed (a) and disturbed (b) by recation — at the Slapy dam near Živohošť (anthropophytes A)

Relevé	a		b		
Exposition	SE		SE		
Slope (°)	5		5 — 7		
Area (m^2)	20		35		
Number of species	24		18		
Coverage (%) E_3	55		65		
E_2	20		30		
E_1	55		80		
E_0	35		0 (not analysed)		
E_3		T (%)		T (%)	
Alnus glutinosa	—	—	3	3.5	
Betula pendula	—	—	3	3.5	
Picea abies	7	41.5	3	3.5	
Pinus sylvestris	4	10	4	10	
Quercus petraea	—	—	7	41.5	
E_2					
Betula pendula	4	10	—	—	
Carpinus betulus	2	2	2	2	
Corylus avellana	—	—	4	10	
Quercus petraea	4	10	—	—	
Rubus fruticosus L.	2	2	—	—	
Sambucus racemosa	—	—	3	3.5	A
Sorbus aucuparia	—	—	3	3.5	
E_1					
Calamagrostis arundinacea	2	2	—	—	
Carex pallescens	2	2	—	—	
Deschampsia caespitosa	3	3.5	—	—	
Deschampsia flexuosa	3	3.5	—	—	
Epilobium angustifolium	4	10	—	—	
Fragaria vesca	—	—	2	2	
Hieracium murorum	2	2	—	—	
Impatiens parviflora	—	—	8	62.5	A
Luzula luzuloides	5	20	—	—	
Luzula pilosa	7	41.5	—	—	
Moehringia trinervia	2	2	2	2	
Maianthemum bifolium	—	—	3	3.5	
Mycelis muralis	1	1	—	—	A
Oxalis acetosella	7	41.5	6	29	
Picea abies (juv.)	+	0.5	—	—	
Poa nemoralis	1	1	—	—	
Potentilla erecta	2	2	—	—	
Quercus petraea (juv.)	+	0.5	—	—	
Ranunculus repens	—	—	1	1	A
Rubus fruticosus L.	—	—	8	62.5	
Senecio sylvaticus	1	1	—	—	
Vaccinium myrtillus	4	10	1	1	
Viola reichenbachiana	2	2	—	.	

ΣT_{E3}	51.5	62
ΣT_{E2}	24	20
ΣT_{E1}	146.0	163.5
I	1152.3	3213.1
I_{E3}	1030.0	3100.0
I_{E2}	96.0	100.0
I_{E1}	26.3	13.1
A_{E2}	0	3.5
A_{E1}	0	1.3
I_{AE2}	0	3.5
I_{AE1}	0,1	9.7

Špindlerův Mlýn), and cultural one (spruce monoculture near the Slapy dam).

The first example (Tab. 5) — the community *Acereto-Fraxinetum* KLIKA 1932 from the Bohemian Karst near Karlštejn — is compared with originally the same community near the castle changed by eutrophization where an expansion of anthropophytes leads to forming a substitutional community provisionally called "*Sambuco-Fraxinetum*". Indices I, A, I_A document changes in species composition, especially in shrub and herb layers.

Tab. 6 compares two herb layers in the community *Tilieto-Aceretum* FABER 1933, the first one in its natural state and the other one quite destroyed as a result of short-cutting switch backs. This leads to the complete destruction of the herb layer, damage of tree roots and erosion.

Very interesting results are shown when the cultural spruce forest in an unnatural habitat near the Slapy dam (Tab. 7) is compared with one near the camping site at Špindlerův Mlýn (Tab. 8) in its natural habitat. The long-term use of the Slapy dam for recreational purposes has caused disturbance of a spruce monoculture and a return of more or less autochthonous species of shrubs and trees, but the herb layer influenced especially by trampling is poorer in species and a number of anthropophytes are present.

The last example (Tab. 9) is a pine forest near Dvůr Králové on poor sandy soil. The recreational impact on such an oligotrophic habitat is more severe and becomes evident sooner than that in eutrophic habitats. This fact was also proved by the work of BEARDSLEY et WAGAR (1971).

The results show that the herb layer is always changed in the most drastic way due to recreation. This is understandable for the herb layer is influenced immediately while the shrub and tree layers suffer especially from the environmental factors; these changes do not appear at once, but after some time.

The communities of scree forests on steep slopes, those of pine forests on poor soils and alpine communities of wind-exposed habitats seem to be quite vulnerable and susceptible especially to quick changes connected with trampling. On the other hand some communities, e.g. spruce forest monocultures in their unnatural habitats are enriched, as a result of long-term recreation, by some species of the natural habitat.

Tab. 8. — Spruce forest — more or less undisturbed (a) by recreation and disturbed (b) — near the camping site at Špindlerův Mlýn (anthropophytes A)

	a		b		
Relevé	a		b		
Exposition	W		S		
Slope (°)	1 — 4		0 — 3		
Area (m^2)	200		200		
Number of species	18		14		
Coverage (%) E_3	65		60		
E_2	10		10		
E_1	70		30		
E_0	20		3 — 5 (not analysed		
E_3		T (%)		T (%)	
Alnus incana	—	—	3	3.5	
Fagus sylvatica	1	1	—	—	
Picea abies	8	62.5	8	62.5	
Sorbus aucuparia	1	1	—	—	
E_2					
Acer pseudoplatanus	—	—	2	2	
Alnus incana	—	—	1	1	
Fagus sylvatica	1	1	1	1	
Picea abies	—	—	+	0.5	
Rubus idaeus	3	3.5	3	3.5	
Sambucus racemosa	—	—	1	1	A
Sorbus aucuparia	3	3.5	4	10	
E_1					
Calamagrostis villosa	2	2	5	20	
Carex strigosa	2	2	—	—	
Cicerbita alpina	—	—	2	2	
Deschampsia flexuosa	6	29	4	10	
Dryopteris austriaca	7	41.5	1	1	
Dryopteris carthusiana	1	1	—	—	
Gentiana asclepiadea	1	1	—	—	
Homogyne alpina	1	1	—	—	
Luzula luzuloides	2	2	4	10	
Mainthemum bifolium	1	1	—	—	
Picea abies (juv.)	1	1	—	—	
Polygonatum verticillatum	—	—	4	10	
Prenanthes purpurea	—	—	4	10	
Rumex acetosella	—	—	3	3.5	A
Silene dioica	—	—	3	3.5	A
Vaccinium myrtillus	8	62.5	3	3.5	
ΣT_{E3}		64.5		65.5	
ΣT_{E2}		8		19	
ΣT_{E1}		144		83.5	
I		1974.8		1452.2	
I_{E3}		1935.0		1310.0	
I_{E2}		24.0		133.0	
I_{E1}		15.8		9.2	
A_{E2}		0		1	
A_{E1}		0		0.1	
I_{AE2}		0		0.7	
I_{AE1}		0		1.5	

Tab. 9. — Pine forest — more or less undisturbed (a) by recreation and disturbed (b) — along the road Dvůr Králové—Praha, near Dvůr Králové (anthropophytes A)

Relevé	a		b		
Exposition	—		—		
Slope (°)	0		0		
Area (m^2)	90		90		
Number of species	6		7		
Coverage (%) E_3	50		40		
E_2	10		3		
E_1	85		10		
E_0	40		1 (not analysed)		
E_3		T (%)		T (%)	
Betula pendula	3	3.5	—	—	
Picea abies	3	3.5	—	—	
Pinus sylvestris	8	62.5	8	62.5	
E_2					
Betula pendula	3	3.5	—	—	
Picea abies	3	3.5	—	—	
Sorbus aucuparia	—	—	+	0.5	
E_1					
Calluna vulgaris	—	—	1	1	
Deschampsia flexuosa	7	41.5	4	10	
Pinus sylvestris (juv.)	—	—	2	2	
Poa annua	—	—	1	1	A
Vaccinium myrtillus	8	62.5	1	1	
Vaccinium vitis-idaea	3	3.5	1	1	
ΣT_{E3}		69.5		62.5	
ΣT_{E2}		7.0		0.5	
ΣT_{E1}		107.5		16	
I		2102.2		626.5	
I_{E3}		2085.0		625.0	
I_{E2}		14.0		0.5	
I_{E1}		3.2		1.0	
A_{E1}		0		0	
I_{AE1}		0		1.0	

The results obtained during one single season cannot be generalized, nevertheless they are in accordance with some investigations made abroad (see e.g. Seibert 1974).

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SOUHRN

Článek se zabývá využitím některých numerických indexů, navržených Kostrowickým (Kostrowicki 1970) při hodnocení vlivu rekreace na vegetaci. Kostrowicki navrhl tzv. index diverzity a komplexity vegetace

$$I = \frac{(1000\,p.g)^{a1} + (700\,p.g)^{a2} + (500\,p.g)^{a3} + (100\,p.g)^{b} + (p.g)^{c}}{100},$$

a^1, a^2, a^3, b, c = jednotlivá patra, p = celková pokryvnost patra, g = celkový počet druhů v patře, konstanty 1000, 700 atd. jsou převzaty z práce Boysen-Jensen (1932) k vyjádření

rozdílů v biomase mezi jednotlivými patry. Dále Kostrowicki užívá stupně antropogenizace A:

$A = \frac{g_A \cdot p_A}{100}$, g_A = počet antropofyt v daném patře, p_A = pokryvnost antropofyt v daném patře, a stupně diverzity a komplexity antropofyt I_A:

$I_A = \frac{g_A \cdot p_A}{(p \cdot g)^c} \cdot 100\ (\%)$ pro bylinné patro a obdobně pro ostatní patra.

Na podkladě těchto indexů bylo provedeno hodnocení v několika typech společenstev od teplomilných travinných a dřevinných společenstev Českého a Moravského krasu přes většinou kulturní lesní společenstva středních nadmořských výšek ke hřebenovým společenstvům Krkonoš. Snímky dokumentují společenstva jednak rekreací více méně nenarušená a jednak ovlivněná rekreací, hlavně sešlapem a eutrofizací.

Největší změny nastávají zásadně v bylinném patře. Zejména společenstva suťových lesů na svazích, společenstva borů na chudých půdách a horská travinná společenstva exponovaných stanovišť velmi trpí vysokou frekvencí návštěvníků.

Některá společenstva, např. smrkové monokultury kolem Slap, jsou naopak „zásluhou" dlouhodobé rekreace obohacována o druhy původních společenstev.

Travnatá společenstva okolí Prahy zřejmě nejsou zatím ohrožena úplnou devastací, i když zde určitě poroste návštěvnost. Indexy I v narušeném a nenarušeném typu vegetace nejsou příliš rozdílné, ale důležité je jednak druhové ochuzení, při čemž se rozrůstají vůči sešlapu odolnější druhy a do společenstva vstupují antropofyta, což se projevuje zvýšením indexu A a konečně i I_A.

Výsledky jedné sezóny neopravňují k předčasným závěrům, ale jistě by bylo vhodné ve snadno zranitelných oblastech rekreaci co nejvíce usměrňovat.

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