

# METHODOLOGY FOR ESTABLISHING THE DEGREE OF NATURALNESS OF FOREST STANDS

J. Macků

Received: October 19, 2011

## Abstract

MACKŮ, J.: *Methodology for establishing the degree of naturalness of forest stands*. Acta univ. agric. et silvic. Mendel. Brun., 2012, LX, No. 5, pp. 161–166

Forest stands naturalness degree represents the real tree species composition comparison with the tree species on natural vegetation level – It means forest typology units. The natural tree species composition is derived from Typological System of UHUL (Forest Management Institute). The degree of naturalness of forests is one of the attributes for the assessment of the ecological stability of forests, whilst the broader basis for analysis of sustainable development of the territory.

The real tree species composition comes from the forest management planes database and the natural potential vegetation one from typological sites units (forest site complex). Forests types complex is a higher unit of this system hierarchy.

The solution based on comparison of the real species composition with natural potential vegetation, e.g. forest stands naturalness degree, is to be used in the ecosystem platform way. The preparation of entry data, e.g. allocation of structured stand type code to the real and natural species composition precedes the analysis itself. Then follows the tree species index calculation which means the final sum of tree index present and any absent species. This index presents the difference between the real tree condition and the model one. It is used entirely original concept algorithm of structured stand types.

This algorithm allows for the application computer technology and process so the range from forest stand group of up to the large territory (CZ).

The naturalness degree classification is defined on 0–6 levels, from zero degree for introduced species, 3rd degree for cultural forests, to 6th degree for those with natural tree composition. The limited criterion is the stand naturalness degree which should be on 4<sup>th</sup> level and above.

This method is for 15 years of application not only in the works of forestry sites typology completely worked.

degree of naturalness, natural tree species composition, current tree species composition, structured stand type, forest sites units

Synthetic processing database of forest management plans and guidelines allows a comparison of natural (in terms of potential natural vegetation) and actual tree species composition (based index nature of vegetation), respectively stand types (MACKŮ, J., 1996; MACKŮ, J. *et al.*, 1999).

The degree of naturalness of forests is one of the attributes for the assessment of the ecological stability of forests, whilst the broader basis for analysis of sustainable development of the territory.

A characteristic feature of our forest ecosystems is heavily dependent on anthropogenic deposits of

materials and energy. Their balance is not steady and spontaneous on natural processes.

The basic unit of valuation degree of naturalness is a forest sites type. "Typological System of UHUL" is the official name of a recently established forestry classification.

Forest sites type is than a part of forest inclusive of all on one origin geobicoenosis with homogenous ecological or growth conditions and with explicit amplitude of the potential autochthonous and allochthonous tree species production.

The forest type is characterized by a dominant species combination of the phytocoenosis, soil

properties, habitat and potential yield class of the trees species. Forests types complex is a higher unit of this system hierarchy.

Our methodology of forest stands naturalness degree is influenced in a qualitative way by:

- stand type a principle condition for forest ecosystem feature potential,
- current tree species representation and their mixture (what species composition and arrangement of trees closer to the natural, being favourably affected by the ecological stability of the stand),
- tree species origin and stand suitability (Most favourable to the stands of indigenous trees, the trees allochthonous sufficiently plastic and non-aggressive exotics, tailored to your circumstances. Unfavourable forest stands species are unable to tolerate the habitat conditions.),
- inside space arrangement (environmentally friendly forest stands are properly established and educated, with well developed crowns, a vertically indent, or floor stands and the firming elements),
- changes of growth conditions caused by external influences (deformation causes unfavourable growth conditions – such as poisoning of soil, moisture conditions change,
- outside relationship variability (by stands stable under the preceding criteria is an ecologically unfavorable isolation, preventing the migration of species, and a relatively small area).

Quantitatively, the changes are distinguished in forest ecosystems:

- negligible, for which there is no doubt that it can not be distinguished from endogenous cyclical fluctuations or the ecological balance of the ecosystem type (eg, changes in representation of species associated with age stand),
- compatible, which can be expected of spontaneous (or 'natural' in the preceding text) return to the ecological balance of an ecosystem. It does not exceed the limits of its environmental stability (eg, canopy disturbance, which adjusts the stand during the development of self, or regeneration harvesting),
- critical, in which symptoms appear. The ecosystem collapses and changes the existing ecosystem type to intolerable. Natural regeneration is the baseline in a socially acceptable time and impossible solution alternatives are either leaving the area of extreme ecological instability (which is usually undesirable), or create a new type of stable ecosystem man.

Parts of the forest (forest and groups) that exists currently in the required time frame is relatively stable internally, are elements of ecological stability of the skeleton (segments of ecological stability), the objects of Natura 2000, 1-st. Natural parks zones and so on.

## MATERIALS AND METHODS

### The source data consists of:

- the mensurational data (forest management plan)) for the evaluation unit (forest management unit, forest management-plan area, forest stand or floor group), age, forest sites type, density, representation of trees, natural forest area and cadastral territory),
- a vector layer of the forest division at the division of continuous forest,
- a vector map layer of forest typological units,
- representation of the natural composition of tree species by forest units types.

### Methodology for defining degrees of naturalness of forest

The degree of naturalness of forest stands based on species composition compared with the actual species composition at the level of potential natural vegetation. The natural tree species composition is derived from typological units. Difference representation of topical condition to model representation in absolute values indicate the index of naturalness. For the species composition the index is calculated as the sum of indices of tree species represented in the module and the module tree unrepresented (missing).

Procedure:

1. step – matching the index values contained in the species present in the current model,
2. step – assign a value to index the actual species present in the model unoccupied,
3. step – sum of the values observed by previous steps,
4. step – matching the degree of naturalness according achieved the index value.

The whole calculation algorithm is developed as a structured program in FoxPro software.

### Analyses of structured forest stand types

Due to application of the algorithm degrees nature of a forest has been developed as a structured

I: Examples of derivation of the degree of naturalness of forest stands

examples	model:	M6Z2P1	Fir beechwood
1.	Topical condition: Process:	C1 index 11, degree 2	Spruce pure stand
2.	Topical condition: Process:	D6P1 index 71 + 11 = 82, degree 5	Dominant beechwood with adulterant of spruce

## II: Degree of naturalness of the grading scale

	naturalness degree	index naturalness	classification of tree species
0	unsuitable	≤ 0	introduced tree species
1	very low	1–10	most unsuitable composition
2	low	11–30	rather unsuitable composition
3	medial	31–50	culture forest-appropriate composition
4	high	51–70	most natural composition
5	very high	71–90	near by natural composition
6	exceptional	≥ 91	natural composition

## III: Evaluation of the index of naturalness of species composition

Groups of forest tree species		model	Topical condition					
structured forest stand types			C	D	M	Z	P	V
% tree species representation			≥ 91	71–90	51–70	31–50	11–30	≤ 10
1	1e, 2e, 3e, 5e, 9e	E	–30	–20	–11	–10	–5	–1
	7e, 4 along Forest area 27,28*							
2	2, 5, 6 Quercus ceris L. (9x) only in Forest area 35*	C	≥ 91	90	60	31	10	5
		D	91	91	70	40	11	5
		M	71	71	71	50	20	5
		Z	51	51	51	51	30	5
		P	31	31	31	31	31	10
		V	11	11	11	11	11	11
missing		N	10	10	10	10	10	10
3	7, 8, 9, 9x	C	≥ 91	71	50	20	5	5
		D	80	80	51	30	5	5
		M	60	60	60	31	10	5
		Z	40	40	40	40	11	5
		P	20	20	20	20	20	5
		V	10	10	10	10	10	10
missing		N	5	5	5	5	5	5
4	1, 3, 4k 4x 4 only in Forest area 27, 28*	C	≥ 91	60	40	11	5	5
		D	71	71	50	20	5	5
		M	51	51	51	30	5	5
		Z	31	31	31	31	10	5
		P	11	11	11	11	11	5
		V	10	10	10	10	10	10
missing		N	1	1	1	1	1	1

C, D, M, Z, P, V ....code of species composition

1–9x .....code of tree species

\*..... Annouc. The Ministry of Agriculture CZ No. 83/1996 Digest

method for typification of a forest stand (MACKŮ, J., 1996). System of structured forest stand types (SFST) speaks of both about groups species composition and about the way they are mixed. The coding SFST has the necessary skills and allows further use in the processing of ecosystem analysis.

Algorithm – making of stand types is based on the following aspects:

- defining the group of introduced tree species,
- agrees species with similar ecological claims in groups,

- defines mixed of tree groups in the structured stand types.

A total 98 trees species (Announc. The Ministry of Agriculture CZ No. 84/1996 Digest) are included in the 17 groups of tree species in the algorithm.

Applications of SFST providing an essential step for calculating the naturalness degree of forest.

## IV: Group of forest trees

code.	sign	tree	code	sign	tree
1	SM	spruce	5	DB	oak
1e	SMe	introduced spruce	5e	DBe	introduced oak
2	JD	fir	6	BK	beech
2e	JDe	introduced fir	7	JS	ash
3	BO	pine	7e	AK	locust
3e	BOe	introduced pine	8	OL	alder
4	MD	larch	9	TP	poplar
4k	KOS	mountain pine	9e	LIe	introduced broadleaves
4x	JX	other conifers	9x	LI	other broadleaves

## V: Table V: Groups of tree species create under the mixed form following of forest stand type:

C	pure stands	(91–100%)	C1	pure spruce
D	dominant	(71–90%)	D2	dominant fir
M	major	(51–70%)	M3	major pine
Z	basical	(31–50%)	Z4	basical larch
P	admixture	(11–30%)	P7	admixture ash
V	incidental	(0–10%)	V9x	incidental other broadleaves

Combining groups tree with stand type creates SFST:

Examples:

C1 .....spruce monoculture,

D1P6 .....dominant spruce with admixture beech,

Z1Z3 .....mixture of spruce and pine

## RESULTS AND DISCUSSION

The other methods determination of degree nature forest stands contains in search VRŠKA, T., HORT, L., 2003. There are history and present nomenclature from a whole range authors. The term forest stands naturalness degree is used for the expression of the dimension the rate good forest stand. In the example: ò– the original stand, ò– natural stand, ò– close-to-nature stand, cultural, and allochthonous stand.

The concept is the wider and contains the structure stand. For the development forest excluding direct human intervention (i.e. mainly forest regeneration and young stand tending) it is therefore preferable to use the term spontaneous development.

Our concept is clearly aimed to compare the current species composition with the species composition of the level potential natural vegetation for forest type unit (forest site complex). It is used entirely original concept algorithm of structured stand types (MACKŮ, J., 2001). This algorithm allows for the application computer technology and process so the range from forest stand group of up to the large territory (CZ).

Establishing the degree of naturalness of forest stands so allows differentiated representation diagnostic species by forest sites units (forest site complex).

This method is for 15 years of application not only in the works of forestry sites typology, completely worked.

Our own calculation of the degree of naturalness can be done by two methods. Methods of numerical and graphical.

### Numerical method

Numerical method - an assignment degrees of naturalness of each forest stand (forest group) by the dominant group of typological units.

Data structure suitable for processing SW FoxPro:

1. Congregating input files
2. Transforming data into structured files forest storey and tree species
3. Representation of forest site units with the possibility of merging
4. Assigning a structured forest stands of forest stand type (group)
5. Composition of SFST
6. Areas of forest units types within the forest stands (group)
7. Determination of the SFST in the forest stands and forest units type
8. The composition SFST according System analysis g to forest stands (groups) and their representation in forest units types
9. Identification of naturalness degree according System analysis
10. Allocation of the degree of naturalness to forest stands (groups)
11. Recapitulation by degree of naturalness
12. Representation of degree of naturalness in forest units types

13. Reports for approval correctness of the results

14. Outputs for the calculation of areas.

### Graphical method

Graphical method – an assignment showing degrees of naturalness of each forest stand (forest group) by the proportion represented by typological units.

Used layers: from Data centre (Forest Management Institute Brandýs n. L.) layer F\_A\_PSK, layer forest

units type and the other layers for example cadastral territory, owner of forest and so on.

Geoanalyses of data from data depository for design mapping composition in SW Integraph Geomedia:

1. Attribute query to select from code of Forest management plan according to a layer of F\_A\_PSK
2. Spatial intersection obtained of layers with the layers of forest typology.

## CONCLUSION

The forest stands naturalness condition in the Czech Republic is not suitable. The comparison of degrees 0–3 with 60% to 40% of area with 4–6 degrees of the forest land is almost a warning. It is also an appeal to solve this problem.

In forestry, or forest management practice these methods of forest stands naturalness degree were used at first during the process of Regional development plans of forests (MACKŮ, J. *et al.*, 1996, 1999) for analyses of forest ecosystems and underwent the greatest degree of naturalness of use during the process of Regional typological works (MACKŮ, J. *et al.*, 2004). Here it was necessary to distinguish between forests with a tree species composition close to the potential natural vegetation from the forests of those remote from them.

In relation to the processing of local analytical work for territorial planning documentation, and evidence of planning activities (Announc. The Ministry for Local Development No. 500/2006 Digest) is the degree of naturalness of forest stands under investigation (encl. No. 1. pt. B, paragraph 31), as a basis for the analysis of sustainable development. The basic spatial unit for which a degrees of naturalness should be processed within territorial planning documentation is the cadastral territory.

## REFERENCES

- MACKŮ, J., 1996: In: VYSKOT, I. *et al.*: Projekt PPŽP/620/3/96), MZLU Brno, 1996, 60 str.
- MACKŮ, J. *et al.*, 1999: Metodika Oblastních plánů rozvoje lesů, ÚHÚL Brandýs n. L., 90 str.
- MACKŮ, J., 2001: Analýzy strukturovaných porostních typů, Lesnická práce č. 2/2001, 15, 6–71.
- MACKŮ, J., 2003: In: VYSKOT, I. *et al.*: Quantification and Evaluation of Forest Functions on the Example of the Czech Republic, Ministry of Environment of the Czech Republic, Prague, ISBN 80-7212-265-7, 50–54.
- MACKŮ, J. *et al.*, 2004: Pracovní postupy – Oblastní typologický elaborát, ÚHÚL Brandýs n. L., 33 str.
- VRŠKA, T., HORT, L., 2003: Zásady názvosloví při hodnocení „přirozenosti“ lesních porostů, AOPK ČR, projekt VaV 610/6/02, 8 str.
- VYHLÁŠKA MZe ČR č. 83/1996 Sb., o zpracování oblastních plánů rozvoje lesů a o vymezení hospodářských souborů.
- VYHLÁŠKA MZe ČR č. 84/1996 Sb., o lesním hospodářském plánování, příloha č. 4
- VYHLÁŠKA MMR ČR č. 500/2006 Sb., o územně analytických podkladech, územně plánovací dokumentaci a způsobu evidence územně plánovací činnosti. Příl. 1. Část B – Územně analytické podklady kraje – podklad pro rozbor udržitelného rozvoje území, pol. 31. stupeň přirozenosti lesních porostů.

### Address

Dr. Ing. Jaromír Macků, Ústav pro hospodářskou úpravu lesů Brandýs nad Labem, pobočka Brno, Vrázova 1, 616 00 Brno, Česká republika, e-mail: macku.jaromir@uhul.cz

