Methods of analysing data in the TERMERD project

Based on the data filled in the field form, and the corresponding species list, we used 56 indicators of forest naturalness. Individual indicators can be grouped into sets describing different criteria (Figure 1). Analyses can focus on a single indicator, a criterion (or criterion-group), or – based on all indicators – we can compose the naturalness value of the whole stand.

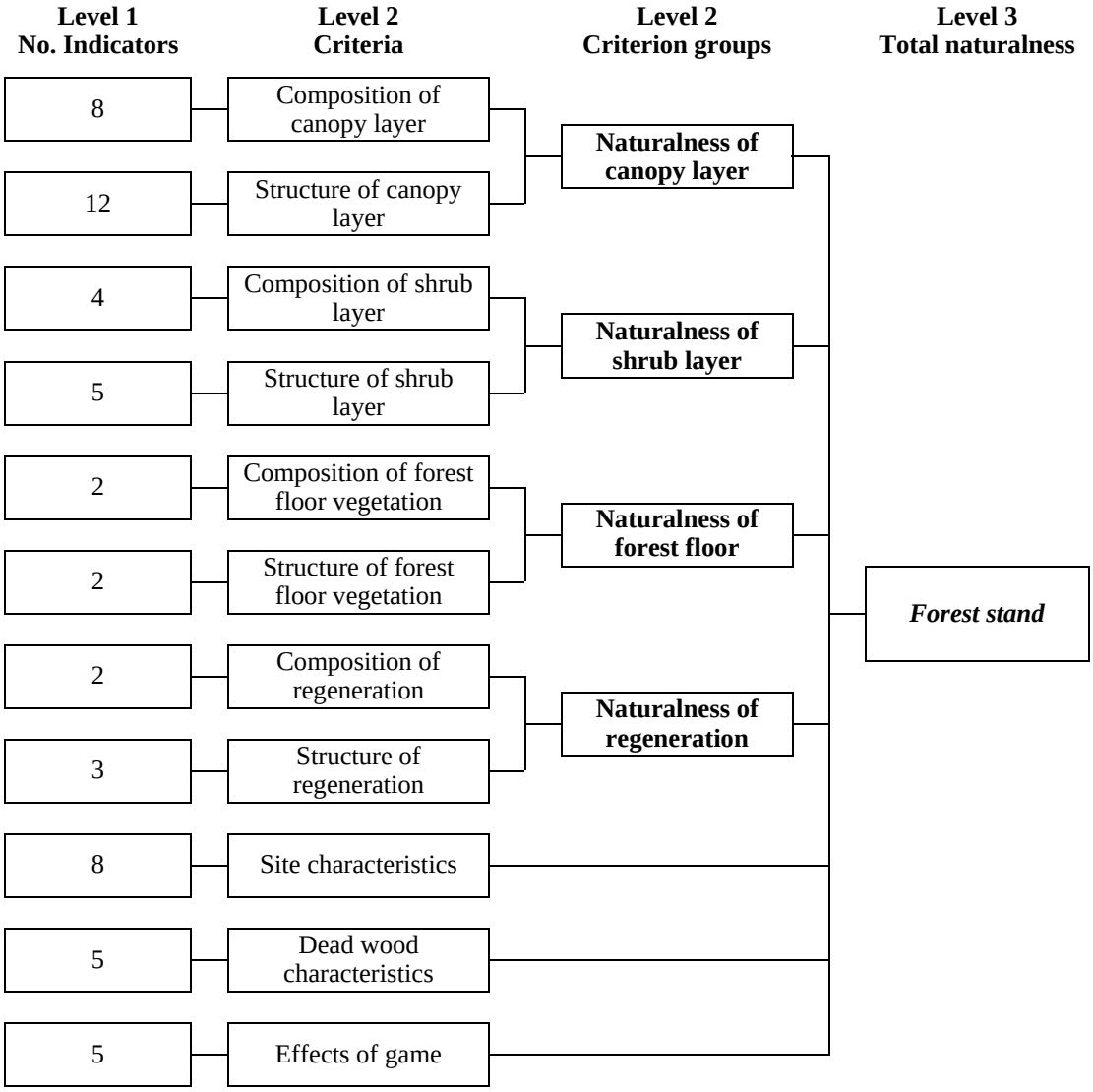

Figure 1. Conceptual framework of composing naturalness value. Indicators are evaluated by attaching a numerical value (level 1), than naturalness values of individual criteria are derived from the values of corresponding indicators (level 2), and finally, naturalness values of criterion-groups and the total naturalness value of the stand are derived from those of criteria (level 3). Values in the first column indicate the number of indicators describing the given criterion.

Naturalness values are derived during a hierarchical process composed of three levels. At the first level, we evaluate the qualitative or quantitative indicators (observed in the field) by attaching a numerical value (on a ratio scale ranging from 0 to 100) based on how the status

of the indicator in question corresponds to that of the hypothetical reference forest. The obtained value may depend on the potential natural forest community (PNFZ) of the stand. At the second level, the naturalness value of a criterion is derived as a weighed sum of the values of corresponding indicators. For each indicator, the applied weight is defined by estimating how important it is in determining the naturalness of the given criterion. To make naturalness values of different criteria comparable, for each criterion the obtained weighed sum is normalized by its possible theoretical maximum in the given PNFC. At the third level, the total naturalness value of the stand (a single number based on all assessed aspects) is calculated. It is derived as a weighed sum of the naturalness values of all the criteria used at the second level. Weight of a criterion may depend on PNFC.
Below, we give a detailed description on how we calculated the naturalness values at each level, and we also explain the applied weights.

Level 1.

Composition of canopy layer

A1. Proportion of natural tree species with cover > 5%

A1a. Number of natural tree species with cover > 5%

The increase in the number of associate species with cover > 5 % is treated as a factor increasing naturalness. Since PNFCs may differ in their natural species richness, the value of this indicator depends on PNFC. Three types are distinguished:

PNFC	Number of species						
	0	***1***	***2***	***3***	***4***	***5***	***6, or more***
Type 1.	0	40	60	90	100	100	100
Type 2.	0	25	40	60	80	100	100
Type 3.	0	10	20	40	60	80	100

Type 1. (naturally species poor types): beech forests, acidophilous oak forests, acidophilous beech forests, acidophilous oak–hornbeam forests, juniper–poplar steppe woods, alkali steppe oak woods, alder swamp woods, willow and birch swamp woods
Type 2. (intermediate types): willow–poplar galleries, sand steppe oak woods, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, slope forests, mixed deciduous–coniferous forests of W–Transdanubia, ash–oak–elm galleries, stream woods, turkey oak–pedunculate oak forests, scree forests
Type 3. (naturally species rich types): thickets, ravine forests, calciphile and thermophilous oak forests, loess steppe oak woods, turkey oak–sessile oak forests
Indicator can not be assessed: riverine willow scrubs

A1b. Presence of natural dominants

A close to natural forest is expected to contain the characteristic dominant tree species of the respective PNFC in the canopy layer in sufficient amount. Hence, if this expectation is met (see table below), this indicator gets a value of 100. Otherwise the value is 0. SUMA1 means that the cover % of all natural species should exceed the threshold.
Species codes in the table: B – beech; KTT – sessile oak; KST – pedunculate oak; GY – hornbeam, CS – turkey oak; MOT – downy oak; FRNY – white poplar, SZNY – grey poplar; BO -juniper; FFÜ – white willow; TFÜ – crack willow; FTNY – black poplar, MAK – narrow-leafed pannonian ash; MK – common ash, MÉ – black alder.

PNFC	Main tree species	Threshold value (%)
Zonal forests		
beech forests	B	50
sessile oak–hornbeam forests	KTT + GY	50
pedunculate oak–hornbeam forests	KST + GY	50
turkey oak–sessile oak forests	CS + KTT	60
turkey oak–pedunculate oak forests	CS + KST	60
Forests on rocky spots		
scree forests	SUMA1	80
ravine forests	SUMA1	80
slope forests	SUMA1	80
Acidophilous forests		
acidophilous beech forests	B	70
acidophilous oak–hornbeam forests	GY + KTT + B	80
acidophilous oak forests	KTT	70
mixed deciduous–coniferous forests of W–Transdanubia	SUMA1	80
Calciphile forests		
thickets	MOT + KTT	50
calciphile and thermophilous oak forests	MOT + CS + KTT	50
Steppe woods		
sand steppe oak woods	KST	50
juniper–poplar steppe woods	FRNY + SZNY + BO	80
loess steppe oak woods	KTT + KST + MOT + CS	70
alkali steppe oak woods	KST	50
Riverine forests		
riverine willow scrubs	-	-
willow–poplar galleries	FFÜ + TFÜ + FTNY + FRNY	80
ash–oak–elm galleries	KST + MAK + MK	50
stream woods	MÉ	50
Swamp woods		
alder swamp woods	MÉ + MAK + MK	70
willow and birch swamp woods	-	-
Other semi-natural forests	SUMA1	80

A2. Proportion of natural associate tree species with cover < 5%

A2a. Number of associate tree species

The increase in the number of associate species with cover < 5 % is treated as a factor that increases naturalness. Since PNFCs may differ in their natural species richness, the value of this indicator depends on PNFC. Three types are distinguished:

	Number of associate tree species								
	0	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8, or more***
Type 1.	0	20	40	60	75	85	90	95	100
Type 2.	0	25	55	80	100	100	100	100	100
Type 3.	0	35	70	100	100	100	100	100	100

Type 1.: beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, turkey oak–sessile oak forests, scree forests, ravine forests, slope forests, mixed deciduous–coniferous forests of W–Transdanubia, calciphile and thermophilous oak forests, sand steppe oak woods, loess steppe oak woods, alkali steppe oak woods, ash–oak–elm galleries, stream woods, Other semi-natural forests.
Type 2.: turkey oak–pedunculate oak forests, acidophilous beech forests, acidophilous oak–hornbeam forests, acidophilous oak forests, thickets, willow–poplar galleries, alder swamp woods, willow and birch swamp woods.
Type 3.: juniper–poplar steppe woods, riverine willow scrubs.

A2b. Proportion of associate tree species

Increase in the joint relative cover of rare (cover < 5 %) associate tree species is treated as a factor that increases the naturalness of the stand regardless of PNFC.

	Proportion of associate tree species (%)										
	0	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10, or more***
Value	0	10	20	30	40	50	60	70	80	90	100

This indicator cannot be assessed in the case of riverine willow scrubs.

A3. Proportion of non-indigenous tree species

Increase in the joint relative cover of non-indigenous tree species is treated as a factor that decreases the naturalness of the stand regardless of PNFC. Relative share of aggressive (capable of invasion) non-indigenous tree species is considered at the second level of our analysis.

	Proportion of non-indigenous tree species (%)											
	< 1	***1-5***	***6-10***	***11-20***	***21-30***	***31-40***	***41-50***	***51-60***	***61-70***	***71-80***	***81-90***	***91-100***
Value	100	95	90	80	70	60	50	40	30	20	10	0

This indicator cannot be assessed in the case of riverine willow scrubs.

A4. Proportion of cultivars of native tree species

Increase in the joint relative cover of cultivars of native tree species is treated as a factor that decreases the naturalness of the stand regardless of PNFC.

	Proportion of cultivars of native tree species (%)							
	< 1	***1-5***	***6-10***	***11-20***	***21-40***	***41-60***	***61-80***	***81-100***
Value	100	95	90	80	60	40	20	0

This indicator cannot be assessed in the case of riverine willow scrubs.

A5. Proportion of native tree species, not suited to the site

Increase in the joint relative cover of native tree species, not suited to the site is treated as a factor that decreases the naturalness of the stand regardless of PNFC.

	Proportion of native tree species, not suited to the site (%)					
	≤ 10	***11-20***	***21-40***	***41-60***	***61-80***	***81-100***
Value	100	90	80	60	30	0

This indicator cannot be assessed in the case of riverine willow scrubs.

S t r u c t u r e o f c a n o p y l a y e r

A6. Age-structure of the canopy layer

Increase in the number of, and distance between age-classes are treated as factors that increase the naturalness of the stand. In those PNFCs where natural stands may be composed of a single or of a few age-classes the obtained value is less sensitive to the number of age-classes:

PNFC	Number and distribution of age-classes				
	1	*2, close*	*2, distant*	*3 or more, close*	*3 or more, distant*
Zonal forests					
beech forests	0	40	60	100	100
sessile oak–hornbeam forests	0	30	50	100	100
pedunculate oak–hornbeam forests	0	30	50	100	100
turkey oak–sessile oak forests	0	40	60	100	100
turkey oak–pedunculate oak forests	0	40	60	100	100
Forests on rocky spots					
scree forests	0	40	40	100	100
ravine forests	0	40	40	100	100
slope forests	0	40	40	100	100
Acidophilous forests					
acidophilous beech forests	0	40	60	100	100
acidophilous oak–hornbeam forests	0	30	50	100	100
acidophilous oak forests	0	50	50	100	100
mixed deciduous–coniferous forests of W–Transdanubia	0	30	50	100	100
Calciphile forests					
thickets	0	50	50	100	100
calciphile and thermophilous oak forests	0	40	60	100	100
Steppe woods					
sand steppe oak woods	0	40	60	100	100
juniper–poplar steppe woods	0	50	50	100	100
loess steppe oak woods	0	40	60	100	100
alkali steppe oak woods	0	40	60	100	100
Riverine forests					
riverine willow scrubs	-	-	-	-	-
willow–poplar galleries	0	50	50	100	100
ash–oak–elm galleries	0	30	50	100	100
stream woods	0	40	40	100	100
Swamp woods					
alder swamp woods	0	50	50	100	100
willow and birch swamp woods	0	50	50	100	100
Other semi-natural forests	0	30	50	100	100

A7. Canopy closure

A7a. Difference between maximum and minimum canopy closure

We calculate the difference between the maximum and the minimum value of canopy closure (measured in circular plots with radius of tree height) in the stand. Increase in this difference is treated as a factor that increases the naturalness of the stand.

	Difference between maximum and minimum canopy closure (%)									
	0-10	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*
Value	0	10	20	30	50	70	100	100	100	90

A7b. Mean canopy closure

The natural level of canopy closure is PNFC dependent, but we assume, that none of the PNFCs has extremely dense closed canopy (at the whole stand – 3 to 10 ha – scale) in its natural status.

PNFC	Mean canopy closure (%)							
	0-20	***21-40***	***41-50***	***51-60***	***61-70***	***71-80***	***81-90***	***91-100***
beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests	0	0	20	50	80	90	100	80
acidophilous beech forests, acidophilous oak–hornbeam forests	0	10	50	70	100	100	100	80
Turkey oak–sessile oak forests, Turkey oak–pedunculate oak forests	0	10	50	80	100	100	90	70
scree forests	0	50	70	100	100	100	100	90
ravine forests, slope forests	0	20	50	90	100	100	100	80
acidophilous oak forests	0	30	70	90	100	100	90	70
mixed deciduous–coniferous forests of W–Transdanubia	0	10	30	70	90	100	100	80
thickets, juniper-poplar steppe woods	50	100	100	100	100	50	10	0
calciphile and thermophilous oak forests, loess steppe oak woods, alkali steppe oak woods, sand steppe oak woods	0	30	70	90	100	100	90	70
willow–poplar galleries, alder swamp woods	0	30	70	100	100	100	100	80
ash–oak–elm galleries, stream woods	0	0	20	50	80	100	100	80
Willow and birch swamp woods	0	100	100	100	100	60	0	0
Other semi-natural forests	0	0	20	50	80	100	100	80
riverine willow scrubs	-	-	-	-	-	-	-	-

A8. Cover of clearings (non-wooded areas)

In stands, where the corresponding PNFC does not contain clearings naturally, if clearings are present, the obtained value is 0, whereas a value of 100 is given if there is no clearing in the stand. In PNFCs where clearings are natural parts of the woodland-grassland mosaic, stands with or without clearings obtain scores 100 and 0, respectively. In PNFCs where presence/absence of clearings is not related to naturalness of the stand, we did not evaluate this indicator.

PNFC	Cover of clearings (%)		
	none	***≤ 20***	***> 20***
Zonal forests			
beech forests	100	30	0
sessile oak–hornbeam forests	100	30	0
pedunculate oak–hornbeam forests	100	30	0
turkey oak–sessile oak forests	100	100	0
turkey oak–pedunculate oak forests	100	100	0
Forests on rocky spots			
scree forests	-	-	-
ravine forests	100	30	0
slope forests	100	30	0
Acidophilous forests			
acidophilous beech forests	100	30	0
acidophilous oak–hornbeam forests	100	30	0
acidophilous oak forests	100	100	0
mixed deciduous–coniferous forests of W–Transdanubia	100	30	0
Calciphile forests			
thickets	0	100	100
calciphile and thermophilous oak forests	-	-	-
Steppe woods			
sand steppe oak woods	-	-	-
juniper–poplar steppe woods	0	100	100

loess steppe oak woods	-	-	-
alkali steppe oak woods	0	100	100
Riverine forests			
riverine willow scrubs	-	-	-
willow–poplar galleries	-	-	-
ash–oak–elm galleries	100	30	0
stream woods	100	100	0
Swamp woods			
alder swamp woods	-	-	-
willow and birch swamp woods	-	-	-
Other semi-natural forests	100	30	0

A9. Cover of patches with canopy closure < 50 %

In certain PNFCs patches with low canopy closure occur as a result of heterogeneous site conditions (e.g., steppe woods). Hence, this indicator is less sensitive to the relative cover of these patches in such PNFCs than in others, where openings are created by natural stand dynamics. In these latter cases, the highest scores are obtained if the relative cover of these patches with low canopy closure is less than 20%.

PNFC	**Cover of patches with canopy closure < 50 %**		
	none	***≤ 20***	***> 20***
Zonal forests			
beech forests	0	100	50
sessile oak–hornbeam forests	0	100	50
pedunculate oak–hornbeam forests	0	100	50
turkey oak–sessile oak forests	0	100	70
turkey oak–pedunculate oak forests	0	100	70
Forests on rocky spots			
scree forests	0	100	100
ravine forests	0	100	70
slope forests	0	100	70
Acidophilous forests			
acidophilous beech forests	0	100	50
acidophilous oak–hornbeam forests	0	100	50
acidophilous oak forests	0	100	85
mixed deciduous–coniferous forests of W–Transdanubia	0	100	50
Calciphile forests			
thickets	0	70	100
calciphile and thermophilous oak forests	0	100	70
Steppe woods			
sand steppe oak woods	0	100	100
juniper–poplar steppe woods	0	70	100
loess steppe oak woods	0	100	100
alkali steppe oak woods	0	90	100
Riverine forests			
riverine willow scrubs	0	100	100
willow–poplar galleries	0	100	70
ash–oak–elm galleries	0	100	50
stream woods	0	100	50
Swamp woods			
alder swamp woods	0	100	70
willow and birch swamp woods	0	100	100
Other semi-natural forests	0	100	50

A10. Cause of canopy openness

If canopy openness is increased as a result of forestry operations (e.g., thinning), the presence of patches with less closed canopy cannot be treated as sign of naturalness. On the contrary, if such patches are formed by natural dynamical processes, we treat their presence as a factor increasing naturalness. We use this indicator as a weighing factor at the second level.

	Cause of canopy openness	
	forestry	***natural***
Value	0	100

A11. Pattern of canopy closure

Uniformity of canopy closure at the stands scale is treated as artificial. All other possible patterns are treated as factors increasing naturalness.

	Pattern of canopy closure		
	several patches with different canopy closure	***a few larger patches with different canopy closure***	***uniform canopy closure in the whole subcompartment***
Value	100	75	0

A12. Spatial pattern of associate trees with <50% relative cover

This indicator is not included in the analyses, since no species specific information is obtained and species may have different spatial pattern.

A13. Vertical structure of the canopy

Increase in the number of canopy layers is treated as a factor that increases the naturalness of the stand regardless. However, in PNFCs, where stands with single canopy layer may occur naturally, this indicator is less sensitive to the number of canopy layers, or we do not assess this indicator at all.

PNFC	**Number of canopy layers**		
	1	***2***	***3, or more***
Zonal forests			
beech forests	0	30	100
sessile oak–hornbeam forests	0	50	100
pedunculate oak–hornbeam forests	0	50	100
turkey oak–sessile oak forests	0	50	100
turkey oak–pedunculate oak forests	0	50	100
Forests on rocky spots			
scree forests	0	30	100
ravine forests	0	50	100
slope forests	0	50	100
Acidophilous forests			
acidophilous beech forests	0	50	100
acidophilous oak–hornbeam forests	0	50	100
acidophilous oak forests	0	50	100
mixed deciduous–coniferous forests of W–Transdanubia	0	30	100
Calciphile forests			
thickets	-	-	-
calciphile and thermophilous oak forests	0	50	100
Steppe woods			
sand steppe oak woods	0	50	100
juniper–poplar steppe woods	-	-	-

loess steppe oak woods	0	50	100
alkali steppe oak woods	0	50	100
Riverine forests			
riverine willow scrubs	-	-	-
willow–poplar galleries	0	50	100
ash–oak–elm galleries	0	50	100
stream woods	0	50	100
Swamp woods			
alder swamp woods	0	50	100
willow and birch swamp woods	-	-	-
Other semi-natural forests	0	50	100

A14. Transition between the canopy and shrub layers

We assume, that one characteristic of forests with natural stand structure that (at least locally continuous transition occurs from the canopy to the shrub layer. In managed forests this characteristic can only be used as indicator of naturalness if canopy height exceeds a certain limit.

	Tree canopy has a continuous transition to the shrub layer		
	typically yes	***locally yes***	***no***
Type 1.	0	0	0
Type 2.	100	50	0
Type 3.	100	25	0

Type 1.: The canopy of the tree species with the highest relative cover is lower than 10 meters.
Type 2.: beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, scree forests, ravine forests, slope forests, acidophilous beech forests, acidophilous oak–hornbeam forests, acidophilous oak forests, mixed deciduous–coniferous forests of W–Transdanubia, sand steppe oak woods, willow–poplar galleries, ash–oak–elm galleries, stream woods, alder swamp woods, Other semi-natural forests.
Type 3.: thickets, calciphile and thermophilous oak forests, juniper–poplar steppe woods, loess steppe oak woods, alkali steppe oak woods, riverine willow scrubs, willow and birch swamp woods.

A15. Number of old/veteran tree

We treat the increase in the number of old/veteran trees as a factor that increases naturalness. We assess this indicator regardless of PNFC and on the basis of the density (tree/ha) of such trees.

	Number of old/veteran tree (tree/ha)				
	0	***0-0,1***	***0,1-1,0***	***1,1-2,0***	***> 2,0***
Value	0	20	40	60	100

A16. Pattern of old/veteran trees

Patchy distribution of old trees is regarded as the natural distribution in dense shady forests, whereas in other forest types less emphasis is put on the distribution, so other patterns are better accepted. If there is no old tree present (A15=0), then this indicator gets 0.

PNFC	Pattern of old/veteran tree individuals				
	not present	*large patches*	*small patches*	*random*	*uniform*
Type 1.	0	100	100	50	50
Type 2.	0	100	100	75	75

Type 1. (dense, closed forests): beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, ravine forests, slope forests, acidophilous beech forests, acidophilous oak–hornbeam forests, mixed deciduous–coniferous forests of W–Transdanubia, ash–oak–elm galleries, stream woods, alder swamp woods.
Type 2. (forests with less shade): turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, scree forests, acidophilous oak forests, calciphile and thermophilous oak forests, thickets, sand steppe oak woods, loess steppe oak woods, alkali steppe oak woods, juniper–poplar steppe woods, riverine willow scrubs, willow–poplar galleries, willow and birch swamp woods.

A17. Relative abundance of trees with unusual crown or stem shape

Irregular or unusual shape needs time to develop, so this indicator is assessed only in stands where the mean diameter at breast height (dbh) exceeds a threshold (25 cm). PNFCs listed under type 3 contain more twisted stems because of site conditions.

	Relative abundance of trees with unusual crown or stem shape (%)		
	none	*≤ 10*	*> 10*
Type 1.	0	0	0
Type 2.	0	50	100
Type 3.	0	40	100

Type 1.: stands where dominant tree species has dbh < 25 cm; riverine willow scrubs.
Type 2.: beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, acidophilous beech forests, acidophilous oak–hornbeam forests, acidophilous oak forests, mixed deciduous–coniferous forests of W–Transdanubia, sand steppe oak woods, loess steppe oak woods, alkali steppe oak woods, ash–oak–elm galleries, stream woods, alder swamp woods, Other semi-natural forests.
Type 3.: scree forests, ravine forests, slope forests, thickets, calciphile and thermophilous oak forests, juniper–poplar steppe woods, willow–poplar galleries, willow and birch swamp woods.

Dead wood characteristics

At the first level assessment of dead wood is independent from PNFC.

A18. Relative abundance of standing dead trees and snags

	Relative abundance (%) of standing dead trees and snags (Ø > 5 cm)					
	1	*1-5*	*6-10*	*11-15*	*16-20*	*> 20*
Value	0	20	50	70	90	100

A19. Number of large standing dead trees and snags

	Number of large (∅ >30 cm) standing dead trees and snags (snag/ha)						
	0	***0,01-0,40***	***0,41-0,80***	***0,81-1,20***	***1,21-1,60***	***1,61-2,00***	***> 2,01***
Value	0	10	20	40	60	80	100

A20. Cover of lying dead wood (∅> 5 cm)

	Cover (%) of lying dead wood (∅ > 5 cm)		
	< 1	***1-5***	***> 5***
Value	0	50	100

A21. Decay status of dead wood

If dead wood is virtually missing (A20<1), this indicator is irrelevant. Otherwise, continuous supply of dead wood (evenly represented decay classes) is regarded as natural, the other two categories reflect temporally discontinuous (mostly management induced) input of dead wood. Stands containing well decayed dead wood get slightly higher values because of the lasting availability of dead wood.

	Decay status of dead wood			
	A20 < 1	***all decay classes are evenly represented***	***mostly soft, well-decayed***	***mostly solid, less decayed***
Value	0	100	65	50

A22. Number of large lying dead logs (∅>30 cm)

	Number of large (∅ >30 cm) lying dead logs (log/ha)						
	0	***0,01-0,40***	***0,41-0,80***	***0,81-1,20***	***1,21-1,60***	***1,61-2,00***	***≥ 2,01***
Value	0	10	20	40	60	80	100

C o m p o s i t i o n o f s h r u b l a y e r

B4. Authenticity of species composition

Similarity of shrub species composition to that of corresponding PNFC is regarded as a factor increasing naturalness. Stands, where composition has been changed by some direct or indirect human impacts, get low score (0).

	Resemblance of composition to natural	
	similar	***different***
Value	100	0

B5. Proportion of non-indigenous and/or aggressive tree and shrub species in the shrub layer

Increase in the relative importance of non-indigenous species in the shrub layer is treated as a factor that decreases naturalness. The occurrences of aggressive species result in lower scores.

	Proportion of non-indigenous tree and shrub species (%)			
	0	***< 10***	***10-50***	***> 50***
Type 1.	100	80	40	0

Type 2.	100	40	20	0

Type 1.: aggressive trees or shrubs are missing from the shrub layer, or they are rare.
Type 2.: at least one aggressive tree or shrub species occur at high abundance in the shrub layer.
Aggressive species: balck locust, box-elder, red ash, tree of heaven, black cherry, hackberry, hop-tree, honey tree, Russian olive, false indigo, golden currant, spiny box-thorn

B6. Proportion of nitrophilous tree and shrub species in the shrub layer

In most PNFCs high abundance of nitrophilous shrubs is the sign of some anthropogenic effects, hence result in low naturalness scores. However, in those PNFCs, where their importance is higher under natural conditions, their presence is judged negatively only when they rich much higher relative cover. We did not assess this indicator in PNFCs, where the amount of nitrophilous species has no relationship with naturalness, i.e., their natural abundance can be extremely high under natural conditions.

PNFC	**Proportion of nitrophilous tree and shrub species in the shrub layer (%)**			
	0	***< 10***	***10-50***	***> 50***
Zonal forests				
beech forests	100	100	50	0
sessile oak–hornbeam forests	100	100	50	0
pedunculate oak–hornbeam forests	100	100	50	0
turkey oak–sessile oak forests	100	100	50	0
turkey oak–pedunculate oak forests	100	75	50	0
Forests on rocky spots				
scree forests	100	75	50	0
ravine forests	100	100	100	0
slope forests	100	100	100	0
Acidophilous forests				
acidophilous beech forests	100	75	50	0
acidophilous oak–hornbeam forests	100	75	50	0
acidophilous oak forests	100	75	50	0
mixed deciduous–coniferous forests of W–Transdanubia	100	100	50	0
Calciphile forests				
thickets	100	100	50	0
calciphile and thermophilous oak forests	100	100	50	0
Steppe woods				
sand steppe oak woods	100	75	50	0
juniper–poplar steppe woods	100	75	50	0
loess steppe oak woods	100	100	50	0
alkali steppe oak woods	100	75	50	0
Riverine forests				
riverine willow scrubs	-	-	-	-
willow–poplar galleries	-	-	-	-
ash–oak–elm galleries	-	-	-	-
stream woods	100	100	100	0
Swamp woods				
alder swamp woods	100	100	100	0
willow and birch swamp woods	100	0	0	0
Other semi-natural forests	100	100	50	0

Structure of shrub layer

B1. Cause of the absence of shrub layer

Absence of the shrub layer because of anthropogenic effects is treated as a factor that decreases the naturalness of the stand.

	Cause of the absence of shrub layer		
	not missing	***human impact***	***natural***
Value	100	0	100

B2. Signs of shrub removal

Even if know that the shrub layer was removed artificially, the lack of the signs of the removal is considered to be a factor increasing naturalness, since it indicates either less drastic impact or earlier date (i.e. more time for recovery).

	Signs of shrub removal	
	visible	***not visible***
Value	0	100

B3. Cover of the shrub layer

B3a. Difference between maximum and minimum cover of shrub layer

We calculate the difference between the maximum and the minimum value of shrub layer cover (measured in circular plots with radius of height of dominant canopy trees) in the stand. Increase in this difference is treated as a factor that increases the naturalness of the stand, because most cases it reflects spatial heterogeneity caused by fine-scale gap dynamics (or by management mimicking such dynamics).

	Difference between maximum and minimum cover of shrub layer (%)				
	0-10	***11-20***	***21-30***	***31-40***	***41-100***
Value	0	25	50	75	100

B3b. Mean cover in the shrub layer

Light conditions under the canopy are PNFC-dependent. Hence, from a naturalness viewpoint, average shrub cover can be judged differently in different PNFCs.

PNFC	**Mean cover of the shrub layer (%)**						
	< 1	***1-5***	***6-20***	***21-40***	***41-60***	***61-80***	***81-100***
Type 1.	0	80	100	100	80	60	40
Type 2.	0	60	80	100	100	80	60
Type 3.	0	40	60	80	100	100	100
Type 4.	50	80	100	50	0	0	0

Type 1. (forests with densely shaded forest floor): beech forests
Type 2. (transitional types): sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, ravine forests, mixed deciduous–coniferous forests of W–Transdanubia, ash–oak–elm galleries, stream woods, scree forests, alder swamp woods, slope forests
Type 3. (forests with well-lit forest floor): calciphile and thermophilous oak forests, sand steppe oak woods, loess steppe oak woods, willow–poplar galleries, turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, alkali steppe oak woods, thickets, juniper–poplar steppe woods, riverine willow scrubs, willow and birch swamp woods.

Type 4. (acidophilous forests): acidophilous beech forests, acidophilous oak–hornbeam forests, acidophilous oak forests

B7. Spatial pattern of shrubs

Uniform distribution is treated as sign of anthropogenic influence. Small patches and random pattern reflect natural processes (depending on species).

	Spatial pattern of shrubs			
	small patches	***large patches***	***random***	***uniform, or missing***
Value	100	75	100	0

Composition of forest floor vegetation

C2. Proportion of weeds and/or nitrophilous herb species

The sensitivity of this indicator is PNFC-dependent. In certain PNFCs these species can attain rather high importance even under natural conditions. In those PNFCs this indicator gets low scores only when cover values are extremely high.

PNFC	**Proportion of weeds and/or nitrophilous herb species (%)**				
	0	***1-10***	***11-30***	***31-60***	***61-100***
Zonal forests					
beech forests	100	100	75	50	0
sessile oak–hornbeam forests	100	100	75	50	0
pedunculate oak–hornbeam forests	100	100	75	50	0
turkey oak–sessile oak forests	100	100	75	50	0
turkey oak–pedunculate oak forests	100	100	75	50	0
Forests on rocky spots					
scree forests	100	100	75	50	0
ravine forests	100	100	100	100	0
slope forests	100	100	100	100	0
Acidophilous forests					
acidophilous beech forests	100	85	50	20	0
acidophilous oak–hornbeam forests	100	85	50	20	0
acidophilous oak forests	100	85	50	20	0
mixed deciduous–coniferous forests of W–Transdanubia	100	85	50	20	0
Calciphile forests					
thickets	100	100	75	50	0
calciphile and thermophilous oak forests	100	100	75	50	0
Steppe woods					
sand steppe oak woods	100	100	75	50	0
juniper–poplar steppe woods	100	85	50	20	0
loess steppe oak woods	100	100	75	50	0
alkali steppe oak woods	100	100	75	50	0
Riverine forests					
riverine willow scrubs	100	100	100	100	0
willow–poplar galleries	-	-	-	-	-
ash–oak–elm galleries	100	100	100	50	0
stream woods	100	100	100	50	0
Swamp woods					
alder swamp woods	100	100	100	50	0
willow and birch swamp woods	100	50	0	0	0
Other semi-natural forests	100	100	75	50	0

C3. Presence of subordinate associate herbs

Both the number of associate species and their abundance are treated as factors that increase naturalness.

	Presence of associate herbs			
	present in great numbers	***present***	***sparse***	***Missing***
Value	100	80	50	0

Structure of forest floor vegetation

C1. Cover of the herb layer

C1a. Difference between maximum and minimum cover of herbaceous species

We calculate the difference between the maximum and the minimum value of herb layer cover (measured in circular plots with radius of height of dominant canopy trees) in the stand. Increase in this difference is treated as a factor that increases the naturalness of the stand. We distinguish two groups of PNFC: In forests belonging to type 1, herb layer is rather heterogeneous, whereas in those belonging to type 2, the cover of the herb layer can be rather uniform under natural conditions.

PNFC	**Difference between maximum and minimum cover of herbs (%)**					
	0-10	***11-20***	***21-30***	***31-40***	***41-50***	***51-100***
Type 1.	0	20	40	60	80	100
Type 2.	0	30	60	100	100	100

Type 1.: beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, ravine forests, slope forests, acidophilous beech forests, acidophilous oak–hornbeam forests, mixed deciduous–coniferous forests of W–Transdanubia, alder swamp woods.
Type 2.: turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, scree forests, acidophilous oak forests, calciphile and thermophilous oak forests, thickets, sand steppe oak woods, loess steppe oak woods, alkali steppe oak woods, juniper–poplar steppe woods, riverine willow scrubs, willow–poplar galleries, willow and birch swamp woods, ash–oak–elm galleries, stream woods.

C1b. Mean cover in the herb layer

Light conditions under the canopy are PNFC-dependent. Hence, from a naturalness viewpoint, average herb cover can be judged differently in different PNFCs.

PNFC	**Mean cover in the herb layer (%)**							
	0-5	***6-10***	***11-20***	***21-30***	***31-40***	***41-80***	***81-90***	***91-100***
Zonal forests								
beech forests	0	50	100	100	100	100	50	0
sessile oak–hornbeam forests	0	50	100	100	100	100	50	0
pedunculate oak–hornbeam forests	0	50	100	100	100	100	50	0
turkey oak–sessile oak forests	0	10	25	50	75	100	100	50
turkey oak–pedunculate oak forests	0	10	25	50	75	100	100	50
Forests on rocky spots								
scree forests	0	50	100	100	100	100	50	0
ravine forests	0	25	50	75	100	100	50	0
slope forests	0	25	50	75	100	100	50	0
Acidophilous forests								
acidophilous beech forests	0	50	100	100	100	100	50	0
acidophilous oak–hornbeam forests	0	50	100	100	100	100	50	0
acidophilous oak forests	0	50	100	100	100	100	50	0
mixed deciduous–coniferous forests of W–Transdanubia	0	50	100	100	100	100	50	0

Calciphile forests								
thickets	0	25	50	75	100	100	100	100
calciphile and thermophilous oak forests	0	10	25	50	75	100	100	50
Steppe woods								
sand steppe oak woods	0	10	25	50	75	100	100	50
juniper–poplar steppe woods	0	30	60	100	100	100	50	0
loess steppe oak woods	0	10	25	50	75	100	100	50
alkali steppe oak woods	0	10	25	50	75	100	100	50
Riverine forests								
riverine willow scrubs	0	50	100	100	100	100	50	0
willow–poplar galleries	0	25	50	75	100	100	100	50
ash–oak–elm galleries	0	25	50	75	100	100	100	50
stream woods	0	25	50	75	100	100	100	100
Swamp woods								
alder swamp woods	0	25	50	75	100	100	100	50
willow and birch swamp woods	0	50	100	100	100	100	50	0
Other semi-natural forests	0	50	100	100	100	100	50	0

C4. Spatial pattern of herbs

Uniform distribution is treated as sign of anthropogenic influence. Small patches and random pattern reflect natural processes (depending on species).

	Spatial pattern of herbs			
	small patches	***large patches***	***random***	***uniform, or missing***
Value	100	100	100	0

C5. Cover of bryophytes

For bryophytes we do not assess the range of cover, but we consider mean cover and PNFC.

PNFC	**Mean cover of bryophytes (%)**					
	< 1	***1-5***	***6-10***	***11-30***	***31-60***	***61-100***
Type 1.	50	100	100	100	50	0
Type 2.	0	50	75	100	100	50
Type 3.	0	25	50	100	100	100

Type 1. (forests with very sparse bryophyte layer): beech forests, sessile oak–hornbeam forests, pedunculate oak–hornbeam forests, turkey oak–sessile oak forests, turkey oak–pedunculate oak forests, thickets, calciphile and thermophilous oak forests, sand steppe oak woods, juniper–poplar steppe woods, loess steppe oak woods, alkali steppe oak woods, riverine willow scrubs, willow–poplar galleries, ash–oak–elm galleries, stream woods
Type 2. (forests with moderately dense bryophyte layer): scree forests, ravine forests, slope forests, acidophilous oak–hornbeam forests, alder swamp woods
Type 3. (forests with very dense bryophyte layer): acidophilous beech forests, acidophilous oak forests, mixed deciduous–coniferous forests of W–Transdanubia, willow and birch swamp woods

Composition of regeneration

D3. Proportion of non-indigenous and/or aggressive species in the regeneration

Presence and increase in the relative importance of non-indigenous species in the regeneration are treated as factors that decrease naturalness. Since aggressively spreading species have much more profound effects on the future of the stand, their occurrence is taken into account more seriously, when at least one such species is present in considerable amounts.

	Proportion of non-indigenous tree species in the regeneration (%)											
	< 1	***1-5***	***6-10***	***11-20***	***21-30***	***31-40***	***41-50***	***51-60***	***61-70***	***71-80***	***81-90***	***91-100***
Type 1.	100	95	90	80	70	60	50	40	30	20	10	0
Type 2.	100	90	80	60	40	20	0	0	0	0	0	0

Type 1.: aggressive trees or shrubs are missing from the regeneration, or they are rare.
Type 2.: at least one aggressive tree or shrub species occur at high abundance in the regeneration.
Aggressive species: balck locust, box-elder, red ash, tree of heaven, black cherry, hackberry, hop-tree, honey tree, Russian olive

S t r u c t u r e o f r e g e n e r a t i o n

D1. Cover of regeneration

D1a. Difference between maximum and minimum cover of regeneration

Large difference between the maximum and minimum cover of regeneration indicates, that, existing patterns of canopy closure resemble that of produced by natural fine-scale gap dynamics. For this reason, increase in this difference is treated as a factor that increases naturalness.

	Difference between maximum and minimum cover of regeneration (%)				
	0-10	***11-20***	***21-30***	***31-40***	***41-100***
Value	0	25	50	75	100

D1b. Mean cover of regeneration of native trees

The presence of vital regeneration has utmost importance for the reproduction of forest stands. In a naturally dynamic forest – at the subcompartment scale – regeneration appears temporarily continuously.

	Mean cover of regeneration of native trees (%)						
	0	***0,1-5***	***6-10***	***11-20***	***21-30***	***31-40***	***41-100***
Value	0	10	20	40	60	80	100

D2. Proportion of viable, several-years-old regeneration

The appearance of one-two years old regeneration does not necessarily ensure the reproduction of the stand, since experience shows, that it often disappears (for different reasons). It is the presence of viable several-year-old regeneration that guarantees successful reproduction. We assess this indicator only in cases, where the proportion of non-indigenous species in regeneration is less than 10% (D3 < 10%).

	Proportion of viable, several-year-old regeneration (%)					
	0	***0,1-5***	***6-10***	***11-30***	***31-60***	***61-100***
Value	0	10	25	50	75	100

D4. Spatial pattern of regeneration

We do not give scores, since the pattern is highly dependent on that of the canopy layer, and from a naturalness viewpoint we cannot differentiate possible.

Site characteristics

F1. Signs of secondary erosion

The occurrence human-induced secondary erosion is treated as a factor decreasing naturalness, whereas in PNFCs, where even strong human impact does not cause secondary erosion, we did not assess this indicator.

PNFC	Signs of secondary erosion	
	visible	*Not visible*
Zonal forests		
beech forests	0	100
sessile oak–hornbeam forests	0	100
pedunculate oak–hornbeam forests	0	100
turkey oak–sessile oak forests	0	100
turkey oak–pedunculate oak forests	0	100
Forests on rocky spots		
scree forests	0	100
ravine forests	0	100
slope forests	0	100
Acidophilous forests		
acidophilous beech forests	0	100
acidophilous oak–hornbeam forests	0	100
acidophilous oak forests	0	100
mixed deciduous–coniferous forests of W–Transdanubia	0	100
Calciphile forests		
thickets	0	100
calciphile and thermophilous oak forests	0	100
Steppe woods		
sand steppe oak woods	0	100
juniper–poplar steppe woods	0	100
loess steppe oak woods	0	100
alkali steppe oak woods	-	-
Riverine forests		
riverine willow scrubs	-	-
willow–poplar galleries	-	-
ash–oak–elm galleries	-	-
stream woods	0	100
Swamp woods		
alder swamp woods	-	-
willow and birch swamp woods	-	-
Other semi-natural forests	0	100

F2. Extent of erosion

With this indicator the obtained scores depend on steepness (using categories of the forest management plan).

Slope	Proportion of area with signs of erosion (%)			
	0	***< 10***	***10-50***	***> 50***
Plain or undulate	100	0	0	0
2,5° - 7,5°	100	50	40	30
7,5° - 12,5°	100	60	50	40
12,5° - 17,5°	100	70	60	50
17,5° - 22,5°	100	80	70	60
22,5° - 27,5°	100	90	80	70
27,5° - 32,5°	100	100	90	80
32,5°<	100	100	100	90
Variable	100	75	50	25

F3. Type of erosion

The more severe the form of occurring secondary erosion, the lower the assessed naturalness score it gets.

PNFC	Type of erosion				
	gully	***rill***	***sheet***	***partial***	***none***
Zonal forests					
beech forests	0	25	50	75	100
sessile oak–hornbeam forests	0	25	50	75	100
pedunculate oak–hornbeam forests	0	25	50	75	100
turkey oak–sessile oak forests	0	25	50	75	100
turkey oak–pedunculate oak forests	0	25	50	75	100
Forests on rocky spots					
scree forests	0	25	50	75	100
ravine forests	0	25	50	75	100
slope forests	0	25	50	75	100
Acidophilous forests					
acidophilous beech forests	0	25	50	75	100
acidophilous oak–hornbeam forests	0	25	50	75	100
acidophilous oak forests	0	25	50	75	100
mixed deciduous–coniferous forests of W–Transdanubia	0	25	50	75	100
Calciphile forests					
thickets	0	25	50	75	100
calciphile and thermophilous oak forests	0	25	50	75	100
Steppe woods					
sand steppe oak woods	0	25	50	75	100
juniper–poplar steppe woods	0	25	50	75	100
loess steppe oak woods	0	25	50	75	100
alkali steppe oak woods	0	25	50	75	100
Riverine forests					
riverine willow scrubs	-	-	-	-	-
willow–poplar galleries	-	-	-	-	-
ash–oak–elm galleries	-	-	-	-	-
stream woods	0	25	50	75	100
Swamp woods					
alder swamp woods	-	-	-	-	-
willow and birch swamp woods	-	-	-	-	-
Other semi-natural forests	0	25	50	75	100

F4. Humus form

The evaluation of this indicator was also PNFC-dependent. In PNFCs where mull type humus is characteristic under natural conditions, the occurrence of less complex humus forms (moder, mor) was treated as result of human use or high game density, both treated negatively.

PNFC			
	mor	***moder***	***mull***
Zonal forests			
beech forests	0	0	100
sessile oak–hornbeam forests	0	0	100
pedunculate oak–hornbeam forests	0	0	100
turkey oak–sessile oak forests	0	75	100
turkey oak–pedunculate oak forests	0	75	100
Forests on rocky spots			
scree forests	0	75	100
ravine forests	0	0	100
slope forests	0	0	100
Acidophilous forests			
acidophilous beech forests	0	100	50
acidophilous oak–hornbeam forests	0	100	100
acidophilous oak forests	30	100	0
mixed deciduous–coniferous forests of W–Transdanubia	-	-	-
Calciphile forests			
thickets	0	75	100
calciphile and thermophilous oak forests	0	75	100
Steppe woods			
sand steppe oak woods	0	75	100
juniper–poplar steppe woods	0	50	100
loess steppe oak woods	0	75	100
alkali steppe oak woods	0	75	100
Riverine forests			
riverine willow scrubs	-	-	-
willow–poplar galleries	0	50	100
ash–oak–elm galleries	0	0	100
stream woods	0	75	100
Swamp woods			
alder swamp woods	100	100	0
willow and birch swamp woods	100	100	0
Other semi-natural forests	0	75	100

F5. Proportion of area with compacted soil

Since soil compaction was treated as a result of industrialized forestry, its extent was treated as a factor decreasing naturalness.

	Proportion of area with compacted soil (%)		
	0	***≤ 10***	***> 10***
Value	100	25	0

F6. Mixing soil horizons

Mixing of soil horizons mostly occurs as a result of intensive soil preparation (ploughing, removing stumps), hence its occurrence was treated as a factor decreasing naturalness.

PNFC	**Mixing soil horizons**	
	present	***missing***

Zonal forests		
beech forests	0	100
sessile oak–hornbeam forests	0	100
pedunculate oak–hornbeam forests	0	100
turkey oak–sessile oak forests	0	100
turkey oak–pedunculate oak forests	0	100
Forests on rocky spots		
scree forests	-	-
ravine forests	-	-
slope forests	-	-
Acidophilous forests		
acidophilous beech forests	0	100
acidophilous oak–hornbeam forests	0	100
acidophilous oak forests	0	100
mixed deciduous–coniferous forests of W–Transdanubia	0	100
Calciphile forests		
thickets	0	100
calciphile and thermophilous oak forests	0	100
Steppe woods		
sand steppe oak woods	0	100
juniper–poplar steppe woods	0	100
loess steppe oak woods	0	100
alkali steppe oak woods	0	100
Riverine forests		
riverine willow scrubs	0	100
willow–poplar galleries	0	100
ash–oak–elm galleries	0	100
stream woods	0	100
Swamp woods		
alder swamp woods	0	100
willow and birch swamp woods	0	100
Other semi-natural forests	0	100

F7. Damage to the soil surface

Damage to the soil surface mostly occurs as a result of forestry operations, hence its occurrence was treated as a factor decreasing naturalness.

	Damage to the soil surface	
	present	***missing***
Value	0	100

F8. Presence of microhabitats

Most valuable microhabitats (root plates, cavity trees, large trees, standing and lying dead wood, habitats along untouched watercourses) can be treated as signs of natural disturbances, and low intensity of management. Hence, both their presence and their frequency were treated as factors increasing naturalness.

	Number of microhabitats		
	none	***few***	***many***
Value	0	75	100

Effects of game

Effects of game are assessed independent from PNFC in all cases. Frequency/intensity of browsing, stripping, and trampling was assessed negatively from a naturalness viewpoint, since we treated them as signs of unnaturally high game density.

E1. Extent of stripping damage

	Proportion of stems damaged (%)			
	0	***< 10***	***10-50***	***> 50***
Value	100	50	25	0

E2. Extent of browsing in the shrub layer

If the shrub layer is missing (c.f. B1), browsing is treated as complete (see E5).

	Extent of browsing in the shrub layer			
	none	***rare***	***abundant***	***on all individuals***
Value	100	50	25	0

E3. Extent of browsing in the herb layer

If the shrub layer is missing (c.f. C1b), browsing is treated as complete (see E5).

	Extent of browsing in the herb layer			
	none	***rare***	***abundant***	***on all individuals***
Value	100	50	25	0

E4. Extent of damage in the litter layer

	Proportion of litter layer damaged (%)						
	0	***1-5***	***6-10***	***11-20***	***21-30***	***31-40***	***41-100***
Value	100	90	80	60	40	20	0

E5. Vegetation layers completely eliminated by game

With this indicator we assess the presence or game-caused absence of the shrub-, and herb layers, and of regeneration. We use this indicator as a multiplier factor at the second level.

Level 2.

Weighing of indicators and calculating the naturalness value of each criterion.

Based on the values each indicator obtained at the first level, we calculated the naturalness values of each criterion using the values of corresponding indicators. Than these naturalness values were normalized by their possible (PNFC-dependent) maxima. The table in Appendix 1 shows theoretical minima and maxima of each criterion and PNFC.

Naturalness value based on composition of canopy layer = (5×A1a + 4×A1b + 3×A2a + 2×A2b + 5×A3 + 2×A4 + 2×A5)×X

While assessing this criterion, the highest weight was given to indicators A1a (number of important natural tree species), A1b (presence of natural dominants, and A3 (proportion of non-indigenous species). The presence and importance of aggressive non-indigenous species was considered by using multiplier X.

Calculation of multiplier "*X*" is based on A3 and the species list recorded in the field.

	Proportion of aggressive non-indigenous species (%)				
	0	***0.1-4***	***5-19***	***20-49***	***> 50***
X	1,0	0.9	0.8	0.7	0,5

Naturalness value based on structure of canopy layer = (A7a + A7b + 2×A8 + A9 + A11)×Y + (2×A6 + 2×A13 + 2×A14 + 5×A15 + A16 + A17)

While assessing the naturalness of the structure of canopy layer, the TERMERD project focused on three aspects:

1. Horizontal patterns (canopy closure (extent and pattern), pattern of associate trees)
2. Vertical patterns (presence/number of age/size-classes, transition to the shrub layer)
3. Presence of trees with extreme size or shape

These three aspects got roughly similar weights. The presence of large veteran trees got the highest weight (5), since we think that it is the lack of such trees that differentiates managed forests the most from the reference forest we use.

Theoretical maximum value of this criterion is PNFC-dependent. There are some PNFCs where on or few of the indicators (presence of age-classes; proportion of clearings; number of canopy layers; transition to the shrub layer; presence of trees with irregular shape) are not treated as characteristics related to the naturalness status of the stand.

Calculation of multiplier "*Y*" is based on A10.

	Cause of canopy openness	
	Forestry operation	***Natural disturbance***
Y	0.8	1,0

Naturalness value based on dead wood characteristics = A18 + 5×A19 + A20 + A21 + 5×A22

Indicators of the amount of large snags and logs got the highest weight (5), since we think that it is the lack of such features that differentiates managed forests the most from the reference forest we use. Organised forest management regularly produces dead wood of small dbh (thinning operations). Although this fine woody debris can have relatively high cover, it is usually present only for a short period (compared to the persistence of large dead logs of

reference forests providing many organisms with food and habitat). For this reason it gets much smaller weight.

Naturalness value based on composition of shrub layer = 5×B4 + 5×B5 + B6
Higher weight was given to B4 (authenticity of species composition9 and B5 (proportion of non-indigenous and/or aggressive tree and shrub species) than to B6 (proportion of nitrophilous tree and shrub species), since nitrophilous and disturbance tolerator species can also occur under natural conditions.

Naturalness value based on structure of shrub layer = 3×(B1 + B2) + 2×B3a + 3×B3b + B7
Spatial pattern of shrubs (B7) got lower weights the other indicators.

Naturalness value based on composition of herb layer = C2 + 2×C3
Presence of natural associate species of the given PNFC (C3) – as a sensitive indicator of changes in natural conditions – got higher weight than proportion of weeds and/or nitrophilous herb species (C2) that can be rather abundant as a result of natural disturbances, too.

Naturalness value based on structure of herb layer = 2×C1a + 2×C1b + 2×C4 + C5
While calculating the naturalness of this criterion, cover of bryophytes (C5) got lower weight than indicators describing the herb layer, since in most PNFCs bryophytes have only a minor importance in the forest floor vegetation.

Naturalness value based on composition of regeneration = D3

This criterion is composed of only a single indicator that was assessed at the first level, hence we do not use any weights here.

Naturalness value based on structure of regeneration = D1a + 4×D1b + D2

Abundance of regeneration of native species got the largest weight, since we treat this as the most important for the reproduction of the stand. Spatial pattern of regeneration got small weight since it is highly dependent on those the canopy and shrub layers (weighed there). Small weight of the presence of several-year-old regeneration is explained by the fact that its lack does not exclude the possibility of future reproduction.

Naturalness value based on effects of game = (E1 + E2 + E3 + E4)×Q
The indicators of different forms of partial damage (E1-E4) got similar weight. Since the complete lack of certain layers (herb and shrub layers, and regeneration) indicate more severe damage to natural status, we used this indicator (E5) as a multiplication factor (Q) determining the value of the whole criterion.

Calculation of multiplier "*Q*" is based on E5.

Number of layers eliminated by game	**Q**
None	1,0
1 layer is missing	0,3
2 layers are missing	
regeneration and shrub layer	0,1
regeneration and herb layer	0,1
shrub layer and herb layer	0
3 layers are missing	0

Naturalness value based on site characteristics = 2×F1 + Z×F2 + F4 + F5 + 5×F6 + F7 + 1,5×F8

Weights of phenomena are proportional to how intense and/or lasting their effects are: humus form deviation (F4), soil compaction (F5), or damage to the soil surface (F7) got the smallest, whereas mixing of soil horizons (F6) the largest weight. Scores given to secondary erosion are derived as a product of its extent (F2) and factor Z, which depends on the type of erosion (F3) and it decreases or increases the slope-dependent score obtained for extent.

Calculation of multiplier "*Z*" is based on F3.

	Type of erosion				
	gully	***rill***	***sheet***	***partial***	***none***
Z	0,2	0,5	1	1,5	2

Level 3.

Naturalness values are measured on ratio scale and are in the range between 0 and 100.

Calculation of the naturalness value of the stand and of criterion-groups.

We calculate the naturalness of the stand as a weighed sum of the naturalness value of the 11 criteria. This means that we multiply the normalized value of each criterion with its PNFC-dependent weight given in Appendix 2, than add these products to get the naturalness value of the stand. In a similar manner, we can also calculate the naturalness of different criterion-groups (see below).

Symbols of weight of each criterion:

A = weight for *normalized value of composition of canopy layer (***CC***)*
B = weight for *normalized value of structure of canopy layer (***SC***)*
C = weight for *normalized value of composition of shrub layer* (**CS**)
D = weight for *normalized value of structure of shrub layer (***SS***)*
E = weight for *normalized value of composition of herb layer (***CH***)*
F = weight for *normalized value of structure of herb layer (***SH***)*
G = weight for *normalized value of composition of regeneration (***CR***)*
H = weight for *normalized value of structure of regeneration (***SR***)*
I = weight for *normalized value of dead wood characteristics (***DW***)*
J = weight for *normalized value of effects of game (***EG***)*
K = weight for *normalized value of site characteristics (***SI***)*

Naturalness value of the stand **= A*CC + B*SC + C*CS + D*SS + F*SH + G*CR + H*SR + I*DW + J*EG + K*SI**

Naturalness values of different criterion-groups:

$$\text{Naturalness value of the canopy layer} = \frac{A*CC + B*SC}{A+B}*100$$

$$\text{Naturalness value of the shrub layer} = \frac{C*CS + D*SS}{C+D}*100$$

$$\text{Naturalness value of the herb layer} = \frac{E*CH + F*SH}{E+F}*100$$

$$\text{Naturalness value of the regeneration} = \frac{G*CR + H*SR}{G+H}*100$$

$$\text{Naturalness value of the compositional features} = \frac{A*CC + C*CS + E*CH + G*CR}{A+C+E+G}*100$$

$$\text{Naturalness value of the structural features} = \frac{B*SC + D*SS + F*SH + H*SR}{B+D+F+H}*100$$

$$\text{Naturalness value of the functional features} = \frac{J * EG + K * SI}{J + K} * 100$$

Appendix 1. Theoretical minima and maxima of the naturalness value calculated for each criterion at the 2nd level.

Criterion	Minimum value	Maximum value	Beech forests	Sessile oak–hornbeam forests	Pedunculate oak–hornbeam forests	Turkey oak–sessile oak forests	Turkey oak–pedunculate oak forests	Scree forests	Ravine forests	Slope forests	Acidophilous beech forests	Acidophilous oak–hornbeam forests	Acidophilous oak forests	Mixed deciduous–coniferous forests of W–Transdanubia	Thickets	Calciphile and thermophilous oak forests	Sand steppe oak woods	Juniper–poplar steppe woods	Loess steppe oak woods	Alkali steppe oak woods	Riverine willow scrubs	Willow–poplar galleries	Ash–oak–elm galleries	Stream woods	Alder swamp woods	Willow and birch swamp woods	Other semi-natural forests
			max	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*	*max*
Composition of canopy layer	200	X	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	2300	300	2300	2300	2300	2300	1900	2300
Structure of canopy layer	0	X	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1700	1700	1700	1700	1700	1900	1100	1700	1900	1900	1700	1500	1900
Dead wood	0	1300																									
Composition of shrub layer	0	X	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1100	1000	1000	1000	1100	1100	1100	1100
Structure of shrub layer	0	1200																									
Composition of herb layer	0	X	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	200	300	300	300	300	300
Structure of herb layer	0	700																									
Composition of regeneration	0	100																									
Structure of regeneration	0	600																									
Effects of game	0	400																									
Site characteristics	0	X	1350	1350	1350	1350	1350	850	850	850	1350	1350	1350	1250	1350	1350	1350	1350	1350	1150	850	950	950	1350	950	950	1350

Appendix 2. Weights of criteria used to calculate the naturalness value of the whole stand at the 3rd level.

	Symbol of criterion or criterion-group	Beech forests	Sessile oak–hornbeam forests	Pedunculate oak–hornbeam forests	Turkey oak–sessile oak forests	Turkey oak–pedunculate oak forests	Scree forests	Ravine forests	Slope forests	Acidophilous beech forests	Acidophilous oak–hornbeam forests	Acidophilous oak forests	Mixed deciduous–coniferous forests of W–Transdanubia	Thickets	Calciphile and thermophilous oak forests	Sand steppe oak woods	Juniper–poplar steppe woods	Loess steppe oak woods	Alkali steppe oak woods	Riverine willow scrubs	Willow–poplar galleries	Ash–oak–elm galleries	Stream woods	Alder swamp woods	Willow and birch swamp woods	Other semi-natural forests
Canopy layer	**A+B**	**35**	**35**	**35**	**35**	**35**	**38**	**38**	**38**	**35**	**35**	**35**	**35**	**34**	**34**	**34**	**34**	**34**	**36**	**15**	**36**	**37**	**35**	**35**	**32**	**35**
Composition of canopy layer	**A**	18	18	18	18	18	19	19	19	18	18	18	18	19	19	19	19	19	19	1	20	19	18	19	17	18
Structure of canopy layer	**B**	17	17	17	17	17	19	19	19	17	17	17	17	15	15	15	15	15	17	14	16	18	17	16	15	17
Shrub layer	**C+D**	**20**	**20**	**20**	**20**	**20**	**21**	**21**	**21**	**20**	**20**	**20**	**21**	**21**	**21**	**21**	**21**	**21**	**21**	**28**	**20**	**20**	**20**	**21**	**23**	**20**
Composition of shrub layer	**C**	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	13	9	9	10	10	11	10
Structure of shrub layer	**D**	10	10	10	10	10	11	11	11	10	10	10	11	11	11	11	11	11	11	15	11	11	10	11	12	10
Forest floor	**E+F**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**9**	**13**	**9**	**9**	**9**	**10**	**10**	**9**
Composition of herb layer	**E**	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	2	3	3	3	3	3
Structure of herb layer	**F**	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	7	6	6	7	7	6
Regeneration	**G+H**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**8**	**7**	**7**	**6**	**7**	**7**	**6**
Composition of regeneration	**G**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Structure of regeneration	**H**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	7	6	6	5	6	6	5
Dead wood	**I**	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	16	12	12	12	12	12	12
Effects of game	**J**	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	7	6	6	6	7	6
Site characteristics	**K**	12	12	12	12	12	8	8	8	12	12	12	11	12	12	12	12	12	10	11	9	9	12	9	9	12