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1	Humus Index as an indicator of forest stand and soil properties
2	
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4	
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11	Abstract
12	
13	The Humus Index, based on the visual assessment of topsoil horizons and a
14	classification of humus forms, is a numerical score which can be used as a correlate of stand
15	and soil properties. In oak stands from the Montargis forest (Loiret, France) we observed a
16	good linear relationship of the Humus Index with most parameters describing stand
17	development (age, basal area, height and diameter at breast height of dominants) and soil
18	type (depth of clay horizon). The relationship with parameters describing nutrient availability
19	(exchangeable bases, base saturation) was similarly good but non-linear. In the studied
20	forest the Humus Index was affected first by stand age and second by soil type. When
21	corrected for age and soil type, data (96 pooled estimates) indicated a slight decrease in the
22	Humus Index (shift towards more active humus forms) in stands converted from old
23	coppices-with-standards when compared with even-aged high forest.
24	

*Keywords:* Humus forms; Stand development; Management practices; Soil types; Oak
stands; Coppices-with-standards; Even-aged high forests

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#### 2 **1. Introduction**

3

There is a growing need for synthetic indicators to be used for the wide scale monitoring of terrestrial ecosystems, in particular when threatened by pollution, climate change and human pratices (Moore and DeRuiter, 1993; Lindenmayer et al., 2000; Duelli and Obrist, 2003). This goal can be achieved through field measurements if (i) they can be done by untrained people and (ii) field data are correlated with a lot of ecosystem parameters indicative of woodland well-being.

10

11 Humus forms (Mull, Moder, Mor) indicate the rate at which nutrients are circulating 12 within terrestrial ecosystems (Ovington, 1965; Chapin et al., 1986; Ponge, 2003). They vary 13 according to climate and parent rock (Vitousek et al., 1994; Ponge and Delhaye, 1995; 14 Sadaka and Ponge, 2003), but also to canopy and understory vegetation (Beniamino et al., 15 1991; Muys et al., 1992; Aubert et al., 2004), stand age (Emmer and Sevink, 1994; Sagot et 16 al., 1999; Aubert et al., 2004), management (Aber et al., 1978; Terlinden and André, 1988; 17 Covington, 1981), fertilization (Toutain et al., 1988; Deleporte and Tillier, 1999), irrigation 18 (Vavoulidou-Theodorou and Babel, 1987) and pollution (Coughtrey et al., 1979; Kuperman, 19 1996; Gillet and Ponge, 2002). In turn, humus forms, by their focus position within 20 biogeochemical cycles, influence many ecosystem compartments and processes such as 21 ground flora (Le Tacon and Timbal, 1973; Klinka et al., 1990; Bartoli et al., 2000), 22 regeneration of forest canopy species (Bernier and Ponge, 1994; Bernier, 1996; Ponge et al., 23 1998), forest productivity (Delecour, 1978) and litter quality (Davies et al., 1964; Toutain and 24 Duchaufour, 1970). They are considered, together with ground vegetation, as an indicator of 25 the soil nutrient regime (Wilson et al., 2001) and we expect them to be the best predictor of 26 stability domains within ecosystems (Odum, 1969; Ulrich, 1987; Ponge, 2003). However, the 27 wider use of humus forms as a site factor is limited by subjectivity in the identification of forest floor and topsoil horizons (Federer, 1982) and by the existence of small-scale variation
 (Riha et al., 1986; Carter and Lowe, 1986; Torgersen et al., 1995).

3

The Humus Index has been designed for the transformation of a scale of discrete humus forms in a numerical parameter, which could be manipulated statistically (Ponge et al., 2002; Ponge et al., 2003; Fédoroff et al., 2005). In the abovementioned studies the Humus Index proved to be significantly correlated with some important ecological parameters of forest ecosystems such as topsoil physical and chemical properties and plant and soil animal communities.

10

In forests, stand and soil properties are of paramount importance for the management and choice of target tree species (Carmean, 1975; Miller, 1981; Muys and Lust, 1992) and for the assessment of health and productivity of the ecosystem (Christie and Lines, 1979; Ulrich 1994; Ponge et al., 1997). The present study was intended to correlate the Humus Index with parameters of stand and soil development under varying management regimes of the same canopy species.

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#### 18 **2. Study sites**

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20 The Montargis forest (Loiret, France) is a state forest (4090 ha) located in the 21 northern half of France (Fig; 1), in the rainwater basin of river Seine. The general aspect is 22 fairly level, with a slight westward declivity, the altitude varying between 95 and 132 m. The 23 climate is oceanic, with a weak continental influence. The mean annual precipitation, 24 calculated over the last thirty years, is 650 mm, 50% of which falling as rain during the 25 growing season, from early April to late September. The mean temperature, calculated over 26 the same thirty-year period, is 10.9°C, with a minimum monthly mean of 3.7°C in January 27 and a maximum monthly mean of 19.0°C in July. The parent rock is Senonian chalk (late 28 Cretaceous), covered with postglacial (Holocene) deposits of variegated textural properties,

1 sand being dominant in the western part and silt in the eastern part. This is at the origin of a 2 variety of soil types, weakly acidic to acidic, with a depth of 40 to 70 cm, generally well-3 drained year-round or at worst with weak temporary water-logging during Winter. Most 4 variation occurs through changes in the vertical distribution of particle size, in particular the 5 depth at which clay becomes dominant varies to a great extent, ranging from 30 to 80 cm in 6 our data set.

7

8 The Montargis forest exhibits a compact shape, extending around the Paucourt 9 village (Fig. 1), without any change in surface area and tree composition since the 12e 10 century (Garnier, 1965). Coppice-with-standards, with sessile oak [Quercus petraea (Mattus.) 11 Liebl.] standards and hornbeam (Carpinus betulus L.) coppices, was the dominant 12 management type from 1670 on. The cutting period for coppices was first fixed to 70 years 13 then to 25, 40 or 50 years (according to site conditions) from 1783 on. Since 1857, coppices-14 with-standards were partly converted to oak-dominated stands, with some admixture of 15 beech (Fagus sylvatica L.) and hornbeam according to the sites. The conversion was total 16 from 1872 on. Even-aged oak stands were issued from seed from the original mixed stands, 17 oldest ones being 99 years-old, without any agricultural past nor plantation.

18

19 Ninety-six stands were selected, in order to embrace the variety of oak stands 20 growing on medium acidic, well-drained sandy loam with level aspect, with one sampling 21 area in each stand. All soils are luvisols according to FAO classification, varying according to 22 the depth of the argillic horizon. The sampling area was selected in homogeneous vegetation 23 and stand structure, beyond 50 m of stand limit. The choice of a restricted array of site 24 conditions was aimed at testing the influence of stand properties. The sampling design was 25 balanced according to 8 forest types, either even-aged high forest or conversion from 26 previous coppice-with-standards:

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• FG15: even-aged high forest 15 years-old (12 stands)

1 • FG35: even-aged high forest 35 years-old (12 stands) 2 • FG50: even-aged high forest 50 years-old (12 stands) FG90: even-aged high forest 90 years-old (12 stands) 3 • • CS1: coppice-with-standards converted to medium-diameter regular stand (19 4 5 stands) 6 CS2: coppice-with-standards converted to large-diameter regular stand (14 stands) 7 • CS3: coppice-with-standards converted to irregular stand (15 stands) 8 9 3. Methods 10 11 In each sampling area the Humus Index was visually assessed in triplicate at four 12 plots, located at 14 m from the central post in the four main directions. At each plot three 13 replicated estimates of the Humus Index were made at angles of a one-meter side equilateral 14 triangle. The twelve measurements were averaged, giving a composite value for the 15 sampling area, which could smooth out two scales of the local variation not directly related to 16 stand properties (Riha et al., 1986; Ponge et al., 2002). The Humus Index was based on the classification of humus forms by Brêthes et al. (1995), modified by Jabiol et al. (2000): 17 18 Eumull = 1, Mesomull = 2, Oligomull = 3, Dysmull = 4, Hemimoder = 5, Eumoder = 6, 19 Dysmoder = 7.

20

21 At each of the four plots within the same sampling area, a probe was used to 22 measure the depth at which clay enrichment was found for the first time and the depth at 23 which clay was dominant. The four values were averaged for each sampling area. At each of 24 the four plots a soil sample was taken at 15-20 cm depth, then the four samples were pooled 25 then air-dried for laboratory analyses on the fraction less than 2 mm: particle size distribution (clay, silt, sand), pH<sub>water</sub>, pH<sub>KCl</sub>, cation exchange capacity, main exchangeable bases 26 27 (extracted at soil pH using cobaltihexamine), and base saturation. Analytical methods 28 followed ISO standards (Anonymous, 1999).

At each sampling area we noted the time elapsed from the last thinning operation (except for clear-cuts), the age of the stand (only for even-aged high forest), we measured the height and diameter at breast height of three dominant trees distant from less than 14 m from the central post, and we estimated the wood standing crop, using production tables by Dagnélie et al. (1999). At each plot we measured the basal area (BA), the percent basal area occupied by beech, the percent basal area occupied by hornbeam. These four values were averaged for each sampling area.

9

10 The statistical treatment of the data involved regression analysis, using the Humus 11 Index as a predicted (dependent) variable and several stand and soil properties as 12 explanatory (independent) variables (Sokal and Rohlf, 1995). The analyses were performed 13 with the StatBox® software. Residuals were tested for normality previous to analysis.

14

#### 15 **4. Results**

16

17 The Humus Index exhibited a significant (P<0.05) to highly significant (P<0.001) 18 correlation with 17 out of 21 stand and soil properties in oak stands of the Montargis forest 19 (Table 1). Other stand and soil parameters did not reach such a high level of indication, as 20 measured by the number of significant coefficients. For instance pH<sub>water</sub> was significantly 21 correlated with only 4 out of 8 stand measurements (against 7 our of 8 for Humus Index) and 22 with only 8 out of 12 soil measurements (against 10 out of 13 for Humus Index). The best 23 predicted variable was the age of even-aged high forest (r=0.73, P=5.10<sup>-9</sup>). Among soil parameters, Humus Index predicted the best base saturation (r=-0.61, P=6.10<sup>-11</sup>). 24

25

The Humus Index increased in value with the age of stands, indicating a shift from Mull to Moder in the course of time (Fig. 2), but it was not seemingly influenced by thinning operations (r=0.10, P=0.18, Table 1). It should be noted that pH<sub>water</sub>, on the contrary, was negatively correlated with the time elapsed from the last thinning operation (r=-0.27,
 P=0.006). In short, after each thinning operation, soil acidity decreased then increased again
 but without any concomitant change in the humus form.

4

5 These global trends were depicted by the whole set of sampling areas, without any 6 account to possible effects of management pratices. If we separate even-aged high forest 7 stands from stands converted from old coppices-with-standards, a more variegated 8 landscape appears (Fig. 3).

9

10 The positive correlation between Humus Index and dominant height was better 11 depicted by even-aged high forest (Fig. 3b) than by the whole set of oak stands (Fig. 3a). 12 Coppices-with-standards did not exhibit any such trend, all of them falling within the range of 13 even-aged high forest stands with tallest trees as dominants. A comparison by paired t-test 14 between actual and calculated values of Humus Index for coppices-with-standards (using 15 equation 1) did not reveal any departure from the trend exhibited by even-aged high forest, 16 provided trees are of the same height (t=0.89, P=0.19). Thus the relationship between 17 Humus Index and dominant height was not affected by management practices.

18

19 A quite different picture was exhibited by dominant diameter. Similar to dominant 20 height, the correlation between Humus Index and dominant diameter was positive, better 21 depicted by even-aged high forest than by the whole set of stands, and null for coppices-22 with-standards (Figs. 3c and 3d). However, Humus Indices measured in coppices-with-23 standards differed by more than one unit from values calculated using equation 1 derived for even-aged high forest (t=7.48, P=2.10<sup>-9</sup>). Thus, provided they had the same dominant 24 25 diameter, coppices-with-standards seemed to exhibit more active humus forms than even-26 aged high forest. However, when comparing Figures 2b and 2d it appears that coppices-with-27 standards, the dominants of which have the same height than tallest trees of even-aged high 28 forest (90 years-old, see Fig. 2), exhibit larger diameters at breast height, which flaws any

comparison based on diameter. Coppices-with-standards, the mean diameter of dominant
 trees is 45 cm, should compare with even-aged high forest stands with a mean diameter of
 35 cm for dominants.

4

5 Wood standing crop was estimated using both diameter and height of trees. If we 6 consider wood volume and Humus Index, most coppices-with-standards fell within the range of tallest even-aged high forest stands (also oldest, r=0.98, P=2.10<sup>-32</sup>), but some coppices-7 8 with-standards exhibited higher volumes of wood and lower Humus Indices than expected on 9 the base of even-aged high forest (Figs. 3e and 3f). However, a comparison between 10 observed and calculated values of the Humus Index for coppices-with-standards did not 11 reveal any significant shift (t=1.17, P=0.12). Here too, there was no effect of management 12 practices.

13

Basal area did not vary to a great extent among oak stands, although this parameter displayed a positive correlation with the Humus Index (Fig. 3g). Most coppices-withstandards fell within the range of variation of even-aged high forest stands (Fig. 3h) but they exhibited a higher Humus Index than expected from their basal area (t=-4.96, P=5.10<sup>-6</sup>). Beech and hornbeam (in percent of the total basal area) were positively correlated with the Humus Index, but at a lower level of significance than age, height, diameter and basal area (Table 1).

21

There was a positive relationship between the Humus Index and the depth at which clay becomes dominant (Fig. 4a): the shallower was the clay horizon, the lower was the Humus Index (Mull). Both even-aged high forest and coppices-with-standards exhibited the same relationship (Fig. 4b), with a similar slope of the regression line (t=1.52, P=0.13). This figure may also help to verify that even-aged high forest and coppices-with-standards grew on the same range of soil conditions, thus comparisons between management pratices were not biased by a possible influence of the soil type. When the combined effect of stand age and soil type (expressed by depth of clay horizon) on the Humus Index of full-gown stands
 was analysed by multiple regression, the mixed model explained 70.1% of the total variation,
 shared between 52.9% for age and 17.2% for soil type.

4

5 For the same depth of clay horizon, coppices-with-standards exhibited a higher Humus Index than the even-aged high forest (t=7.13,  $P=5.10^{-9}$ ), the difference being ca. 1 6 7 unit. However, since the group of even-aged high forest stands included young stands with 8 more active humus forms (lower Humus Index), a possible bias due to aging was questioned. 9 If a Humus Index could be extrapolated for young stands supposed at the age of 90-years, 10 then more valid comparisons between coppices-with-standards and even-aged high forest 11 would be made. We used the equation shown in Figure 2 to extrapolate Humus Indices at 90 12 years (HI<sub>90</sub>) from actual values of young stands (HI), according to the formula 13 HI<sub>90</sub>=HI+0.03(90-age), with the age of the stand expressed in years. The Humus Index thus 14 calculated for theoretical 90-years-old even-aged high forest remained significantly (and 15 positively) explained by the depth of clay horizon ( $R^2=0.37$ ,  $P=10^{-4}$ ). When even-aged high 16 forest stands were thus corrected for aging, coppices-with-standards exhibited a lower Humus Index (ca. 0.5 unit less) than even-aged high forest (t=3.8, P=2.10<sup>-4</sup>), for the same 17 18 soil conditions (expressed by depth of clay horizon).

19

The Humus Index showed a negative relationship with exchangeable Ca (fig. 4c), but, contrary to above mentioned parameters, a better fitness was obtained with logarithmic values of calcium concentrations ( $R^2$ =0.53 against 0.26 for linear regression). Even-aged high forest and coppices-with-standards exhibited the same relationship (Fig. 3d), and for the same concentration of exchangeable Ca the Humus Index did not differ between them (t=0.06, P=0.48).

Similarly, the relationship between Humus Index and base saturation was non-linear
 (Fig. 4e) and was depicted both by even-aged high forest and coppices-with-standards (Fig.
 4f), which did not differ between them at a given level of base saturation (t=0.017, P=0.49).

4

#### 5 5. Discussion

6

7 First, it should be highlighted that our Humus Index differs to a great extent from the 8 same notation recently used by other authors to describe humus quality (Godefroid et al., 9 2005). The Humus Index they used was based on floristic composition, by averaging scores 10 of different plant species pertaining to the same plant community. The scores were 11 calculated on the model of Ellenberg (1974) indices, by noting the presence of plant species 12 along a scale of humus forms, which were given a number as in our own method. In the 13 present study, as in previously published papers (Ponge et al., 2002; Ponge et al., 2003; 14 Fédoroff et al., 2005), the Humus Index was directly derived from the observation of humus 15 forms, not of flora. Several authors noted that Ellenberg indices should be used with caution, 16 given the existence of regional and temporal changes in ecological requirements of plant 17 species (Parrish and Bazzaz, 1985; Hill et al., 1999; Diekmann and Lawesson, 1999). We 18 suggest that the identification of the humus form (Green et al., 1993; Brêthes et al., 1995), 19 which can be used directly on the field for building a Humus Index, should be preferred to a 20 list of plant species.

21

The positive correlation between the Humus Index and the age of oak stands (Fig. 2) can be attributed to changes in humus forms and associated parameters (soil acidification, organic matter accumulation) which have been repeatedly observed to occur during crop rotation (Adam, 1999; Aubert et al., 2004; Godefroid et al., 2005). The passage from Mull (Humus Index 1-4) to Moder (Humus Index 5-7) accompanies the growth of trees and their increasing influence on the soil, more especially when their litter is poor in nutrients and rich in secondary metabolites (Nicolai, 1988; Ponge et al., 1997; Ponge et al., 1998). Studies on

1 old-growth forests reveal that soil acidification under the influence of tree growth is temporary 2 and may reverse if environmental conditions and spatial configurations of habitats are proper 3 for the re-establishment of adapted decomposer communities (Ulrich, 1987; Bernier and 4 Ponge, 1994; Aubert et al., 2004). This occurs when nutrient requirements of the 5 aboveground compartment of the forest ecosystem decrease after cessation of stem 6 elongation (Nilsson et al., 1982; Miller, 1984a; Chapin et al., 1986). Here we did not show 7 such reversal of the Humus Index in ageing stands, because our stands were probably too 8 young and occupied too large surfaces, in an otherwise intensively managed forest. The fact 9 that the relationship between age and Humus Index was linear (Fig. 2) indicates that the 10 humus form changed steadily during stand development, at least during the first 90 years of 11 crop rotation. The linear relationship between the Humus Index and the age of trees 12 contradicts the hypothesis of stability domains within soil communities (Bengtsson, 2002; 13 Graefe, 2003; Ponge, 2003). According to this hypothesis, changes in soil communities 14 would occur by jumping from a species distribution to another, better adapted distribution, 15 when the original community has been disrupted by an environmental stressor, such as for 16 instance changes in environmental conditions and resource availability which occur during 17 stand development. This should result in a discrete response of the Humus Index to tree 18 growth, which was not depicted by our series of even-aged high forest stands.

19

20 The negative influence of beech upon soil biological activity was reflected in the 21 increase in Humus Index when the percent basal area occupied by beech increased (Table 22 1). Muys (1989) observed an increase in humus guality (expressed by an increase in 23 earthworm biomass) and a decrease in soil compaction when beech was replaced by oak in 24 a Belgian forest. Similar results, using herb species as indicators of humus quality, were 25 obtained by Godefroid et al. (2005) in the same country. This phenomenon could be explained by a higher increment in wood standing crop and basal area and a lower 26 27 decomposition rate of litter in beech compared to oak (Lemée and Bichaut, 1973; Monserud and Sterba, 1996), with concomitant soil impoverishment (Nilsson et al., 1982; Chapin et al.,
 1986).

3

4 The relationship between Humus Index and parameters of stand development 5 (height, diameter at breast height, wood standing crop) can be mostly explained by stand 6 age, as these parameters increase steadily during stand development (Miller, 1984b; Chapin 7 et al., 1986; Ulrich, 1994). Stands resulting from the conversion of old coppices-with-8 standards compare well with 90-years-old even-aged high forest stands, the dominants of 9 which are of the same height (25 m, see Fig. 3b), except that they reached a larger diameter 10 at breast height (Fig. 3d), due to higher annual increments (Guilley et al., 2004) and probably 11 older age. Both stand types exhibit a Humus Index averaging 4 (Dysmull). Howvever, 12 coppices-with-standards show a high degree of variation in their stand characteristics, which 13 are not correlated with the Humus Index (Figs. 3b, 3d, 3f, 3h). A more clear picture appears 14 when soil types are taken into account. They explain most of the variation which remained 15 unexplained by stand characteristics: both coppices-with-standards and even-aged high 16 forest show a positive relationship between Humus Index and depth of clay horizon (Fig. 4b). 17 When even-aged high forest trees are corrected for stand age, this relationship remains 18 positive and significant, thus is not age-dependent, and differences between both forest 19 types can be clearly perceived. For a given soil type, coppices-with-standards have a lower 20 Humus Index (minus 0.5 unit) than oldest even-aged high forest stands. This means that 21 coppices-with-standards exhibit less litter accumulation even though they have a higher 22 standing crop and the same basal area than even-aged high forest stands (Figs. 3f and 3h). 23 Given our knowledge of the relationships between humus forms (and closely related 24 processes such as litter decomposition) and functional biodiversity of forest soils (Ponge et 25 al., 1997; Ponge, 2003; Heemsbergen et al., 2004), we hypothesize that stands issuing from 26 coppices-with-standards exhibit slightly more diversified animal and microbial communities 27 than even-aged high forest. At first sight, this improvement of soil condition in converted 28 coppices-with-standards could be explained by a higher diversity of woody vegetation, in

1 particular to the presence of hornbeam in mixture with sessile oak, especially in the 2 understory (Aubert et al., 2004). However, in our study site we did not register any positive 3 influence of hornbeam upon the humus form (Table 1). Similarly, Bonneau and Ranger 4 (1984) observed a shift from Mull or Mull-Moder to Moder and a decrease in exchangeable 5 cations when even-aged high forest stands were compared to coppices-with-standards in the 6 Marchenoir forest, which is located not far from our study site. They attributed this shift to 7 increased nutrient uptake and immobilization in the woody biomass of even-aged high forest, 8 which impoverished the soil. Awaiting further studies, this interpretation could be questioned, 9 because we observed that stands converted from coppices-with-standards neither exhibited 10 a smaller basal area nor a smaller standing crop than even-aged high forest (Fig. 3). An 11 alternative hypothesis could be that even-aged high forest trees were still too young to depict 12 the improvement in soil biological activity (and thus the decrease in Humus Index) which is 13 typically observed under older trees in natural forests (Page, 1974; Ponge et al., 1998). 14 Other comparisons with literature data, especially when climate conditions and tree 15 composition are different, should be made with caution. For instance, Hölscher et al. (2001) 16 concluded that soils from oak coppices exhibited less acidity and higher mineral pools than 17 those from even-aged high forests, but the former group was made of oak while the latter 18 was made of beech, which flawed the comparison.

19

The non-linear relationship between Humus Index and base availability (Fig. 4c-f) possibly indicates a trend towards a saturation of the ecosystem in exchangeable bases, in particular in the below-ground compartment which is chiefly responsible for the building of humus forms (Chapin et al., 1986). Some studies have shown that an increase in nutrient availability maybe ineffective in changing humus quality, if adapted decomposer communities and efficient foodwebs are not present or cannot build-up rapidly (Törne, 1978; Graefe, 1990; Muys and Lust, 1992).

1 The observed stability of the Humus Index against thinning operations (Table 1), 2 despite a significant change in soil pH (see Results), can be ascribed to a redundancy 3 phenomenon within the humus profile, which has been explained in detail by Belotti and 4 Babel (1993). Each time a function (for instance the building of a horizon) is ensured by a 5 variety of organisms, no pronounced change appears until the least sensitive species 6 disappears (Heemsbergen et al., 2004). We hypothesize that the time from selection cutting 7 to crown recovery is too short for destabilizing humus profiles, because of biological inertia, 8 but also of the time required for building or disappearance of a horizon (Ulrich, 1987). A 9 previous study on a spruce chronosequence showed that the increase in earthworm 10 population size which accompanied thinning operations was only temporary and did not 11 reverse the observed shift from Mull to Moder (Bernier and Ponge, 1994).

12

13 We are aware that, although exhibiting a number of significant trends when correlated 14 with stand and soil variables, the Humus Index does not explain the whole variation of these 15 conditions. Roughly, the Humus Index explains at best half the total variation of stand and 16 soil parameters (Figs. 2 to 4). This could be explained by (i) the wide range of stand and soil 17 types covered by our study, (ii) the existence of other, not accounted for, factors which may 18 have influenced the building of humus forms. Among these factors, the past history of the 19 stands is probably responsible for a significant part of the unexplained variation. Fire places 20 for charcoal production, agricultural past, human settlements, among others, are known to 21 affect the distribution of plant species, which is probably true of soil organisms, too (Koerner 22 et al., 1997). Even though we can discard agricultural past in the case of the studied forest, 23 other human influences should not be neglected.

24

#### 25 **6. Conclusion**

26

We showed that the Humus Index can be correlated with several important parameters of stand development and soil type, pointing on its possible use in the

1 assessment of site quality and the long-term survey of ecosystems. Awaiting further 2 theoretical and experimental developments, the Humus Index should be considered as a 3 synthetic measurement of the complexity of soil communities (Ponge, 2003), which could be 4 used as an early tool to predict changes at the ecosystem level, due to tree growth, 5 management pratices, climate change and pollution. Practicability of the method cannot be 6 questioned, since it does not need any other measurement than the estimate by eye of 7 horizons and structures. The only point which deserves further elaboration is a possible shift 8 from person to person in the estimate of horizon thickness, which has been highlighted by 9 Federer (1982). A standardization of the method would alleviate such possible biases. 10 Further studies should also take into account between-forest variation and the time required 11 fro reaching an equilibrium in the humus type (Wilson et al., 2001), before reaching firm 12 conclusions about the use of the Humus Index for ecological site classification (Ray, 2001).

13

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15

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1	Figure captions
2	
3	Fig. 1. Location map of the Montargis forest (France)
4	
5	Fig. 2. Relationship between Humus Index and age of even-aged high forest stands. *** =
6	significant at 0.001 level (F test)
7	
8	Fig. 3. Relationship between Humus Index and four stand measurements. N.S. = not
9	significant; ** = significatn at 0.01 level; *** = significant at 0.001 level (F test)
10	
11	Fig. 4. Relationship between Humus Index and three soil measurements. ** = significant at
12	0.01 level; *** = significant at 0.001 level (F test)
13	

1         energing high fields         67         25         6         Dystruit         3           1         energing high fields         68         20         12         Eurodati         3           1         energing high fields         68         20         11         Mescruit         6           1         energing high fields         68         20         1         Mescruit         6           1         energing high fields         68         20         1         Mescruit         2           1         energing high fields         68         0         4         Oligornull         2           2         energing high fields         68         0         1         Mescruit         2           2         energing high fields         68         0         2         Oligornull         3           2         energing high fields         61         10         Oligornull         8           3         energing high fields         61         10         Oligornull         8           3         energing high fields         61         10         Oligornull         8           3         energing high fields         61         10	Code number	Forest type	% Quercus	% Fagus	% Carpinus	Mean humus form	Last time thinning
2even-space hyph boost6876Dystrall311even-space hyph boost6010Hacenull612even-space hyph boost61611Macenull613even-space hyph boost6163Clippmull114even-space hyph boost6163Clippmull215even-space hyph boost61001Macenull220even-space hyph boost61001Macenull221even-space hyph boost61001Macenull222even-space hyph boost61000Clippmull323even-space hyph boost61000Clippmull224even-space hyph boost61000Clippmull325even-space hyph boost61100Clippmull226even-space hyph boost61100Clippmull327even-space hyph boost7100Clippmull328even-space hyph boost7000Clippmull329even-space hyph boost7000Clippmull329even-space hyph boost70000020even-space hyph boost70000020even-space hyph boost	1	even-aged high forest	67	25	8	Dysmull	3
a         b         b         C         L         L         Departure         B           12         ever-spot sph (bos)         84         0         1         Maccrull         0           13         ever-spot sph (bos)         81         8         0         1         Maccrull         0           14         ever-spot sph (bos)         81         0         1         Maccrull         2           21         ever-spot sph (bos)         81         0         0         1         Maccrull         2           21         ever-spot sph (bos)         81         0         0         1         Maccrull         3           22         ever-spot sph (bos)         81         1         1         1         1         Maccrull         3           23         ever-spot sph (bos)         81         1	2	even-aged high forest	88	7	5	Dysmull	3
12     exclusion of the secture of the s	3	even-aged high forest	69 98	20	12	Oligomull	3
13exe-aged kpb forest9101Meanull614Clipprull1Clipprull115exe-aged kpb forest10001Meanull216exe-aged kpb forest10000Meanull217exe-aged kpb forest10000Clipprull328exe-aged kpb forest1011237Meanull829exe-aged kpb forest1011237Meanull829exe-aged kpb forest1010Clipprull329exe-aged kpb forest1010Clipprull330exe-aged kpb forest1010Clipprull331exe-aged kpb forest1010Clipprull332exe-aged kpb forest1010Clipprull333exe-aged kpb forest1010Clipprull334exe-aged kpb forest1010Clipprull334exe-aged kpb forest1010Clipprull334exe-aged kpb forest1010Clipprull335exe-aged kpb forest1010Clipprull336exe-aged kpb forest1010101036exe-aged kpb forest1010101036exe-aged kpb forest1010101037exe-aged kpb forest1010	12	even-aged high forest	84	5	11	Mesomuli	6
17         energing big hosts         81         6         3         Olgenul         1           10         energing big hosts         80         0         1         Macrul         2           21         energing big hosts         80         0         1         Macrul         2           22         energing big hosts         82         0         17         Olgenul         3           23         energing big hosts         81         0         1         Macrul         8           24         energing big hosts         81         0         1         Macrul         8           25         energing big hosts         81         0         10         Olgenul         3           36         energing big hosts         81         15         0         Olgenul         3           37         energing big hosts         15         0         Olgenul         5         3           44         energing big hosts         70         12         1         Classe         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1	13	even-aged high forest	99	0	1	Mesomull	6
19     even-aged hyb forst     00     0     Mascrull     2       21     even-aged hyb forst     00     0     Mascrull     2       22     even-aged hyb forst     00     0     0     Mascrull     3       23     even-aged hyb forst     01     0     0     0     0     0       24     even-aged hyb forst     01     12     0     0     0     0       24     even-aged hyb forst     01     12     0     0     0     0     0       25     even-aged hyb forst     01     0     0     0     0     0     0       26     even-aged hyb forst     01     0     0     0     0     0     0       27     even-aged hyb forst     01     0     0     0     0     0     0       28     even-aged hyb forst     01     0     0     0     0     0     0       28     even-aged hyb forst     01     0     0     0     0     0       29     even-aged hyb forst     01     0     0     0     0     0       40     even-aged hyb forst     01     0     0     0     0     0	17	even-aged high forest	91	6	3	Oligomull	1
2)         existing heads         9         0         1         Meanual         2           21         existing heads         82         0         17         Cligorull         3           21         existing heads         82         0         17         Cligorull         3           22         existing heads         81         0         1         Cligorull         3           23         existing heads         81         12         37         Herrimoder         8           23         existing heads         81         15         0         Cligorull         3           34         existing heads         82         15         0         Cligorull         5           35         existing heads         82         15         0         Cligorull         5           36         existing heads         82         15         0         Cligorull         5         5           37         existing heads         83         15         0         Cligorull         5         5           38         existing heads         16         15         Existing heads         5         5           44         existing heads	19	even-aged high forest	96	0	4	Oligomull	2
21         existings         100         0         0         Meanual         2           23         existings         100         0         0         0         0         0           24         existings         100         0         0         0         0         0           25         existings         100         100         40         0         0         0           26         existings         100         100         100         0         0         0         0           26         existings         100         10         0 <td>20</td> <td>even-aged high forest</td> <td>99</td> <td>0</td> <td>1</td> <td>Mesomuli</td> <td>2</td>	20	even-aged high forest	99	0	1	Mesomuli	2
34         exe-aged high brest         86         0         1         Outprant         3           27         exe-aged high brest         81         0         12         37         Heinitodort         8           28         exe-aged high brest         81         0         19         Heinitodort         8           39         exe-aged high brest         81         0         0         00         00         37           39         exe-aged high brest         80         15         0         001portul         5           39         exe-aged high brest         80         11         0         Diparul         5           34         exe-aged high brest         70         6         25         Dyrant         6           44         exe-aged high brest         70         6         25         Euroder         6           44         exe-aged high brest         70         23         5         Euroder         6           44         exe-aged high brest         70         24         2         Dyrant         3           5         corrent coppic-with standards         80         7         Heinitodort         7           44 <t< td=""><td>21</td><td>even-aged high forest</td><td>100</td><td>0</td><td>0</td><td>Mesomuli</td><td>2</td></t<>	21	even-aged high forest	100	0	0	Mesomuli	2
25         even-aged high brest         68         0         2         Oilganuil         8           23         even-aged high brest         61         12         37         Hemimodar         8           34         even-aged high brest         81         0         19         Hemimodar         8           34         even-aged high brest         80         0         10         Oilganuil         3           35         even-aged high brest         80         15         0         Oiganuil         5           34         even-aged high brest         80         16         5         Eumodar         7           41         even-aged high brest         70         20         2         Dyrmuil         6           42         even-aged high brest         70         2         3         5         Eumodar         6           43         even-aged high brest         70         2         11         10         Eumodar         2           44         even-aged high brest         70         2         14         Eumodar         2           45         covered coppice-with-bandards         8         7         15         Eumodar         2	23	even-aged high forest	82 99	0	17	Oligomuli	3
27     existing high best     90     0     90     00     90     00     90     00     90       28     existing high best     81     0     0     13     Heiminder     8       29     existing high best     81     0     00     00     00       39     existing high best     80     0     00     00     00       30     existing high best     80     15     0     00     00       30     existing high best     80     15     0     00     00       41     existing high best     80     15     0     00     00       42     existing high best     70     60     25     00     00       44     existing high best     70     60     17     14     Euroder     6       45     existing high best     70     10     17     14     Euroder     6       50     existing high best     77     22     14     Euroder     6       51     existing high best     77     10     13     Heiminder     7       52     existing high best     77     10     13     Heiminder     7       54     existing hisisting h	26	even-aged high forest	98	0	2	Oligomull	8
3B         even-appet high httest         8         12         37         Hemmoder         8           34         even-appet high httest         80         0         1         10         0)ipprulit         2           35         even-appet high httest         80         0         0         0         0)ipprulit         3           36         even-appet high httest         80         15         0         0)ipprulit         3           36         even-appet high httest         80         15         0         0)ipprulit         5           41         even-appet high httest         80         15         0         0)ipprulit         6           42         even-appet high httest         70         6         2         0)ipprulit         6           43         even-appet high httest         70         6         2         0         0         0         0           54         even-appet high httest         70         2         1         0<	27	even-aged high forest	90	0	9	Oligomull	8
34         een-sign high herest         90         4         6         Dynami         2           35         een-sign high herest         82         1         17         Oilgonull         3           38         een-sign high herest         83         15         0         Oilgonull         5.5           34         een-sign high herest         83         15         0         Dipartual         5.5           44         een-sign high herest         81         15         0         Dipartual         6.6           44         een-sign high herest         70         6         2.5         Dyranull         6           44         een-sign high herest         70         7         2.3         5         Eunoder         6           45         een-sign high herest         70         4.2         16         Eunoder         2           46         een-sign high herest         77         2.3         5         Eunoder         2           55         converted coppice-with-standunds         8.3         9         7         Herminoder         2           56         converted coppice-with-standunds         8.3         9         Merminoder         7	28	even-aged high forest	51 81	12	37	Hemimoder	8
35         ewn-agod high forest         87         0         3         Oligomul         3           38         ewn-agod high forest         88         15         0         Oligomul         5.           38         ewn-agod high forest         88         15         0         Digomul         5.           44         ewn-agod high forest         78         20         2         Dyarnul         6           44         ewn-agod high forest         78         20         2         Dyarnul         6           44         ewn-agod high forest         78         20         2         Dyarnul         6           45         ewn-agod high forest         77         22         1         Digmanil         3.5           46         ewn-agod high forest         77         22         1         Digmanil         3.5           55         connerfed coppic-with-standards         80         9         7         Herminoder         12           56         connerfed coppic-with-standards         80         9         13         Herminoder         12           57         connerfed coppic-with-standards         80         9         1         Herminoder         12	34	even-aged high forest	90	4	6	Dysmull	2
37         ewn-aged high forest         82         1         17         Oligonull         3           38         ewn-aged high forest         88         15         0         Dyrnull         5.5           40         ewn-aged high forest         88         15         0         Dyrnull         6           41         ewn-aged high forest         81         15         4         Eunoder         7           42         ewn-aged high forest         70         63         2         Dyrnull         6           44         ewn-aged high forest         70         63         Eunoder         6           44         ewn-aged high forest         77         22         1         Cligonull         3.5           55         connettal coppic-ewth-standards         83         9         7         Herminoder         2           56         connettal coppic-ewth-standards         77         10         13         Herminoder         12           57         connettal coppic-ewth-standards         77         10         13         Herminoder         7           58         connettal coppic-ewth-standards         70         10         10         Dyrmull         12           <	36	even-aged high forest	97	0	3	Oligomull	2
abs         period         period <td>37</td> <td>even-aged high forest</td> <td>82</td> <td>1</td> <td>17</td> <td>Oligomull</td> <td>3</td>	37	even-aged high forest	82	1	17	Oligomull	3
40         ewn-sight fyring         88         11         0         Dysnull         5.5           42         ewn-sight fyring         81         15         4         Euroder         7           42         ewn-sight fyring         71         60         25         Dysnull         6           44         ewn-sight fyring         71         61         Euroder         6           45         ewn-sight fyring         68         17         15         Euroder         6           46         ewn-sight fyring         68         17         16         Euroder         6           51         ewn-sight fyring         72         22         1         Cligornull         3.5           55         connetic coppic-with-standards         73         7         15         Herrinoder         2           56         connetic coppic-with-standards         73         7         15         Herrinoder         7           61         connetic coppic-with-standards         7         15         Herrinoder         7           62         connetic coppic-with-standards         7         15         Herrinoder         7           63         connetic coppic-with-standards	39	even-aged high forest	85	15	0	Oligomull	5.5
41         exen-aged high forest         80         15         5         Eumoder         7           42         exen-aged high forest         78         20         2         Dymull         6           44         exen-aged high forest         78         20         2         Dymull         6           44         exen-aged high forest         80         17         16         Eumoder         6           50         exen-aged high forest         60         17         14         Eumoder         6           51         exen-aged high forest         60         47         7         Hermoder         2           54         connetted coppic ewith-standards         83         9         7         Hermoder         2           55         connetted coppic ewith-standards         82         9         18         Hermoder         12           66         connetted coppic ewith-standards         82         0         18         Hermoder         12           67         connetted coppic ewith-standards         82         0         18         Hermoder         12           68         connetted coppic ewith-standards         82         0         14         Hermoder         12	40	even-aged high forest	88	11	0	Dysmull	5.5
44         example high first         91         13         4         Euroder         7           44         example high forest         73         23         5         Euroder         6           47         example high forest         83         17         15         Euroder         6           48         example high forest         88         17         14         Euroder         6           50         example high forest         77         22         1         Oligonull         3.5           55         converted coppice-with-standard         83         9         7         Herninoder         2           56         converted coppice-with-standard         80         2         18         Herninoder         2           57         converted coppice-with-standard         80         2         18         Herninoder         7           56         converted coppice-with-standard         80         13         Herninoder         7           56         converted coppice-with-standard         80         8         4         80         Digmull         1           66         converted coppice-with-standard         80         8         4         80         Digmull <td>41</td> <td>even-aged high forest</td> <td>80</td> <td>15</td> <td>5</td> <td>Eumoder</td> <td>7</td>	41	even-aged high forest	80	15	5	Eumoder	7
44         even-agad high forest         70         6         25         Dyarmal         6           44         even-agad high forest         80         11         10         Eumoder         6           50         even-agad high forest         80         17         14         Eumoder         6           51         even-agad high forest         77         12         1         Oligonull         3.5           54         converted coppice-with-standard         80         9         7         Hernimoder         2           55         converted coppice-with-standard         80         9         1         Eumoder         2           60         converted coppice-with-standard         81         9         1         Eumoder         7           61         converted coppice-with-standard         85         3         13         Hernimoder         7           62         converted coppice-with-standard         85         3         18         Oligonull         7           63         converted coppice-with-standard         81         0         12         14         Hernimoder         7           64         converted coppice-with-standard         81         0         12	42	even-aged high forest	81 78	15 20	4	Eumoder	6
47         exen-aged high forest         73         23         5         Eumoder         6           48         exen-aged high forest         88         17         15         Eumoder         6           51         exen-aged high forest         77         22         1         Oligomull         3.5           54         converted coppice-with-standard         83         9         7         Herninoder         2           55         converted coppice-with-standard         80         9         7         Herninoder         2           56         converted coppice-with-standard         80         9         7         Herninoder         7           66         converted coppice-with-standard         80         9         18         Herninoder         7           66         converted coppice-with-standard         80         9         11         Herninoder         7           67         converted coppice-with-standard         80         9         11         Herninoder         7           68         converted coppice-with-standard         80         9         9         9         11         12           76         converted coppice-with-standard         80         9         9	44	even-aged high forest	70	6	25	Dysmull	6
48         exernaged high forest         80         11         10         Eumoder         6           50         exernaged high forest         67         12         14         Eumoder         6           51         exernaged high forest         68         17         14         Eumoder         6           54         exernaged high forest         68         17         14         Eumoder         2           55         convented coppice-with-standards         83         9         7         Hernimoder         2           56         convented coppice-with-standards         83         9         7         15         Hernimoder         12           60         convented coppice-with-standards         86         2         61         11         00         pysmul         7           63         convented coppice-with-standards         86         14         38         Dysmul         7           63         convented coppice-with-standards         81         0         4         Hernimoder         7           64         convented coppice-with-standards         70         26         4         Oigpnull         12           75         convented coppice-with-standards         81 <td>47</td> <td>even-aged high forest</td> <td>73</td> <td>23</td> <td>5</td> <td>Eumoder</td> <td>6</td>	47	even-aged high forest	73	23	5	Eumoder	6
S0         even-agad high brasit         69         17         14         Eurosder         6           51         even-agad high brasit         69         4         27         Dysmull         3.5           54         converted coppice-with-standards         82         6         12         Eurosder         2           55         converted coppice-with-standards         80         2         18         Hemimoder         12           56         converted coppice-with-standards         80         2         18         Hemimoder         12           62         converted coppice-with-standards         80         2         18         Otigonull         7           64         converted coppice-with-standards         80         4         38         Dysmull         7           65         converted coppice-with-standards         80         9         11         10         Dysmull         13           66         converted coppice-with-standards         80         9         12         14         14         Nemmoder         7           7         converted coppice-with-standards         80         9         12         12         12         12         12         12         12	48	even-aged high forest	80 68	11 17	10 15	Eumoder	6
51         even-spic high forest         77         22         1         Digmull         3           54         converted copple-with-standards         83         9         7         Herminoder         2           55         converted copple-with-standards         80         2         68         12         Euroder         2           60         converted copple-with-standards         80         2         18         Herminoder         12           61         converted copple-with-standards         80         2         18         Herminoder         7           62         converted copple-with-standards         82         0         18         Oligonull         7           63         converted copple-with-standards         82         0         18         Oligonull         7           64         converted copple-with-standards         83         0         62         Oligonull         12           75         converted copple-with-standards         83         0         62         Digonull         12           76         converted copple-with-standards         83         0         12         12         12           77         converted copple-with-standards         86	50	even-aged high forest	69	17	14	Eumoder	6
64         converted coppie-with-standards         69         4         27         Dysmull         3           65         converted coppie-with-standards         82         6         12         Euroder         2           67         converted coppie-with-standards         82         6         12         Euroder         2           63         converted coppie-with-standards         83         2         18         Hemimoder         12           63         converted coppie-with-standards         83         2         64         Oligomull         12           64         converted coppie-with-standards         82         4         38         Dysmull         7           65         converted coppie-with-standards         83         0         62         11         Hemimoder         7           66         converted coppie-with-standards         83         0         62         4         Oligomull         13           77         converted coppie-with-standards         80         9         Dipsmull         12           78         converted coppie-with-standards         65         3         32         Oligomull         12           79         converted coppie-with-standards         65	51	even-aged high forest	77	22	1	Oligomull	3.5
b3         converted copple-with-standards         83         9         /         Herminober         2           57         converted copple-with-standards         78         12         Euroder         2           58         converted copple-with-standards         80         2         18         Herminoder         2           62         converted copple-with-standards         85         3         13         Herminoder         7           64         converted copple-with-standards         88         4         80         Operuit         1           65         converted copple-with-standards         80         9         11         Herminoder         7           68         converted copple-with-standards         80         9         11         Herminoder         7           69         converted copple-with-standards         79         11         10         Dysmull         13           76         converted copple-with-standards         66         19         Oligomull         12           78         converted copple-with-standards         66         3         Oligomull         12           76         converted copple-with-standards         66         7         Oligomull         12 </td <td>54</td> <td>converted coppice-with-standards</td> <td>69</td> <td>4</td> <td>27</td> <td>Dysmull</td> <td>3</td>	54	converted coppice-with-standards	69	4	27	Dysmull	3
Bit         converted coppic-with-standards         78         7         15         Hernimoder         2           60         converted coppic-with-standards         34         2         64         Olgomuli         7           63         converted coppic-with-standards         85         3         13         Hernimoder         7           64         converted coppic-with-standards         85         3         13         Hernimoder         7           65         converted coppic-with-standards         81         0         49         Hernimoder         7           66         converted coppic-with-standards         83         0         62         Dysmuli         1           75         converted coppic-with-standards         83         0         62         4         Olgomuli         12           76         converted coppic-with-standards         65         16         19         Olgomuli         12           83         converted coppic-with-standards         66         3         32         Olgomuli         12           84         converted coppic-with-standards         68         23         9         Olgomuli         12           95         converted coppic-with-standards         71	55 57	converted coppice-with-standards	83 82	9	12	Eumoder	2
59         connetad coppice-with-standards         34         2         18         Hemimoder         12           62         connetad coppice-with-standards         77         10         13         Dysrull         7           64         connetad coppice-with-standards         82         0         18         Oligomull         7           66         connetad coppice-with-standards         88         4         38         Dysrull         7           66         connetad coppice-with-standards         89         11         Hemimoder         7           66         connetad coppice-with-standards         79         11         Dysrull         13           76         connetad coppice-with-standards         79         11         10         Dysrull         12           78         connetad coppice-with-standards         68         9         6         Dysrull         12           79         connetad coppice-with-standards         66         7         Oligomull         12           80         connetad coppice-with-standards         66         7         Oligomull         12           70         connetad coppice-with-standards         66         7         Oligomull         12	58	converted coppice-with-standards	78	7	15	Hemimoder	2
60         converted coppice-with-standards         34         2         64         Objecnuli         7           62         converted coppice-with-standards         85         3         13         Herninoder         7           64         converted coppice-with-standards         82         0         18         Objecnuli         7           65         converted coppice-with-standards         51         0         49         Herninoder         7           66         converted coppice-with-standards         70         20         Dysmuli         13           76         converted coppice-with-standards         72         11         10         Dysmuli         12           77         converted coppice-with-standards         72         21         7         Dysmuli         12           83         converted coppice-with-standards         86         9         6         Dysmuli         12           84         converted coppice-with-standards         88         6         7         Objecnuli         12           85         converted coppice-with-standards         88         6         7         Objecnuli         12           86         converted coppice-with-standards         71         1	59	converted coppice-with-standards	80	2	18	Hemimoder	12
Description         Description         Description         Description         Description           65         connents coppice-with standards         86         3         13         Object         Telescopice           66         connents coppice-with standards         86         3         18         Object         Telescopic           66         connents coppice-with standards         80         9         11         Hernimoder         7           66         connents coppice-with standards         79         11         10         Dysmull         13           76         connents coppice-with standards         79         11         10         Dysmull         12           77         connents coppice-with standards         66         19         Objecn         12           78         connents coppic-with standards         68         9         6         Dysmull         12           79         connents coppic-with standards         68         23         9         Dysmull         12           84         connents coppic-with standards         68         23         9         Dysmull         12           77         connents coppic-with standards         71         12         8         12	60 62	converted coppice-with-standards	34 77	2	64 13	Oligomull	12
64         converted coppice-with-standards         82         0         18         Oligonull         7           66         converted coppice-with-standards         80         9         11         Hemimoder         7           68         converted coppice-with-standards         80         9         11         Hemimoder         7           69         converted coppice-with-standards         79         Converted coppice-with-standards         70         Dysmull         12           77         converted coppice-with-standards         67         16         19         Oligonull         12           81         converted coppice-with-standards         86         9         6         Dysmull         12           82         converted coppice-with-standards         86         7         Oligonull         12           84         converted coppice-with-standards         88         6         7         Oligonull         12           90         converted coppice-with-standards         88         6         7         Oligonull         12           91         converted coppice-with-standards         51         14         8         Euroder         12           92         converted coppice-with-standards         52<	63	converted coppice-with-standards	85	3	13	Hemimoder	7
66         converted coppice-with-standards         51         9         Hernimoder         7           68         converted coppice-with-standards         80         9         11         Hernimoder         7           68         converted coppice-with-standards         38         0         62         Dysmull         13           76         converted coppice-with-standards         70         11         10         Dysmull         12           77         converted coppice-with-standards         72         21         7         Dysmull         12           83         converted coppice-with-standards         86         9         6         Digmull         12           84         converted coppice-with-standards         88         6         7         Oligomull         12           90         converted coppice-with-standards         68         23         9         Dysmull         2           91         converted coppice-with-standards         50         1         48         Euroder         12           92         converted coppice-with-standards         52         8         41         Hernimoder         12           93         converted coppice-with-standards         5         5 <t< td=""><td>64</td><td>converted coppice-with-standards</td><td>82</td><td>0</td><td>18</td><td>Oligomull</td><td>7</td></t<>	64	converted coppice-with-standards	82	0	18	Oligomull	7
converted copple>with standards         80         9         11         Hernimoder         7           68         converted copple>with standards         78         0         62         Dysmull         13           76         converted copple>with standards         79         26         4         Oligomull         12           77         converted copple>with standards         65         16         19         Oligomull         12           78         converted copple>with standards         69         6         Dysmull         12           84         converted copple>with standards         68         9         6         Dysmull         12           84         converted copple>with standards         68         23         9         Dysmull         12           87         converted copple>with standards         68         23         9         Dysmull         12           80         converted copple>with standards         71         18         21         Dysmull         6           91         converted copple>with standards         72         8         41         Hernimoder         12           93         converted copple>with standards         74         30         Hernimoder         <	65	converted coppice-with-standards	58	4	38	Dysmull	1
econverted coppice-with-standards         38         0         62         Dysmull         7           75         converted coppice-with-standards         79         11         10         Dysmull         13           77         converted coppice-with-standards         70         28         4         Oligomull         13           77         converted coppice-with-standards         72         21         7         Dysmull         12           83         converted coppice-with-standards         86         9         6         Dysmull         12           84         converted coppice-with-standards         88         6         7         Oligomull         12           90         converted coppice-with-standards         68         23         9         Dysmull         2           91         converted coppice-with-standards         50         1         48         Euroder         12           92         converted coppice-with-standards         50         1         48         Euroder         12           93         converted coppice-with-standards         51         3         53         Dysmull         6           101         converted coppice-with-standards         71         11         1	68	converted coppice-with-standards	51 80	9	49 11	Hemimoder	7
75converted coppice-with-standards701110Dysmull1377converted coppice-with-standards70264Oilgomull1279converted coppice-with-standards72217Dysmull1284converted coppice-with-standards86283Oilgomull1284converted coppice-with-standards86332Oilgomull1286converted coppice-with-standards867Oilgomull391converted coppice-with-standards88677Oilgomull292converted coppice-with-standards71128Heinmoder1293converted coppice-with-standards711821Dysmull694converted coppice-with-standards71821Dysmull695converted coppice-with-standards72841Heinmoder196converted coppice-with-standards733Dysmull6101converted coppice-with-standards7442Euroder8103converted coppice-with-standards7443Heinimoder1.5105converted coppice-with-standards54442Euroder8104converted coppice-with-standards54442Euroder8105converted coppice-with-standards54443Heinimoder1.5103	69	converted coppice-with-standards	38	0	62	Dysmull	7
76         converted coppice-with-standards         70         26         4         Oligonull         13           77         converted coppice-with-standards         66         19         Oligonull         12           84         converted coppice-with-standards         68         9         6         Dysmull         12           84         converted coppice-with-standards         68         9         6         Dysmull         12           87         converted coppice-with-standards         68         6         7         Oligonull         3           90         converted coppice-with-standards         68         6         7         Oligonull         2           91         converted coppice-with-standards         68         6         7         Dysmull         2           92         converted copice-with-standards         50         1         48         Eumoder         1           93         converted copice-with-standards         52         8         41         Hemimoder         1           94         converted copice-with-standards         53         Dysmull         6         1         14         1         1         1           95         converted copice-with-standards	75	converted coppice-with-standards	79	11	10	Dysmull	13
79         Converted coppice-with-standards         72         1         7         Dysmull         12           83         converted coppice-with-standards         69         28         3         Oligomull         12           84         converted coppice-with-standards         65         3         32         Oligomull         12           86         converted copice-with-standards         66         7         Oligomull         12           90         converted copice-with-standards         68         6         7         Oligomull         12           91         converted copice-with-standards         50         1         48         Eumoder         12           92         converted copice-with-standards         50         1         48         Eumoder         12           93         converted copice-with-standards         50         1         48         Eumoder         12           94         converted copice-with-standards         52         8         41         Hemimoder         12           101         converted copice-with-standards         71         11         18         Dysmull         6           102         converted copice-with-standards         71         11         1	76 77	converted coppice-with-standards	70 65	26 16	4 19	Oligomull	13
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84         converted coppice-with-standards         86         9         6         Dysmull         12           86         converted coppice-with-standards         82         10         28         Oligomull         12           87         converted coppice-with-standards         88         6         7         Oligomull         3           91         converted coppice-with-standards         71         1         28         Hemimoder         12           92         converted coppice-with-standards         71         8         21         Dysmull         6           93         converted coppice-with-standards         71         8         21         Dysmull         6           94         converted coppice-with-standards         71         8         21         Dysmull         6           100         converted coppice-with-standards         76         0         24         Hemimoder         1           101         converted coppice-with-standards         71         11         18         Dysmull         6           103         converted coppice-with-standards         71         11         18         Dysmull         3           116         converted coppice-with-standards         56         <	83	converted coppice-with-standards	69	28	3	Oligomull	12
action         converted coppice-with-standards         60         3         32         Originnull         12           90         converted coppice-with-standards         88         6         7         Oligonnull         3           91         converted coppice-with-standards         71         1         28         Hernimoder         12           92         converted coppice-with-standards         71         8         21         Dysmull         6           98         converted coppice-with-standards         71         8         21         Dysmull         6           99         converted coppice-with-standards         52         8         41         Hernimoder         1           100         converted coppice-with-standards         52         8         41         Hernimoder         1           101         converted coppice-with-standards         52         8         41         Hernimoder         1           102         converted coppice-with-standards         52         8         41         Hernimoder         1           103         converted coppice-with-standards         65         1         34         Hernimoder         8           114         converted coppice-with-standards <td< td=""><td>84</td><td>converted coppice-with-standards</td><td>86</td><td>9</td><td>6</td><td>Dysmull</td><td>12</td></td<>	84	converted coppice-with-standards	86	9	6	Dysmull	12
90         converted coppice-with-standards         88         6         7         Oligonull         3           91         converted coppice-with-standards         68         23         9         Dysmull         2           92         converted coppice-with-standards         50         1         48         Euroder         12           96         converted coppice-with-standards         52         8         41         Hemimoder         6           99         converted coppice-with-standards         52         8         41         Hemimoder         1           100         converted coppice-with-standards         55         1         34         Hemimoder         1           101         converted coppice-with-standards         76         0         24         Hemimoder         1           102         converted coppice-with-standards         63         7         30         Hemimoder         1.5           105         converted coppice-with-standards         54         4         42         Euroder         8           114         converted coppice-with-standards         56         23         21         Dysmull         3           115         converted coppice-with-standards         55	87	converted coppice-with-standards	62	3 10	32 28	Oligomull	12
91         converted coppice-with-standards         86         23         9         Dysmull         2           92         converted coppice-with-standards         50         1         48         Eumoder         12           93         converted coppice-with-standards         50         1         48         Eumoder         12           96         converted coppice-with-standards         71         8         21         Dysmull         6           97         converted coppice-with-standards         76         0         24         Hemimoder         1           100         converted coppice-with-standards         76         0         24         Hemimoder         1           101         converted coppice-with-standards         76         0         24         Hemimoder         1           102         converted coppice-with-standards         71         11         18         Dysmull         1           103         converted coppice-with-standards         71         11         18         Dysmull         3           114         converted coppice-with-standards         39         2         59         Hemimoder         7           115         converted coppice-with-standards         61	90	converted coppice-with-standards	88	6	7	Oligomull	3
92         Converted coppice-with-standards         71         1         2.8         Hemmoder         12           96         converted coppice-with-standards         71         8         21         Dysmull         6           98         converted coppice-with-standards         22         11         67         Dysmull         6           100         converted coppice-with-standards         45         3         53         Dysmull         6           101         converted coppice-with-standards         65         1         34         Hemimoder         1           102         converted coppice-with-standards         65         1         34         Hemimoder         1           103         converted coppice-with-standards         65         1         34         Hemimoder         1           106         converted coppice-with-standards         71         11         18         Dysmull         3           114         converted coppice-with-standards         54         4         4         2         Eumoder         8           114         converted coppice-with-standards         61         5         34         Hemimoder         7           117         converted coppice-with-standards	91	converted coppice-with-standards	68	23	9	Dysmull	2
96         converted coppice-with-standards         71         8         21         Dysmull         6           98         converted coppice-with-standards         52         8         41         Hemimoder         6           100         converted coppice-with-standards         45         3         53         Dysmull         6           101         converted coppice-with-standards         66         1         34         Hemimoder         1           103         converted coppice-with-standards         63         7         30         Hemimoder         12           106         converted coppice-with-standards         54         4         42         Euroder         8           109         converted coppice-with-standards         39         2         59         Hemimoder         12           116         converted coppice-with-standards         61         5         34         Hemimoder         7           117         converted coppice-with-standards         55         26         18         Mesomull         6           128         converted coppice-with-standards         55         26         18         Mesomull         9           131         converted coppice-with-standards         52	92 93	converted coppice-with-standards	50	1	28 48	Eumoder	12
98converted coppice-with-standards52841Hemimoder699converted coppice-with-standards221167Dysmull6101converted coppice-with-standards76024Hemimoder1102converted coppice-with-standards63730Hemimoder1103converted coppice-with-standards63730Hemimoder8104converted coppice-with-standards711118Dysmoder8105converted coppice-with-standards39259Hemimoder8114converted coppice-with-standards562321Dysmull2115converted coppice-with-standards63307Dysmull3116converted coppice-with-standards63307Dysmull3117converted coppice-with-standards65350Eumoder7128converted coppice-with-standards59437Hemimoder9130converted coppice-with-standards59437Hemimoder99133even-aged high forest1000Mesomull99134even-aged high forest98111Mesomull99135even-aged high forest9406Mesomull99144even-aged high forest9406Mesomull99135even-aged	96	converted coppice-with-standards	71	8	21	Dysmull	6
99         converted coppice-with-standards         22         11         67         Dysmull         6           100         converted coppice-with-standards         76         0         24         Hemimoder         1           101         converted coppice-with-standards         66         1         34         Hemimoder         2           103         converted coppice-with-standards         63         7         30         Hemimoder         1.5           105         converted coppice-with-standards         71         11         18         Dysmull         3           106         converted coppice-with-standards         39         2         59         Hemimoder         8           114         converted coppice-with-standards         66         23         21         Dysmull         3           115         converted coppice-with-standards         66         30         7         Dysmull         6           119         converted coppice-with-standards         55         26         18         Mesomull         6           128         converted coppice-with-standards         52         4         37         Hemimoder         9           130         converted coppice-with-standards         52 <td>98</td> <td>converted coppice-with-standards</td> <td>52</td> <td>8</td> <td>41</td> <td>Hemimoder</td> <td>6</td>	98	converted coppice-with-standards	52	8	41	Hemimoder	6
100         Converted coppice-with-standards         76         0         24         Hemimoder         1           101         converted coppice-with-standards         65         1         34         Hemimoder         1           103         converted coppice-with-standards         65         1         34         Hemimoder         1.5           105         converted coppice-with-standards         71         11         18         Dysmoder         8           106         converted coppice-with-standards         39         2         59         Hemimoder         8           114         converted coppice-with-standards         39         2         59         Hemimoder         8           114         converted coppice-with-standards         61         5         34         Hemimoder         7           117         converted coppice-with-standards         61         5         34         Hemimoder         7           128         converted coppice-with-standards         55         26         18         Mesomull         9           131         converted coppice-with-standards         32         0         68         Dysmull         12           133         even-aged high forest         100	99 100	converted coppice-with-standards	22 45	11	67 53	Dysmull	6
102         converted coppice-with-standards         65         1         34         Hemimoder         2           103         converted coppice-with-standards         63         7         30         Hemimoder         1.5           106         converted coppice-with-standards         54         4         42         Eumoder         8           109         converted coppice-with-standards         39         2         59         Hemimoder         8           114         converted coppice-with-standards         54         20         39         Dysmull         3           115         converted coppice-with-standards         56         23         21         Dysmull         3           116         converted coppice-with-standards         61         5         34         Hemimoder         7           117         converted coppice-with-standards         55         26         18         Mesomull         6           128         converted coppice-with-standards         52         26         18         Mesomull         9           131         converted coppice-with-standards         52         26         18         Mesomull         99           133         converted coppice-with-standards         52<	101	converted coppice-with-standards	76	0	24	Hemimoder	1
103       converted coppice-with-standards       63       7       30       Hemimoder       1.5         105       converted coppice-with-standards       71       11       18       Dysmoder       12         106       converted coppice-with-standards       39       2       59       Hemimoder       8         114       converted coppice-with-standards       61       23       21       Dysmull       3         115       converted coppice-with-standards       61       5       34       Hemimoder       7         119       converted coppice-with-standards       65       25       06       18       Hemimoder       8         129       converted coppice-with-standards       55       26       18       Mesomull       6         130       converted coppice-with-standards       55       26       18       Mesomull       9         131       converted coppice-with-standards       55       4       37       Hemimoder       2         132       even-aged high forest       100       0       0       Mesomull       9         133       eower-aged high forest       100       0       0       Mesomull       99         134       even-a	102	converted coppice-with-standards	65	1	34	Hemimoder	2
Index       converted coppice-with-standards       54       4       42       Eumoder       12         106       converted coppice-with-standards       39       2       59       Hemimoder       8         114       converted coppice-with-standards       39       2       59       Hemimoder       8         115       converted coppice-with-standards       66       23       21       Dysmull       3         116       converted coppice-with-standards       61       5       34       Hemimoder       8         119       converted coppice-with-standards       76       6       18       Hemimoder       7         129       converted coppice-with-standards       55       26       18       Mesomull       6         120       converted coppice-with-standards       55       26       18       Mesomull       9         130       converted coppice-with-standards       52       0       68       Dysmull       12         131       converted coppice-with-standards       52       0       68       Dysmull       9         133       even-aged high forest       100       0       0       Mesomull       99         133       even-aged high fore	103	converted coppice-with-standards	63	7	30	Hemimoder	1.5
109         converted coppice-with-standards         39         2         59         Hemimoder         8           114         converted coppice-with-standards         41         20         39         Dysmull         3           115         converted coppice-with-standards         66         23         21         Dysmull         3           116         converted coppice-with-standards         61         5         34         Hemimoder         7           119         converted coppice-with-standards         76         6         18         Hemimoder         7           128         converted coppice-with-standards         55         26         18         Mesomull         6           129         converted coppice-with-standards         59         4         37         Hemimoder         2           131         converted coppice-with-standards         52         0         68         Dysmull         12           132         converted coppice-with-standards         52         0         68         Dysmull         99           133         even-aged high forest         100         0         0         Mesomull         99           134         even-aged high forest         94         0	105	converted coppice-with-standards	54	4	42	Eumoder	8
114       converted coppice-with-standards       41       20       39       Dysmull       3         115       converted coppice-with-standards       66       23       21       Dysmull       2         116       converted coppice-with-standards       63       30       7       Dysmull       3         117       converted coppice-with-standards       61       5       34       Hemimoder       7         119       converted coppice-with-standards       55       26       18       Mesomull       6         128       converted coppice-with-standards       55       26       18       Mesomull       9         130       converted coppice-with-standards       52       0       68       Dysmull       12         131       converted coppice-with-standards       52       0       08       Dysmull       99         132       even-aged high forest       100       0       0       Mesomull       99         133       even-aged high forest       98       0       2       Hemimoder       99         134       even-aged high forest       94       0       6       Mesomull       99         144       even-aged high forest       20	109	converted coppice-with-standards	39	2	59	Hemimoder	8
115         converted coppice-with-standards         56         23         21         Dysmull         2           116         converted coppice-with-standards         63         30         7         Dysmull         3           117         converted coppice-with-standards         61         5         34         Hemimoder         7           119         converted coppice-with-standards         55         26         18         Mesomull         6           129         converted coppice-with-standards         55         26         18         Mesomull         9           130         converted coppice-with-standards         59         4         37         Hemimoder         2           131         converted coppice-with-standards         59         4         37         Hemimoder         9           132         even-aged high forest         100         0         0         Mesomull         99           133         even-aged high forest         100         0         0         Mesomull         99           134         even-aged high forest         84         0         6         Mesomull         99           140         even-aged high forest         84         0         6	114	converted coppice-with-standards	41	20	39	Dysmull	3
117       converted coppice-with-standards       61       5       34       Hemimoder       7         119       converted coppice-with-standards       76       6       18       Hemimoder       8         128       converted coppice-with-standards       55       26       18       Mesomull       6         129       converted coppice-with-standards       65       35       0       Eumoder       7         130       converted coppice-with-standards       59       4       37       Hemimoder       2         131       converted coppice-with-standards       32       0       68       Dysmull       12         132       even-aged high forest       100       0       0       Mesornull       99         133       even-aged high forest       100       0       0       Mesornull       99         134       even-aged high forest       98       0       2       Hemimoder       99         135       even-aged high forest       94       0       6       Mesornull       99         140       even-aged high forest       20       0       80       Mesornull       99         144       even-aged high forest       95       0 <td>115</td> <td>converted coppice-with-standards</td> <td>50 63</td> <td>23 30</td> <td>7</td> <td>Dysmull</td> <td>2</td>	115	converted coppice-with-standards	50 63	23 30	7	Dysmull	2
119         converted coppice-with-standards         76         6         18         Hemimoder         8           128         converted coppice-with-standards         55         26         18         Mesonull         6           129         converted coppice-with-standards         55         26         18         Mesonull         6           130         converted coppice-with-standards         59         4         37         Hemimoder         2           131         converted coppice-with-standards         59         4         37         Hemimoder         9           132         even-aged high forest         100         0         0         Mesonull         99           133         even-aged high forest         100         0         0         Mesonull         99           136         even-aged high forest         100         0         0         Mesonull         99           140         even-aged high forest         89         1         11         Mesonull         99           144         even-aged high forest         20         0         80         Mesonull         99           144         even-aged high forest         99         0         1         Oligonull<	117	converted coppice-with-standards	61	5	34	Hemimoder	7
128         converted coppice-with-standards         55         26         18         Mesonull         6           129         converted coppice-with-standards         65         35         0         Eumoder         7           130         converted coppice-with-standards         59         4         37         Hemimoder         2           131         converted coppice-with-standards         52         0         68         Dysmull         12           132         even-aged high forest         100         0         0         Mesomull         99           133         even-aged high forest         100         0         0         Mesomull         99           136         even-aged high forest         94         0         6         Mesomull         99           138         even-aged high forest         89         1         11         Mesomull         99           140         even-aged high forest         82         0         6         Mesomull         99           143         even-aged high forest         82         0         80         Mesomull         99           144         even-aged high forest         95         0         4         Oligomull <td< td=""><td>119</td><td>converted coppice-with-standards</td><td>76</td><td>6</td><td>18</td><td>Hemimoder</td><td>8</td></td<>	119	converted coppice-with-standards	76	6	18	Hemimoder	8
123         converted coppice-with-standards         55         6         Clinicitie         7           130         converted coppice-with-standards         59         4         37         Hemimoder         2           131         converted coppice-with-standards         52         0         68         Dysmull         12           132         even-aged high forest         100         0         0         Mesomull         99           133         even-aged high forest         100         0         0         Mesomull         99           136         even-aged high forest         94         0         6         Mesomull         99           138         even-aged high forest         84         0         6         Mesomull         99           140         even-aged high forest         84         0         6         Mesomull         99           143         even-aged high forest         20         0         80         Mesomull         99           144         even-aged high forest         94         0         6         Mesomull         99           144         even-aged high forest         94         0         6         Mesomull         99	128	converted coppice-with-standards	55 65	26 35	18	Mesomull	6
131       converted coppice-with-standards       32       0       68       Dysmull       12         132       even-aged high forest       100       0       0       Mesomull       99         133       even-aged high forest       100       0       0       Mesomull       99         135       even-aged high forest       98       0       2       Hemimoder       99         136       even-aged high forest       94       0       6       Mesomull       99         140       even-aged high forest       89       1       11       Mesomull       99         141       even-aged high forest       20       0       80       Mesomull       99         144       even-aged high forest       20       0       80       Mesomull       99         144       even-aged high forest       94       0       6       Mesomull       99         144       even-aged high forest       94       0       6       Mesomull       99         145       even-aged high forest       99       0       1       Oligomull       99         146       even-aged high forest       99       1       0       Mesomull       99 <td>130</td> <td>converted coppice-with-standards</td> <td>59</td> <td>4</td> <td>37</td> <td>Hemimoder</td> <td>2</td>	130	converted coppice-with-standards	59	4	37	Hemimoder	2
132       even-aged high forest       100       0       0       Mesomull       99         133       even-aged high forest       100       0       0       Mesomull       99         135       even-aged high forest       98       0       2       Hemimoder       99         136       even-aged high forest       100       0       0       Mesomull       99         136       even-aged high forest       100       0       0       Mesomull       99         138       even-aged high forest       89       1       11       Mesomull       99         140       even-aged high forest       62       0       38       Mesomull       99         141       even-aged high forest       20       0       80       Mesomull       99         143       even-aged high forest       94       0       6       Mesomull       99         144       even-aged high forest       94       0       6       Mesomull       99         145       even-aged high forest       99       0       1       Oligomull       99         146       even-aged high forest       99       1       0       Mesomull       99 <td>131</td> <td>converted coppice-with-standards</td> <td>32</td> <td>0</td> <td>68</td> <td>Dysmull</td> <td>12</td>	131	converted coppice-with-standards	32	0	68	Dysmull	12
135         even-aged high forest         98         0         2         Hemimoder         99           136         even-aged high forest         100         0         0         Mesomuli         99           136         even-aged high forest         100         0         0         Mesomuli         99           138         even-aged high forest         94         0         6         Mesomuli         99           140         even-aged high forest         83         1         11         Mesomuli         99           141         even-aged high forest         62         0         38         Mesomuli         99           143         even-aged high forest         94         0         6         Mesomuli         99           144         even-aged high forest         94         0         6         Mesomuli         99           145         even-aged high forest         95         0         1         Oligomuli         99           147         even-aged high forest         99         1         0         Mesomuli         99           148         even-aged high forest         76         0         24         Dysmuli         8           152 </td <td>132</td> <td>even-aged high forest</td> <td>100</td> <td>0</td> <td>0</td> <td>Mesomuli</td> <td>99</td>	132	even-aged high forest	100	0	0	Mesomuli	99
136         even-aged high forest         100         0         Mesomull         99           138         even-aged high forest         94         0         6         Mesomull         99           140         even-aged high forest         89         1         11         Mesomull         99           140         even-aged high forest         89         1         11         Mesomull         99           141         even-aged high forest         20         0         80         Mesomull         99           143         even-aged high forest         94         0         6         Mesomull         99           144         even-aged high forest         94         0         6         Mesomull         99           145         even-aged high forest         95         0         4         Oligomull         99           147         even-aged high forest         99         1         0         Mesomull         99           148         even-aged high forest         99         1         0         Mesomull         99           152         even-aged high forest         76         0         24         Dysmull         8           153         even	135	even-aged high forest	98	0	2	Hemimoder	99
138         even-aged high forest         94         0         6         Mesomull         99           140         even-aged high forest         89         1         11         Mesomull         99           141         even-aged high forest         62         0         38         Mesomull         99           143         even-aged high forest         20         0         80         Mesomull         99           144         even-aged high forest         94         0         6         Mesomull         99           144         even-aged high forest         95         0         4         Oligomull         99           145         even-aged high forest         99         0         1         Oligomull         99           147         even-aged high forest         99         0         1         Oligomull         99           148         even-aged high forest         99         0         24         Dysmull         8           152         even-aged high forest         100         0         Oligomull         5           155         even-aged high forest         89         0         11         Dysmull         8           156         eve	136	even-aged high forest	100	0	0	Mesomull	99
140         even-aged high forest         89         1         11         Mesomull         99           141         even-aged high forest         62         0         38         Mesomull         99           143         even-aged high forest         20         0         80         Mesomull         99           144         even-aged high forest         94         0         6         Mesomull         99           144         even-aged high forest         95         0         4         Oligomull         99           145         even-aged high forest         99         0         1         Oligomull         99           147         even-aged high forest         99         0         1         Oligomull         99           148         even-aged high forest         99         1         0         Mesomull         99           152         even-aged high forest         100         0         Oligomull         5           153         even-aged high forest         91         3         6         Oligomull         5           156         even-aged high forest         89         0         11         Dysmull         8           158         co	138	even-aged high forest	94	0	6	Mesomuli	99
143         even-aged high forest         20         0         80         Mesomuli         99           144         even-aged high forest         20         0         80         Mesomuli         99           144         even-aged high forest         95         0         4         Oligomuli         99           145         even-aged high forest         95         0         4         Oligomuli         99           147         even-aged high forest         99         0         1         Oligomuli         99           148         even-aged high forest         99         0         24         Dysmuli         8           152         even-aged high forest         100         0         Oligomuli         5           153         even-aged high forest         100         0         Oligomuli         5           156         even-aged high forest         89         0         11         Dysmuli         8           158         converted coppice-with-standards         76         8         16         Euroder         12           159         converted coppice-with-standards         55         23         22         Mesomuli         10           167 <t< td=""><td>140 141</td><td>even-aged high forest</td><td>89 62</td><td>1 0</td><td>11 38</td><td>Mesomuli</td><td>99 99</td></t<>	140 141	even-aged high forest	89 62	1 0	11 38	Mesomuli	99 99
144         even-aged high forest         94         0         6         Mesonull         99           145         even-aged high forest         95         0         4         Oligomull         99           147         even-aged high forest         99         0         1         Oligomull         99           148         even-aged high forest         99         1         0         Mesonull         99           152         even-aged high forest         76         0         24         Dysmull         8           153         even-aged high forest         100         0         Oligomull         5           155         even-aged high forest         91         3         6         Oligomull         5           156         even-aged high forest         89         0         11         Dysmull         8           158         converted coppice-with-standards         76         8         16         Eumoder         12           159         converted coppice-with-standards         55         23         22         Mesonull         10           160         converted coppice-with-standards         76         3         21         Dysmull         2	143	even-aged high forest	20	0	80	Mesomuli	99
14b         even-aged high forest         95         0         4         Oligomull         99           147         even-aged high forest         99         0         1         Oligomull         99           148         even-aged high forest         99         1         0         Mesornull         99           152         even-aged high forest         99         1         0         Mesornull         8           153         even-aged high forest         91         3         6         Oligomull         5           155         even-aged high forest         91         3         6         Oligomull         8           156         even-aged high forest         89         0         11         Dysmull         8           158         converted coppice-with-standards         76         8         16         Eumoder         12           159         converted coppice-with-standards         76         3         22         Mesomull         10           160         converted coppice-with-standards         76         3         21         Dysmull         2	144	even-aged high forest	94	0	6	Mesomull	99
148     even-aged high forest     99     1     0     Mesonull     99       152     even-aged high forest     99     1     0     Mesonull     99       153     even-aged high forest     100     0     0     Oligomull     5       155     even-aged high forest     91     3     6     Oligomull     5       156     even-aged high forest     89     0     11     Dysmull     8       158     converted coppice-with-standards     76     8     16     Eumoder     12       159     converted coppice-with-standards     55     23     22     Mesonull     10       160     converted coppice-with-standards     76     3     21     Dysmull     2	145 147	even-aged high forest	95 99	0	4	Oligomull	99 99
152         even-aged high forest         76         0         24         Dysmull         8           153         even-aged high forest         100         0         0         Oligomull         5           155         even-aged high forest         91         3         6         Oligomull         5           156         even-aged high forest         89         0         11         Dysmull         8           158         converted coppice-with-standards         76         8         16         Eumoder         12           159         converted coppice-with-standards         55         23         22         Mesomull         10           160         converted coppice-with-standards         76         3         21         Dysmull         2	148	even-aged high forest	99	1	0	Mesomull	99
153         even-aged high forest         100         0         0         Oligomull         5           155         even-aged high forest         91         3         6         Oligomull         5           156         even-aged high forest         89         0         11         Dysmull         8           158         converted coppice-with-standards         76         8         16         Eumoder         12           159         converted coppice-with-standards         55         23         22         Mesomull         10           160         converted coppice-with-standards         76         3         21         Dysmull         2	152	even-aged high forest	76	0	24	Dysmull	8
156     even-aged high forest     81     3     6     Uligomuli     5       156     even-aged high forest     89     0     11     Dysmuli     8       158     converted coppice-with-standards     76     8     16     Eumoder     12       159     converted coppice-with-standards     55     23     22     Mesomuli     10       160     converted coppice-with-standards     76     3     21     Dysmuli     2	153	even-aged high forest	100	0	0	Oligomull	5
158     converted coppice-with-standards     76     8     16     Eumoder     12       159     converted coppice-with-standards     55     23     22     Mesomuli     10       160     converted coppice-with-standards     40     6     53     Hemimoder     10       167     converted coppice-with-standards     76     3     21     Dysmuli     2	155	even-aged high forest	ฮา 89	о 0	ა 11	Dvsmull	5 8
159         converted coppice-with-standards         55         23         22         Mesomuli         10           160         converted coppice-with-standards         40         6         53         Hernimoder         10           167         converted coppice-with-standards         76         3         21         Dysmuli         2	158	converted coppice-with-standards	76	8	16	Eumoder	12
100         converted coppice-with-standards         40         b         53         Hemimoder         10           167         converted coppice-with-standards         76         3         21         Dysmull         2	159	converted coppice-with-standards	55	23	22 52	Mesomull	10
	167	converted coppice-with-standards	76	3	21	Dysmull	2

**Table 2.** Product-moment correlation coefficients between Humus Index,  $pH_{water}$  and main parameters describing stand and soil condition. Correlation coefficients were tested by t test. Significance levels are: \* = 0.05, \*\* = 0.01, \*\*\* = 0.001. Degrees of freedom = 94, except for stand age (46) and time from last thinning operation (82)

	Humus Index	pH <sub>water</sub>
Time from last thinning operation	0.10 NS	-0.27**
Age of the stand	0.73***	0.05 NS
Height of the three dominant trees	0.61***	-0.35***
Diameter at breast height of the three dominant trees	0.64***	-0.46***
Basal area	0.41***	-0.13 NS
% basal area occupied by beech	0.29**	-0.20 NS
% basal area occupied by hornbeam	0.21*	-0.16 NS
Wood standing crop	0.59***	-0.34***
Depth of the first enrichment in clay	0.43***	0.04 NS
Depth of the first clay-dominated horizon	0.47***	-0.05 NS
% clay	-0.21*	-0.31**
% silt	-0.19 NS	-0.40***
% sand	0.20 NS	0.38***
pH <sub>water</sub>	-0.39***	
рН <sub>кСI</sub>	0.12 NS	0.58***
Cation exchange capacity	-0.25*	-0.27**
Exchangeable Ca	-0.51***	0.45***
Exchangeable Mg	-0.38***	0.13 NS
Exchangeable K	-0.29**	-0.09 NS
Total exchangeable bases	-0.50***	0.39***
Base saturation	-0.61***	0.68***



- 2 Fig. 1















