Species diversity and area-relationships in Danish beech forests

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Abstract

The vascular flora of 62 Danish beech forests of eastern Jutland ranging in size from 1-445 ha, was investigated for species-area relations. Species richness reflecting total diversity, forest diversity, and of different habitat groups, were corrected for non-linearity by means of a log-log power function transformation and regressed to forest area. The transformed forest species diversity showed a negative relationship with forest area. It is highly questionable whether the often stated positive correlation between forest area and species number is valid when the total species numbers are corrected for the area-error. The often stated theorem that the larger the forest, the smaller the disturbance, is not valid in Danish broad-leaved forests. On the contrary, if the number of ruderals is taken as an indication of human disturbance, the correlation of area with the proportion of ruderals to all species and to forest species, both failed to detect correlation with area. This is probably due to the less intensive management regimes in small forests compared with larger forests. A substantially larger number of forest species is found in ancient forest than in middle-aged forest. This shows the great importance of forest continuity for the species diversity. Lists of indicator species for ancient and old broad-leaved forest are presented. The corrected species diversity value is recommended as a good nature quality indicator, to be used in comparative studies and for assessing biological quality for management and conservation actions.

Keywords: Disturbance; Fragmentation; Forest habitats; Indicator species; Species value

1. Introduction

The correlation between area and species richness has been stressed for over a century (de Candolle, 1855; Arrhenius, 1921; Gleason, 1922; Cain, 1938; Godall, 1952; Hopkins, 1955; Rice and Keling, 1955; Dony, 1963; Kilbum, 1966; Usher, 1979; Zacharias and Brandes, 1990; Wu and Vankat, 1991; Buys et al., 1994; Kohn and Walsh, 1994) although the explanations of this relationship have been questioned (Kelly et al., 1989). The understanding of this relationship is essential in biodiversity management and nature conservation, when limited resources may be used for either the conservation of many small or a few larger units. Traditional gradient theory (Whittaker, 1975) may be used to support the adoption of a smaller number of larger nature reserves, which would contain longer gradients, and thu s, contain more specific niches. Contradictory, Simberloff and Gotelli (1984) found from studies in the American prairie-forest ecotone that: (1) the total of several small sites tend to contain more species than do single larger ones of the same size; (2) no species are excluded from smaller sites; (3) small sites tend to have more species, and larger sites have fewer species than expected; and (4) rare species are more often found in small sites than larger ones.

These considerations are central to the science of nature reserve planning and conservation (Higgs and Usher, 1980). Yet, such issues have attracted little empirica! research in plant ecology, not to mention forest plants, either becau se adequate data on plant species are rarely available or, becau se these topics have been dealt with by landscape ecologists, considering all environmental heterogeneity a question of shape, numbers and distribution of homogeneous patches (Palmer, 1992).

The Danish flora is well-known, and most species have well described ecological affinities. The cumulative numbers of species, indicating historica(or geometrie properties of a forest, may be worthy of a detailed study. That may be in order to evaluate some of the views mentioned earlier in a Danish context, but also to see whether particular subsets of species respond in a similar way to different area, age or management.

Our objective here is to examine floristic rich ness of forests of different size, age, and disturbance, and to analyse whether particular species groups are related to the same forest characteristics as are the total pool of species.

2. Methods

2.1. Study area

The study area is situated in eastem Jutland, in the vicinity of Arhus, from the hilly area of Mols to Frijsenborg (UTM coordinates 554-597 E; 6218-6243 N). The area is a typical moraine landscape, mainly with calcareous and clayey till s (Alfisols and Luvisols). There are only a few lakes and ponds. Climate is mild, with annual average temperatures of about 8°C, and annual precipitation of 600 mm (Rasmussen et al., 1982; Jacobsen, 1989).

The vegetation of the study area has been affected by agriculture and forestry for centuries. The natura! forest vegetation is unknown, but few forests which have been left largely untouched for the last 100 years indicate that the area must have been covered by a mosaic of mixed-deciduou s oak and beech forest types. Important species in such forests may have been beech (*Fagus sylvatica*), oak (*Quereus robur*), elm (*Ulmus glabra*), birch (*Betula pendula*), maple (*Acer pseudoplatanus*), lime (*Tilia cordata*), holly (*!lex aquifolium*), wild cherry (*Prunus avium*), crab apple (*M alus sylvestris*) and many others. On the wetter soils, alder (*Alnus g lutinosa*) and ash (*Fraxinus excelsior*) probably prevailed. The forest edges were probabl y just as today dominated by hazel (*Corylus avellana*), spindle (*Euonymus europeaus*), hawthom (*Crataegus monogyna*) and guelder rose (*Viburnum opulus*).

The landscape is now dominated by arable land in which forest species are restricted to forest fragments of various size. Yet, the original ground flora often survives in smaller isolated parts of the forests. Furthermore, large areas of deciduous forest have been converted into uniform beech or coniferous monoculture s during the last 100 years.

2.2. *Field sampling*

Detailed lists of vascular plant species were compiled for 62 forests in 1995 (Appendix A). We define a forest as tal! tree vegetation of at least 1 ha size, with a total woody cover of at least 80%.

The age of the forests was determined with historica! maps, the studied forests divided into ancient (forest in 1789), old (forest in 1878) and young forests (forest in 1957). Data were collected in June and A ugu st. Most vemal species were excluded. At the first vi sit, 10 plots (10 X 10 m) were established by a stratified-random procedure and the species composition determined. In the forests smaller than 5 ha, only five plots were made. Yisual recognizance

Table 1
Categories of species, as defined in this study

Type	Characteristics
a	True forest species, found in the interior parts of the forests
b	Heliophilious forest species along forest edges, gaps, trails and roads
c	Hydrophilious species, growing in fens, bogs, but not in standing waters
d	Swamp species in wet ditches and other areas with temporarily standing water
e	Water plants of lakes, creeks, etc.
f	Heliophilious plants of dry roadside environments and grassy areas within the forest, bul not ruderals
g	Heliophilious ruderals along trails and roads
h	Shade-tolerant ruderals in darker environments of the forest
	Naturalised garden escapes
j	Forest species on humid (but not wet) rich soils along trails, roads and natura! clearings
k	Seedlings of planted coniferous trees
	Plants of open, dry, man-made, clear-cut clearings
m	Planted trees and shrubs (ornamentals)

was subsequently used to determine the presence of low-density and rare species.

2.3. Data analysis

The species identified were divided into groups (Table 1) by their habitat preferences (Hansen, 1981; Mosberg et al., 1992). As species may have wide ecological affinities, occurring also outside forests, the species were assigned uniquely to one group, based on the ecological conditions found in the forests. For instance, several of the ruderate species may also be found in pioneer communities outside the forests.

Table 2
Regression coefficients between corrected species diversity value *c* vs. log forest area

Abbreviation	Habitat affinity/species type	*z*	*r*	*p*	Number of species
	Regression of corrected species richness of species groups vs. log forest area				
a	Interior forest species	0.12	0.03	ns	48
b	Forest edge	0.07	0.05	ns	85
c	West areas	0.14	0.09	ns	36
d	Swamps	0.23	0.16	ns	46
e	Lakes, ponds, creeks	-0.0004	0.18	ns	5
	Grassland	0.36	0.06	ns	56
g	Heliophilious ruderale	0.38	0.03	ns	34
h	Other ruderale	0.3	0.13	ns	54
	Aliens	0.02	0.17	ns	26
j	Heliophilious forest of humid soils	0.12	0.04	ns	31
k	Alien conifers	0.02	0.23	ns	9
	Clearings	0.17	0.02	ns	7
m	Ornamentals	0.05	0.26	ns	10
F = a + b + j	Forest	0.11	-0.83	0.0001	165
S	All species	0.16	0.07	ns	447
R (g + h)	Ruderals	0.37	0.1	ns	
F/S	Proportion forest species of all species	-0.06	0.01	ns	
	Disturbance and density measures vs. forest area, etc.				
(f + g + h)/S	Proportion ruderals to all species	0.15	0.99	0.0001	
(f + g + h)/F	Proportion ruderals to forest species	0.21	0.02	ns	

See Table 1 for explanations of categories of species groups.
ns: Non-significant correlation.

It may be added, that we consider ruderals as plant species that often indicate high nutrient contents, high stress and little competition, as the result of human activity (disturbance). In forests, ruderals are therefore indicators of disturbed soils, such as on roads and trails, along tracks, built-up areas, etc.

The correlation between species numbers in the various groups and the area of forests were analysed by applying the procedure described by Rosenzweig (1996) in which the parameter c of the algorithm: S = cA : is calculated, S being the species number, c a parameter indicating species richness, corrected for the area-error, A is the area studied, and z the slope of the line in a log-log plot of species and area. Thus, when the z value has been found for each individual forest, the c value may likewise be calculated. We shall call this the area corrected species richness value (c). The relation between c, log area and age of forests was subsequently analysed by applying a linear regression of the type $y = ax + b$.

3. Results

3.1. Overall species diversity and area

In total, 447 species were recorded, the species richness ranging from more than 150 in some large forests, to fewer than 50 species in small forests of only a few hectares. The average species number in the forests studied was 90 species. Yet, the species value c, if regressed to the Jog-area (Appendix A), showed no significant pattem (Table 2).

Forest species richness, as defined as the sum of interior, edge and heliophilious species, amounts to 165 species, which is similar to findings of Peterken and Game (1984) who found 183 species in 79 forests in Lincolnshire, UK. The relationship between forest species value and area was negative. The ratio of forest species to all species (F:S) was Jargest in the smaller forests, i.e., relatively more forest species were found in smaller forest (Table 2), but when corrected for area-error, no relationship was detectable.

Table 3
Number of species found in ancient, old and young forests in this study. Regression of c vs. age, $r = 0.29$, $p = 0.02$

Age of Forest	Ancien!	Old	Young	All
Class	< 1789	– 1878	– 1957	
Number of forests	51	10	3	64
Number of Forest species	162	117	61	164
Number of exclusive species	47	1	0	

Table 4
Rare Forest species occurrence in 3-10 forests (of 64 studied) and type of habitat group

Species	Category	Occurrence
Blechnum spicant	a	3
Listera ovata	a	4
The/ypteris ph egopteris	a	4
Gymnocarpium dryopteris	a	6
Actaea spicata	a	8
Aesculus hippocastanum	a	10
Agrimonia eupatoria	b	3
Alliwn scorodoprasum	b	3
Carex strigosa	b	3
Primula veris	b	3
Hieracium umbellatum	b	3
Prunus cerasifera	b	3
Rhamnus cathartica	b	4
Allium cleraceum	b	5
Calluna vulgaris	b	5
Polypodium vulgare	b	5
Adoxa moschatellina	b	5
Anthoxanthum odoratum	b	5
Vacciniwn myrtillus	b	5
Geranium sylvaticum	b	6
Hypericum hirsutwn	b	7
Acer campestre	b	8
Solidago virga urea	b	8
Melampyrum pratense	b	9
Carex leporina	b	10
Carex pallescens	b	10
Lysimachia nwnmularia		3
Phyteuma spicatum		3
Lysimachia nemorum		4
Ranunculisji caria		4
Pulmonaria obscura		8
Stellaria nemorwn		10
lmpa tiens par vijlora		10

For group types, see Table 1.

3.2. Habitat species groups and area

The species richness value (c) for true forest species (category a), species of forest edges, trails and roads (category b), heliophilious and humid environments (category j), swampy areas (category d), wet areas (category c), true water plants (category e), grassland species (category f), clearings (category l), ruderates (categories g and h) and alien species (categories i, k and m) all failed to be correlated with forest area.

3.3. Area and age

If forest species diversity is compared with ancient, old and young forests, markedly more species are found in the oldest forests, and fewest species in the young (Table 3). The regression of the corrected

Table 5
Ancient forest species indicators from this study, and some other countries: Germany, United Kingdom, Belgium, Poland and Czech Republic

Species name	Freq. DK/%	Germ	UK	Belg	Pol	Czec
A. campestre	15.7			+	+	+
A. moschatellina	9.8	+	+		+	
A. eupatoria	5.9					
A. scorodoprasum	5.9					
Arum alpinum	3.9					
Berberis vulgaris	2	+				
B. spicant	5.9					
Calamagrostis arundinacea	3.9					
Calamagrostis epigeios	2		+			
Cardamine dentaria	3.9					
C. strigosa	5.9	+	+			
Carpinus betulus	3.9					
Circaea alpina	3.9	+				
Equisetum pratense	2					
Festuca rubra	3.9					
Fragaria vesca	21.6		+	+		
G. sylvaticum	11.8					
G. dryopteris	13.7					
Hepatica nobilis	2	+			+	+
H. hirsutum	13.7	+	+			+
I. aquifolium	3.9	+				
Lamiastrum galeobdolon	3.9	+	+	+	+	
Lathyrus montanus	3.9	+	+			
Lathyrus niger	3.9					
Luzula sylvatica	2	+	+			
Lysimachia nemorum	7.8	+	+		+	
Lysimachia nummularia	5.9					
Melampyrum cristatum	3.9					
M. pratense	17.6	+	+	+		
Melica nutans	2	+	+	+	+	
Myosotis sylvatica	3.9					
Neottia nidus-avis	2	+	+		+	+
Orchis mascula	3.9	+	+			
P. spicatum	5.9	+		+		+
Potentilla sterilis	2	+	+			
P. veris	5.9					
Prunus serotina	3.9					
R. ficaria	7.8					
Salix pentandra	2					
Solidago virgaurea	15.7			+		
T. cordata	2		+			
Vicia sylvatica	2		+			

value c, on forest age, shows the same pattem . Simberloff and Gotelli (1984) suggested that smaller sites are not excluded from having any of the species of the larger sites, and that rare species are more often found in smaller sites than in larger sites. If rare forest species are defined as species occurring in 3-10 forests, 28 rare species are found in 53 forests (Table 4). Most of the forests contain only one rare species, but Kal0 Ringelmose contains 14 rare species. The regressions of c to area, and to age, showed no relationship.

3.4. Disturbance and area

Two measures of disturbance were applied, firstly, the ratio of ruderal and grassland species to all species (S), and then only the number of forest species (F) regressed to log area. The first of these measures was related to area (TabIe 2). Janzen (1983) claimed that there is an increase in interference from outside with decreasing size, but the opposite may be the case in Denmark , where the forest size largely deterrnines its management and thus, its ecological status. Small and undrained forests are often left without much management. Occasional logging of valuable trees may occur, but the removal of dead wood only, for fuel-wood, is more common. The bigger forests are usually well-managed, with draining and road-buildings, thus causing some disturbance.

3.5. Indicators of ancient forest

The age of forest and thus, its continuity, has been shown to be of prime importance for species richness in Belgium (Herrny et al., 1993) and UK (Peterken and Game, 1984; Peterken, 1996). If forest species found only in the ancient forests are examined, a list of 42 species emerges (Table 5). Several species are indicators of ancient broad-leaved forests in Poland, UK, Belgium and Denmark. They are, e.g" *A. campestre, A. moschatellina, L. galeobdolon, M. nutans, N. nidus-avis, M. pratense* and *P. spicatum*.

Species often mentioned in the literature on ancient forests are *Anemone nemorosa, Convallaria majalis, Melica uniflora, Mercurialis perennis* (Peterken and Game, 1 981), *Paris quadrifolia, Primula elatior* and *Sanicula auropaea*, but these are not restricted in their distribution in Denmark but found in the majority of the studied forests.

3.6. Indicators of old forest

A total of 34 species have their highest frequency in old forest (Table 6). It may be noted that *A. pseudoplatanus, A. sylvestris, F. excelsior* and S. *nigra* are abundant.

Table 6
Old forest species indicators, and frequency in percent, in the total number of forests studied

Species name	Frequency
Acer pla1anoides	40
A. pseudopla1anus	100
A. spicma	30
A. oleraceum	10
Aruhriscus sylves1ris	100
A1hyriumfilix-femina	70
Brachypodium sylvmicum	30
Bromus benekeni	10
Calluna vulgaris	10
Campanula lalifolia	40
Campanula /rachelium	70
C. *monogyna*	70
Daclylis polygama	90
Deschampsia caespilosa	90
Epipac1is helleborine	60
F. excelsior	100
Malus syluestris	40
Milium ejfusum	90
Poa nemoralis	80
Polygonatum multijlorum	80
Polygonatum uerticillatum	20
Prunus padus	30
Prunus spinosus	70
Ranuncu.lus auricomus	30
Ribes rubrwn	70
Rwnex sanguineus	90
Sambucus nigra	100
S. europaea	60
Silene dioica	70
Sorbus aucuparia	80
Stachys sylues1ris	90
U. glabra	90
Veronica chamaedrys	80
V. opulus	70

4. Discussion

The species richness of forests seems to be a function of area and of species group when only the species numbers are exarnined. However, when the species richness has been corrected for difference in the sampling area, few species groups show a significant pattem with forest size. Indeed, *only* the group of forest species consistently shows a negative relationship with forest area. All other groups, in addition to the total number of species, fail to detect a pattem.

The most unlikely result from a theoretica] perspective is that the forest species value tended to decrease with increasing forest size. This relates to the forest management ; the larger forests are heavily managed and while they tend to contain most species in total, the high levels of disturbance can be tolerated by relatively fewer forest species. In contrast, the smaller forests have been disturbed to a much Iesser extent, and have a relativdy high proportion of forest specialists, including ancient forest indicator species. This is sirnilar to findings in English forests in Shropshire, by Helliwell (1976).

One implication is that the effects of woodland fragmentation on plant distribution in Denmark may be an over-emphasized phenomenon, and the species of Danish beech forests seem to rely on forest characteristics. Most forest fragmentation happened several centuries ago, and according to island biogeography theory (MacArthur and Wilson, 1967; Levenson, 1981; Harris, 1984), small islands of forest should have lost some of their species. However, the effects of fragmentation may not be detectable for plant species; for example, local extinction and imrnigration rates of some species are too slow, and other forest species have developed mechanisms for medium-distance dispersal (Middleton and Merriam, 1983). Fragmentation, not exceeding that medium distance, would then not result in the loss of species. Forest patches should therefore not be regarded as 'islands', at least not in the time-scale applied in most studies, such as ours.

Our study indicates that other features aside from forest area, such as the forest habitat characteristics, may play the most important role, in accordance with the Habitat Diversity Hypothesis (Hamer and Harper, 1976; Connor and McCoy, 1979; van der Werff, 1983) predicting a relationship between species- and habitat-diversity. In the larger forests in our study, the intensity of management is higher, causing more disturbance, and thus, more habitats. This seems to explain the higher number of species in general in the largest forests, and high c-values. However, if the numbers of forest species and the corrected c-values for forest species are studied, it will show that the same disturbance which is favorable to the genera] species richness is negatively affecting the forest species richness.

It is clear that plant richness, and probably biodiversity in genera!, depends more on the range of habitats, and thus, of environmental variation in a forest, than its actual area, shape or isolation. The conservation of plant biodiversity in Danish forests on the basis of forest area alone would therefore not be prudent. Smaller forests may also merit management measures for biodiversity conservation . It is clear that smaller forests, with rich plant communities which have persisted due to a high degree of habitat continuity and little disturbance, should be protected , as well as such smaller fragments within larger forests. The value of corrected species richness applied here, c, may well be taken as a nature quality or biodiversity indicator. The corrected species value is recommended for comparative biodiversity studies and for assessing biological habitat quality. It may, with benefit , be used to asses the general species richness, as well as the value for particular groups of species, such as rare species or forest species. The traditional way of examining biodiversity, i.e., comparing untransformed area and species numbers, is much biased, as shown by Rosenzweig (1996) and exemplified in our study. The value of species richness corrected to area, should thus always be the basis of any evaluation of nature quality and management .

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Appendix A. Forest locations, number of species in ecological groups, number of forest species, all species, area of forests studied and the c -values as calculated for all species (S) and forest species (F)

Forest Locality	Area (ha)	Registration year	Habitat Groups a	b	c	d	e		g	h			k		m	Richness S	F	Corrected values C (S) z = 0.16	C(F) z = 0.11
Ab i/ dhoved	18.7	1875	18	38	17	8		5	8	II		17	4	2		129	73	18.497	19,21
Amerika Skov	3.6	1876	10	12	3			2	1	2		6		2		39	28	7.279	8,83
Ba/ skov Skol'	56.6	1875	22	35	16	5		II	6	4		14		2		117	71	14.052	16,54
BNdstrup Skov V	5.7	1789	25	36	21	8	2	7	2	4	3	16		1		125	77	21.676	23,09
BNdstrup Skov @	2.7	1789	19	34	14	2		4	3	1		14		2		93	67	18.175	21,81
Essig Bjerg	1.3	1875	15	23	2				1	1		5		1		49	43	10.764	15,17
Estrupbirke	80.4	1789	27	34	19	13		12	10	7		18		3		144	79	16.35	17,70
Fa urskovho/t	38.1	1876	27	20	6	2		5	4	3		8		2		77	55	9.852	13,38
Foldby Enemcerke	52.1	1789	24	26	7	3		7	4	3		14		2		91	64	11.075	15,04
Frijsendal Bakk er	98.0	1789	26	21	7	4		6	4	5		8		1		84	55	9.24	12,06
Gedehave	8.5	1789	16	7	2					1		5		2		35	28	5.693	8,03
Cl. Dy rehave	158.0	1789	22	17	4	4		17	16	10		9		5		104	48	10.599	9,99
Ha/ling Skov	69.5	1789	29	29	11	12	2	II	10	12	3	9		4		133	67	15.457	15,26
H araldslund	57.2	1789	25	28	II	5		3	2	2		14	2	2		94	67	11.271	15,59
Harriis Skov	42.5	1789	26	32	17	6		9	9	7		14		3		125	72	15.717	17,31
H a vskov	80.0	1789	21	33	8	5		3	4	6		11		2		94	65	10.682	14,57
H}l?rret	9.1	1875	25	33	18	8		3	2	2	2	13		2		108	71	17.377	20,22
H orsehave	20.8	1789	17	20	3	1		2	2	2		9		2		58	46	8.176	11,96
H oulbjerg Skov	331.7	1789	32	34	18	9		12	10	10	2	18		4		150	84	13.576	16,11
H vorslevgard Skov	83.7	1789	30	29	16	10		11	13	12		17		4		145	76	16.358	16,96
H ar Skov	11.7	1789	25	30	6	3		9	5	7		15		3		103	70	15.919	19,39
Kali? H estehaue	172.4	1789	28	49	25	18		16	18	9		19	5	4		192	96	19.295	19,78
Kastrup Skov	22.5	1789	24	32	19	8			9	8		14		2		117	70	16.287	18,05
Kildedal / Ha111111el Skov	55.3	1876	17	15	5	5		14	6	8		4		2		77	36	9.282	8,41
Klokkerho/111 Skov	30.9	1789	29	39	14	8	2	7	12	9		17		3		142	85	18.789	21,16
Krann estrup Skov	17.6	1789	23	21	8	5		1	2	3		II		2		77	55	11.148	14,57
Kcottrup Skou	42.3	1876	24	27	18	10		3	4	4		II		3		106	62	13.338	14,91
Linda Skou / Balie SkOL'	13.6	1789	17	22	12	3		2	2			8		2		69	47	I0.411	12,81
Lisbj erg Skov	186.0	1789	31	32	18	II	2	6	8	9		14		4		135	77	13.403	15,73
Ly 11gsbcekgaard Dy rehave	21.8	1789	20	20	3	1		4		3	2	12		2		68	52	9.514	13,45
Ly 11gsbcekgaard Plantage	61.6	1952	22	14	3			3	3			3	2	2		53	39	6.28	9,00
Lynga Skov	58.7	1789	25	33	12	5		II	10	13		18		2	2	131	76	15.642	17,63
Lystrup Sl?nderskov	6.8	1789	15	25	4			1	4	1	3	7		2	2	64	47	10.789	13,82
Myg ind Skov	183.3	1789	23	29	3	3		8	9	5		15		3		100	67	9.952	13,71

Norringure	235.8	1789	32	35	18	8		9	10	7		18		4	2	145	85	13.86	16,92
Nr/!rreriis Skou	128.3	1789	25	21	5			8	10	5		14		2		92	60	9.693	12,77
0111111estmp	6.2	1876	17	33	12	4		2	I	1		16				87	66	14.885	19,61
Pyntskoi·en, Vosncesgard	32.4	1789	21	33	5	2		2	5	5		12	2			90	66	11.818	16,35
Pf/Jtmf/Jl/e Skou	158.3	1789	27	29	16	4		4	7	6	2	15		3		113	71	1 1.512	14,77
Ring/111ose Skou	170.6	1789	30	51	21	17		7	13	11	5	21	3	3	2	184	102	18.523	21,04
RisskoL'	80.6	1789	27	45	13	9		20	8	14	6	15	3	2	4	167	87	18.954	19,49
RodskoL' Skou	25.4	1789	24	35	10	Il		11	10	9	2	15		3		132	74	18.022	18,82
Rosenho/111 Skou	340.6	1789	30	35	15	11	2	18	8	8		18	2	4	2	153	83	13.789	15,87
Rf/!dkrers ig	4.6	1789	25	38	19	9		6	6	II		15		2		134	78	24.047	23,94
Sandby Nf/Jrreskou	13.1	1789	18	20	3				3			Il		1		57	49	8.652	13,41
Sandby Sonderskou	34.1	1789	29	35	20	9		8	6	13		17	2	3		142	81	18.495	19,95
Saumf/Jl/e Skou	130.6	1789	22	34	II	5		5	4	2		16	1	2		102	72	10.716	15,30
Skouhaue, Mf/J/lerup	6.9	1789	18	24	4			2	2	4		8	2			65	50	10.932	14,68
Skra/d Skou	90.6	1789	29	37	20	18		14	II	14		20		4		170	86	18.937	19,02
Skorupgard Skou	52.6	1789	24	30	10	8		6	9	10		14		2		115	68	13.975	15,97
Sofie-A111a/iegard Skou	445.7	1789	28	30	17	14		9	8	7	3	19				138	77	l1.913	14,29
Sortemose	10.9	1789	20	24	II	4		2	2	2		10		2		78	54	12.193	15,08
Strerkrer	16.0	1789	21	35	13	5		2	4	5		20	2	2		110	76	16.171	20,34
Sf/J/und / Hadsten Skou	98.7	1789	26	26	16	8		8	5	8		14		3		117	66	12.856	14,46
To/10/1 Skou	81.2	1878	26	37	22	10		9	12	7		18		3		145	81	16.438	18,13
Tornholm	8.2	1789	21	33	14	2		3	2	7		13				96	67	15.706	19,30
Treskel Bakke	3.1	1789	21	30	13	4			2	5		Il		1		88	62	16.822	19,88
Udhf/!}2	1.1	1952	12	17	8	3		2	3	4		6		2		57	35	12.86	12,58
Ulstrup Buske	25.1	1789	25	19	7	5		4	3	3	2	13		2		83	57	11.354	14,52
Vesterskou, Mf/!l/erup	53.0	1789	24	41	17	13		II	12	14		16		3		151	81	18.327	19,00
Vind Skou	45.6	1789	30	28	3	3		Il	10	6	2	5		2		101	63	12.557	15,03
Vrangstrup-H aurum Skou	204.1	1789	30	26	11	9		4	10	6		13		3		113	69	11.604	13,96

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The ecological groups are: (a) true forest or interior; (b) heliophilious forest species occurring along forest edges, gaps, and trails and roads; (c) hydrophilious species, growing in fens and bogs; (d) swamp species in wet ditches and other areas with temporarily standing water; (e) water plants of lakes, creeks etc; (f) grassland species; (g) heliophilious ruderals along trails and roads; (h) shade-tolerant ruderals; (i) naturalised garden escapes; (j) forest species on humid (but not wet) rich soils along trails, roads and natura! clearings; (k) seedlings of planted coniferous trees; (1) plants of man-made clearings; (m) planted trees and shrubs (ornamentals). Categories a, b and j are considered as forest species.

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