

Biodiversity and trees outside forests

The case of Denmark

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5.2.2 Biodiversity and trees outside forests: The case of Denmark²⁷

In Denmark, 12% of the forest covered area is distributed as larger and smaller patches of forest mixed with other habitat types in the landscape. Especially for countryside planning purposes there is a growing need for better integration of the monitoring of forest biodiversity and of biodiversity related to wooded areas within open land.

Both the Danish National Forest Inventory and Countryside Surveys are based on a principle of spatial representativity, in contradiction to the traditional conservationist point of view focusing on monitoring of species or areas of special interests, typically threatened habitats. However, where the NFI is based on a regular, fixed or moving grid, with regularly distributed samples, countryside surveys are normally based on a stratified sampling scheme on a regional base. Different goals explain this difference in methodological approach. Where forest surveys traditionally concentrate on variations in productivity of different places (emphasis on topological characteristics), countryside surveys are more focused on the landscape level (with emphasis on geographical differences due to chronological connections within heterogeneous land units).

The tradition of landscape surveys, which are based on stratified sampling, are from a practical point of view closely related to the recognition of the obvious differences in spatial variation within different sub-regions, as well as to the complex, time-consuming (and therefore expensive) surveys that forces the sampling intensity to be kept at an absolute minimum. In many applications, one might question the statistical representativity and rather consider the sample to represent a good expert-based selection of different landscape complexes. It is surprising that when different stratified countryside surveys in Europe are compared, a very similar percentage-coverage of the sampling (0.2-0.3 %) can be found (Table 22).

Table 22. *Sample-coverage of stratified landscape-monitoring in different countries.*

	United Kingdom*	Austria	Sweden	Denmark
Total area monitored (km ²)	244 019	83 850	449 740	43 044
Number of plots	1197*	200	918	32
Sample area (km ²)	726	200	918	128
Sample-area in % of total area	0.30	0.24	0.20	0.30

*sample comprising 569 one km²-plots in England, Scotland and Wales, and 628 ¼ km²-plots in Northern Ireland.

Due to the low sampling ratio one has to be very careful with the sampling procedure and interpretation of results. The sampling can be extended during the time, as has been done

²⁷ Compiled by Jesper Brandt, Esbern Holmes and Hans Peter Ravn

both in the UK and in Denmark. However, it is very important to keep the same samples through subsequent surveys to ensure that real changes in the landscape are registered.

In Denmark, landscape surveys have been carried out every five years since 1981. The surveys started in the Eastern part of the country with 13 four-km²-plots, extended in Eastern Jutland to 26 four-km²-plots in 1986 and, finally, up to a national coverage of 32 plots in 1991 (Figure 15).

The main purpose of the countryside survey in Denmark has been to quantify the suspected monotonisation of the agricultural landscapes due to the industrialisation process in Danish agriculture since the 1960's. The amount of small landscape elements was considered as a good indicator for this purpose, and emphasis has therefore been put on the development of a strict reproducible methodology for monitoring such landscape elements. These small landscape elements are divided into linear biotopes comprising hedgerows, stone- and earth dikes, road verges, field divides, ditches, brooks, channels and rivers, and area biotopes comprising of woodlots and small plantations, solitary trees, permanent herbaceous cover, prehistoric barrows, bogs and lakes.

A marked decrease in the number and area of small biotopes could be observed in the Danish landscape between 1969 – 1985 (Table 23), *i.e.* during a phase characterised by a rapid intensive industrialisation of agriculture. The length of hedges, dykes, ditches, field divides, road verges and other linear biotopes was reduced by 0.6% every year from 1954 to 1968 and by 2.3% from 1968 to 1981. This means that the total length of these biotopes were reduced by about 26% just within these 13 years. The reduction in the number of patch biotopes also increased during this period.

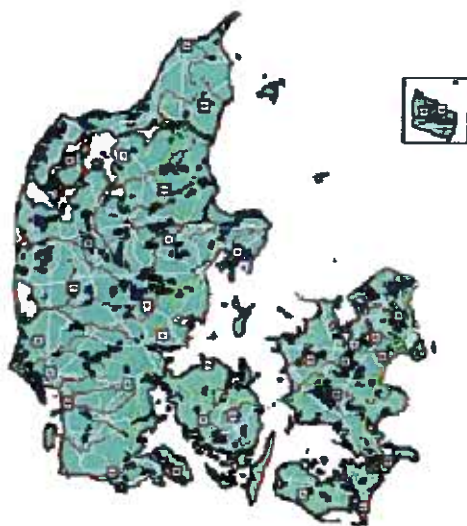


Figure 15. The location of the 32 test sites of four km², which were surveyed in the Danish monitoring programme.

Table 23. The net rate of changes per year of linear and area biotopes in five test areas in Western Denmark (20 km²) during the period 1954-1996 (Brandt and Holmes 2001).

	1954-68	1968-81	1981-86	1986-91	1991-96
Number of years in each period	14	13	5	5	5
LINEAR BIOTOPES*					
% change in length, per year	-0.6	-2.3	-1.3	-1.3	0.9
% change in area, per year	•	•		-2.9	2.5
AREA BIOTOPES**					
% change in number, per year	-0.5	-0.8	-0.8	-0.8	0.3
% change in area, per year	•	•		3.0	1.7

* Linear biotopes comprise hedgerows, stone- and earth dikes, road verges, field divides, ditches, brooks, channels and rivers.

** Area biotopes comprises woodlots and small plantations, solitary trees, permanent herbaceous cover, prehistoric barrows, bogs and lakes.

However, this development changed again during the 1990's. The general trend is now an increase in all types of small biotopes except in wet patch biotopes. Similar trends – both

the dramatic reduction during the 1970's and the increase during the 1990's have been observed in the UK (Haines-Young *et al.* 2000) and in other European agricultural landscapes, with many regional and local variations.

The amount of trees as part of open agricultural landscapes shows similar trends than the that of small biotopes. However, an increase in the wood cover of the agricultural areas could be observed in Denmark as early as the end of the 1970's. This increase was then accelerated during the last part of the 1980's (Table 24).

Table 24. Development of trees and small wooded patches in agricultural areas in Denmark during the period 1981-1996 (after Brandt *et al.* 2001).

	1981	81-86	1986	86-91	1991	91-96	1996
EASTERN PART OF DENMARK (13 PLOTS)							
<i>Solitary trees (number/km²)</i>	0.75	+16%	0.87	+29%	1.12	+19%	1.33
<i>Woods, plantations etc. (number /km²)</i>	1.31	+5%	1.38	+36%	1.88	+18%	2.21
<i>Woods, plantations etc. (Area - %)</i>	1.22	+2%	1.25	+34%	1.68	+10%	1.85
<i>Hedgerows (length - m/km²)</i>	1310	-2%	1290	+6%	1370	+2%	1400
<i>Hedgerows (Area - %)</i>	0.51	-6%	0.48	+6%	0.51	+6%	0.54
<i>Tree rows (length - m/km²)</i>	130	+8%	140	0%	140	21%	170
DENMARK (32 PLOTS)							
<i>Solitary trees (number/km²)</i>					0.84	+32%	1.11
<i>Woods, plantations etc. (number/km²)</i>					1.89	+12%	2.12
<i>Woods, plantations etc. (Area - %)</i>					1.80	+8%	1.95
<i>Hedgerows (length - m/km²)</i>					2010	+1%	2030
<i>Hedgerows (Area - %)</i>					0.65	+5%	0.68
<i>Tree rows (length - m/km²)</i>					140	+29%	180

A distinction between the development of wooded areas within the agricultural land and the real forest development should be made: Indeed, an increase in the forested area in Denmark can be observed. This is closely related to an afforestation policy striving to double the forest area of Denmark (from the present 12 %) within the next tree generations. This increase, however, does not necessarily give rise to a higher density of wooded land in the remaining agricultural areas.

Based on the Danish countryside survey, detailed land cover maps can be produced. These show the distribution of crown cover in each of the monitored 32 areas for each registration year (see Figure 16). The distribution of wooded cover on different land cover categories can be calculated, and maps showing the spatial distribution or it's changes can be produced. For instance, the average forest percentage (NFI-definition) in the test area "Tågerup" increased from 2.8 % in 1991 to 3.4 % in 1996 (Figure 16).

Concurrently, the average percentage of crown covered area increased from 8.0 to 8.5 % and the average percentage of crown covered area outside forest from 6.2 % to 6.5%. Hardly any of the crown covered area was included in the category 'Other wooded land' of the TBFRA-2000 assessment.

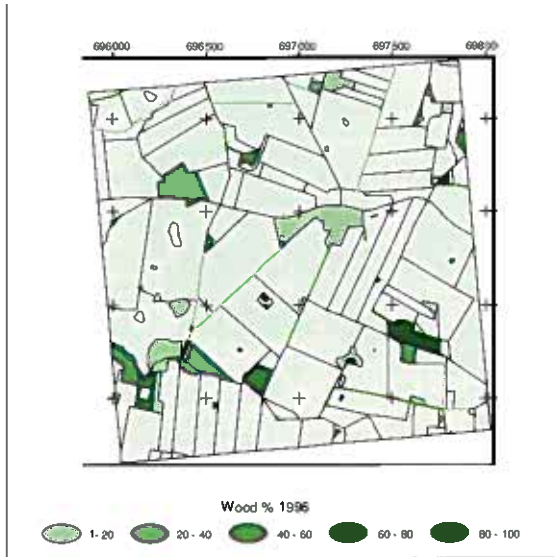


Figure 16. The crown cover percentage of all landscape elements in the test area "Tågerup" (4 km²) in 1996. The matrix colour represents areas without any wooded cover.

In Table 25, statistical information on different land cover categories and their respective crown cover based on 32 monitored areas are provided. The different land cover categories are defined as follows:

- **Forest land** is either land with forest or an area that can produce a forest with a height of at least five metres and with a crown cover of at least 10%. According to the NFI definition, forest area must be larger than 0.5 ha (meaning that the enclosed crown cover area should be at least 500 m²). For example, a small lake surrounded by a tree cover of more than 500 m² will often fulfil these conditions. In Table 25, areas which are smaller than 0.5 ha but fulfil the other conditions of category 'forest' are also shown as 'Forest Land'. The limit of 0.25 ha is shown, since this limit is used for conservation areas within the broad group of nature types according to the Danish Protection Act.

- **Other wooded land (TBFRA)** is an adjusted calculation of land that is not forest land, either with trees that can reach five meters height and have a crown cover of 5 – 9 %, or with shorter trees and bushes with a crown cover of at least 10%.
- **Other area elements** contain all other area features that include wooded vegetation, including elements of urban areas.
- **Linear elements with wood cover** can be hedgerows, tree lines, and woody dykes and watercourses.
- **Point element with woody cover** is a solitary tree.

Table 25. Total area and related crown cover area of forest land (adjusted to NFI-definitions), TBFRA-area and area of other landscape elements in 32 representative agricultural areas in Denmark (128 km²) in 1991 and 1996.

	Sum of ground area						Sum of crown area					
	1991		1996		1991-96	1991		1996		1991-96		
	ha	%	ha	%	%	ha	%	ha	%	%		
Forest land > 0.5 ha	357,5	2,8	403,2	3,1	12,8	272,9	2,1	293,8	2,3	7,7		
'Forest land' 0.25 - 0.5 ha	38,1	0,3	43,6	0,3	14,2	23,9	0,2	26,7	0,2	12,1		
'Forest land' < 0.25 ha	41,9	0,3	46,5	0,4	10,9	24,9	0,2	26,8	0,2	7,7		
'Forest land', total	437,5	3,4	493,2	3,9	12,7	321,6	2,5	347,3	2,7	8,0		
Other wooded land (TBFRA) > 0.5 ha	7,8	0,1	7,6	0,1	-2,3	0,4	0,0	0,4	0,0	-2,3		
Other wooded land (TBFRA) 0.25 - 0.5 ha	0,9	0,0	2,2	0,0	136,6	0,0	0,0	0,1	0,0	150,1		
Other wooded land (TBFRA) < 0.25 ha	2,7	0,0	2,3	0,0	-12,7	1,3	0,0	0,1	0,0	-91,4		
Other wooded land, total	11,3	0,1	12,1	0,1	6,5	1,8	0,0	0,6	0,0	-65,7		
Other areal elements > 0.5 ha with wooded vegetation	366,6	2,9	456,1	3,6	24,4	80,7	0,6	91,2	0,7	12,9		
Other areal elements 0.25 - 0.5 ha with wooded veg.	78,7	0,6	87,3	0,7	10,8	20,8	0,2	23,0	0,2	10,4		
Other areal elements < 0.25 ha with wooded vegetation	20,1	0,2	21,7	0,2	8,1	4,7	0,0	5,2	0,0	10,2		
Other areal elements, total	465,4	3,6	565,1	4,4	21,4	106,2	0,8	119,3	0,9	12,3		
Linear elements with wood cover	388,0	3,0	394,8	3,1	1,8	71,9	0,6	75,0	0,6	4,3		
Point elements with wood cover (Solitary trees)	0,2	0,0	0,2	0,0	6,5	3,5	0,0	6,7	0,1	91,8		
Non forest land, total	864,8	6,8	972,2	7,8	12,4	183,4	1,4	201,6	1,6	9,9		
Grand Total	1302,4	10,2	1465,4	11,4	12,5	505,0	3,9	548,9	4,3	8,7		
Survey area	12800,0	100,0	12800,0	100,0		12800,0	100,0	12800,0	100,0			

Forest land comprises on average of around three percentage of the agricultural land, but this figure has increased by no less than 12.8% between 1991 and 1996 (Table 25). The crown cover area of this category increased from 2.1% in 1991 to 2.3 % in 1996. The total area of landscape elements that include a tree cover was 10.2 % in 1991 and 11.4 % in 1996. The total crown area had a percentage of 4.3% in 1996. Only about half of the tree cover of the Danish countryside is related to land defined as forest (vs. Table 25). It is interesting that the increase of 'Forest Land' on patches between 0.25 – 0.5 ha is greater than the increase in forest land on patches larger than 0.5 ha. This applies both for forest land area and for crown area. The TBFRA category 'other wooded land' comprises only a small part of the countryside with almost no crown cover.