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Jesper Brandt, Esbern Holmes and Dorthe Larsen

ABSTRACT - Small uncultivated areas within the agricultural landscape, in Denmark called 'small biotopes', have attracted growing attention because of their importance for wildlife and their recreational and aesthetic value. The ecological role of these small, uncultivated areas can be demonstrated by regarding them as the lowest level in a hierarchy of ecological networks. But they also have to be understood as integrated functional parts of the agricultural land use system. During the development of a monitoring system for small biotopes in Denmark we have encountered many problems and found a number of solutions. We discuss some of the issues concerning data collection, classification, database construction and the informational context that is necessary for the practical use of such a monitoring system.

Introduction

In Europe there is a rapidly increasing awareness of the importance of the landscape's spatial composition. One aspect of this is the development of the concept of ecological networks. This initially purely academic concept now plays an increasingly important role in landscape valuation, planning and management. The ecological network of a landscape is probably more correctly viewed as a hierarchy of ecological networks, where the highest level is composed by the larger core areas and corridors at the scale of regional planning (see Figure 12.1a) and the lowest level is composed by the small,

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History of the small biotope monitoring system in Denmark

A small biotope monitoring system was set up in Denmark in the late '70s, initially with 13 test sites. This was expanded to a coverage of 32 sites of 4 km^2 each, during campaigns in 1981, 1986 and 1991 (see Figure 12.2).
Basically the small biotope monitoring consists of:

1. Detailed field registrations of all linear and areal biotopes less than 2 ha.
2. Interviews with farmers concerning agricultural practice as well as the functions of and plans for the small biotopes.
3. Historical registration in 5 test sites based on topographical maps and aerial photographs.

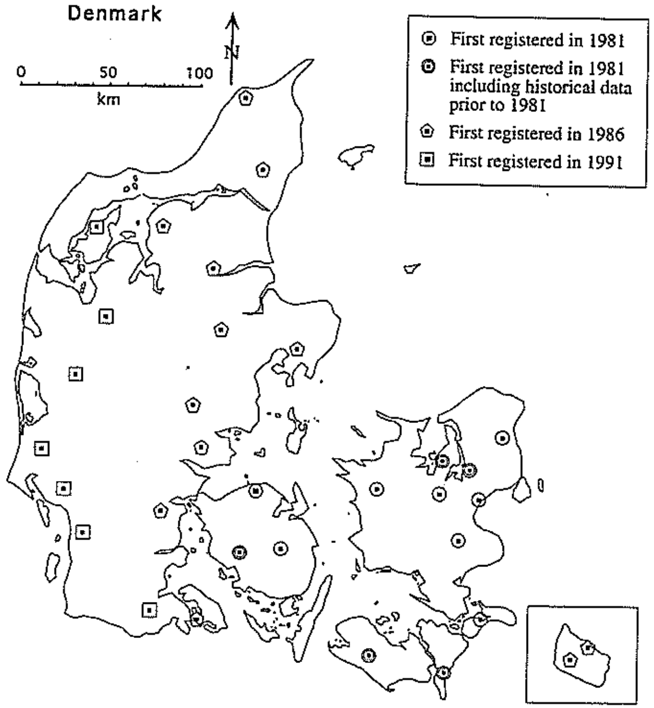

Figure 12.2 The 32 test sites of 4 km^2 surveyed in the monitoring programme

The motivation for the 1981 campaign was the impression of a rapid decrease in number and quality of small biotopes following the concentration, specialisation and industrialisation of Danish agriculture (Biotopgruppen: Agger et al., 1986).

The 1986 campaign was a main source of information on the status and development of marginal land within the intensively-used Weichsel moraine landscapes in Denmark. Here, the dynamics of small biotopes was considered an indicator for the intensification/extensification process within agriculture (Agger and Brandt, 1987). In 1986, spontaneous marginalisation of agricultural land was observed: nine abandoned fields were registered compared to none five years earlier.

The 1991 campaign was carried out in co-operation with the Ministry of Environment as part of the national monitoring programme for wildlife: a monitoring programme not only for small biotopes (Agger et al., 1992, Brandt, 1991) but also for other (larger) types of habitats and selected animal and plant species (Agger and Owesen, 1990).

Impact on policy

An important goal for the project has been to influence policy and decision makers, by changing the focus of conservation interests to incorporate threatened everyday nature values. This goal has been achieved in the sense that the term small biotopes is now an everyday concept in Danish environmental debate. It has fundamentally influenced a new nature protection act since June 1992. This replaced the former nature conservation act, including §43, stating a list of nature types under 'general protection', which means areas that cannot be altered without permission, although no compensation is given. The new act expands the list of nature types regulated by the general protection. In addition, the minimum size of landscape elements regulated by the law has also been lowered considerably to a mere 100 m^2 for small lakes and ponds and 2500 m^2 for most other biotopes (see Table 12.1).
These landscape elements are included in the Nature Protection Act mainly because of their importance as habitats for threatened animal and plant species. Even the incorporation of the smallest lakes and ponds, down to 10 x 10 metres, is primarily justified by their importance for threatened species, especially the 14 existing species of amphibians (most threatened is the Fire-

How to define the 'small biotope' concept

The term 'small biotope' was created to enable us to study the 'rapid decrease in number and quality' of the small, uncultivated areas within the agricultural landscape of Denmark. 'Small biotopes' are defined as '*uncultivated* areas that are *permanently covered with vegetation* (or water) and situated *within* the agricultural areas'. Furthermore, a small biotope must be smaller than 2 ha and either larger then 10 m^2 or longer than 10 m with a width of more than 0.1 m (Agger and Brandt, 1984).

In this definition the small biotopes are regarded as part of the land use, but contrasting to the cultivated areas. Thus, the small biotopes are *not* defined in terms of natural landscape structure, e.g. physiotopes and their chorological extensions.

Based on our small biotope definition, only approximately 1/4 of the small biotopes of Danish agricultural landscapes can be considered to be of natural origin and, even then, are often highly transformed. The rest can be traced back as being manmade features, primarily related to present or former agricultural land use such as dikes, marl pits, etc.

To reflect the anthropogenic nature of the small biotopes, we have chosen to integrate the small biotope classification into the general land use classification. Furthermore, we have chosen to use everyday terms for the small biotope classification, however, giving these everyday terms a precise definition. For instance, a hedge is defined as 20 metres of a linear biotope, of which a minimum of 50% is covered with trees or shrubs, and where the surface is between 0.25 m under and 0.75 m above the surrounding fields. If the surface had been higher we would have had the small biotope type 'hedge on dike'.

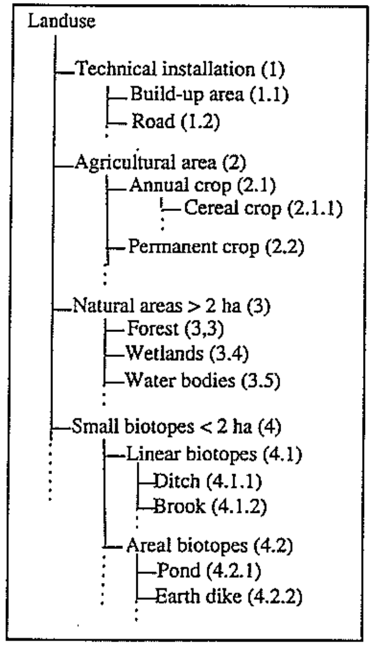

Figure 12.3 Part of the small biotope classification in a CORINE inspired hierarchically-structured land use classification

A major problem of the small biotope definition is that we have stressed that the small biotopes must be within or between agricultural fields. Hence would-be small biotopes within and directly adjacent to farmsteads and urbanised areas are not registered. Restricting the study to a certain matrix is related to the landscape ecological tradition where biotopes are regarded as patches and corridors embedded in a certain matrix, in our case, an agricultural matrix. This does, however, have a major drawback, particularly in connection with the historical analysis, where small biotopes can come into being and disappear as a result of changes solely in the surrounding matrix. For instance, the dismantling of an agricultural holding might involve the upcoming of a ruderate, thickets, hedgerows and ponds, although they always existed as biotopes related to the former garden. In a monitoring system it would certainly also be relevant to follow how existing, small biotopes can be properly embedded in an urban or recreational environment related to an urbanisation process.

How to incorporate agricultural information

Socially induced processes are probably the dominant factor in the production and removal of small biotopes. We believe that these processes should be studied within a context of what Neef (1984) calls *action fields*, e.g. agricultural fields, holdings or owner associations. Until now, we have concentrated on the level of farm holdings, thus relating small biotope data to farm size, spatial configuration, ownership, specialisation, introduction of machinery and game-orientation.

Table 12.2 Table showing the development of small biotopes in Denmark in 1981-91, based on a nature type-oriented classification

DEVELOPMENT OF SMALL BIOTOPES IN DENMARK 1981 - 1991* NATURE TYPE-ORIENTED GROUPING		1981-86 (% per year)	1986-91 (% per year)
13 TEST SITES IN EASTERN DENMARK ($52\ km^2$)	Wet linear	-0.1	-1.1
	Dry linear	-0.1	+0.2
	All linear	-0.1	0.0
	Wet areal	-1.8	-0.8
	Dry areal	+0.9	+2.0
	All areal	-0.6	+0.6
10 TEST SITES IN EASTERN JUTLAND ($40\ km^2$)	Wet linear		+3.2
	Dry linear		0.0
	All linear		+0.4
	Wet areal		+2.4
	Dry areal		+4.7
	All areal		+3.7
25 TEST SITES IN DENMARK ($100\ km^2$)	Wet linear		+0.3
	Dry linear		0.0
	All linear		+0.1
	Wet areal		+0.3
	Dry areal		+2.6
	All areal		+1.5

* Indicated as % annual change on average for all test sites; the linear in % of length; the areal in % of number.

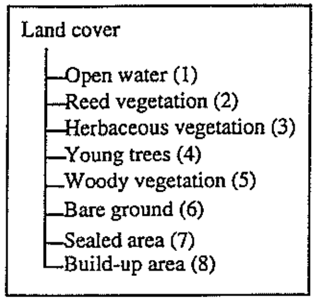

Figure 12.5 Land cover categories for the description of internal small biotope heterogeneity

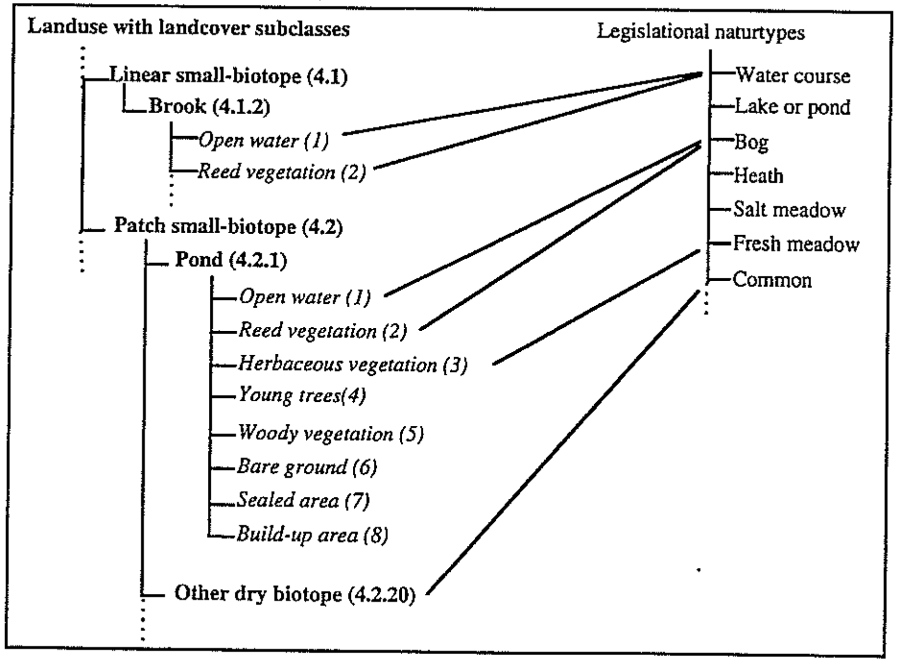

Figure 12.6 The relation between small biotope subclasses and legislational nature types

Table 12.3 The development of small biotopes in Denmark in the period 1981-91, based on a land use functional grouping; compare with Table 12.2

DEVELOPMENT OF SMALL BIOTOPES IN DENMARK 1981 - 1991* - A FUNCTIONAL CLASSIFICATION		1981-86 (% per year)	1986-91 (% per year)
13 TEST SITES IN EASTERN DENMARK (52 km²)	Public infrastructure	0.0	+ 0.9
	Farm infrastructure	- 1.2	- 1.7
	Nature types	+ 0.1	+ 0.5
	Cultural heritage	0.0	- 0.1
	Game orientation	+ 0.2	+ 3.2
	Farm and field layout	- 0.6	- 0.6
	(Former) raw material	- 0.2	+ 0.6
10 TEST SITES IN EASTERN JUTLAND (40 km²)	Public infrastructure		+ 0.9
	Farm infrastructure		+ 0.5
	Nature types		- 0.3
	Cultural heritage		- 1.1
	Game orientation		+ 5.3
	Farm and field layout		- 0.1
	(Former) raw material		- 2.3
25 TEST SITES IN DENMARK ** (100 km²)	Public infrastructure		+ 0.8
	Farm infrastructure		- 0.9
	Nature types		+ 0.4
	Cultural heritage		0.0
	Game orientation		+ 3.8
	Farm and field layout		- 0.5
	(Former) raw material		- 0.1

* Indicated as % annual change in average for all test sites; the linear in % of length; the areal in % of number.

** Including 2 test sites on Bornholm in the Baltic Sea

How to perform the data collection

There are a number of different data sources available for the monitoring of small biotopes, such as topographical maps, remotely sensed data — aerial photographs or high resolution satellite images — and last but not least, field survey.

Several surveys of small biotopes in agricultural landscapes are based on topographical maps. These maps are, however, of restricted usefulness because some of the most common and changeable types of small biotopes such as ditches along roads and field divides are rarely present. Furthermore, the surface area of linear and small areal features cannot be deduced from the map because these are only represented as line or point signatures on the map. Topographical maps traditionally stress features of military interest such as restrictions to military transportation or opportunities for military shelter. This gives the topographical map a bias towards certain types of more stable, wet and visually dominating biotopes. Therefore it is almost impossible to retrieve a reliable quantified description of small biotopes based on topographical maps. However, in cases where other sources of data are lacking — particularly for historical investigations — the topographical maps are an indispensable data source.

The use of aerial photographs is more reliable, but still presents some problems. It is, for instance, difficult to judge the width of linear features because of the shadows from woody vegetation. Moreover, a classification of small biotopes based on aerial photographs alone can be extremely difficult due to their internal differentiation. Woody vegetation with a height of less than 3 metres can rarely be distinguished from scrubs and herbaceous vegetation.

This leaves us with field surveys as the most reliable, although time consuming, way of monitoring small biotopes. Field registration is the only way to obtain information on the biological content of small biotopes such as tree species composition and recent anthropogenic influence, e.g. disposal of waste and stones, cutting and scorching, sign of game care and the like. For field survey aerial photographs are a very important tool for geographical positioning of the features in the field as well as for the digitizing process. General land use data were also obtained solely by field survey, because up-to-date aerial photographs were unavailable. An interesting future perspective is to investigate the extent to which such a general land use survey may be supported by employing high resolution satellite data such as SPOT data.

Interviews are necessary for collecting information on the functions, care of and attitudes towards future utilisation of the small biotopes. This can be done through telephone interviews, but personal interviews with the farmers are definitely preferable. The personal interview is a source of information not only for objective facts like location, and type of the holding; it will also to both thematic and spatial data through a common query-language enabling integrated queries. The relational database system certainly supports complex data structures, enabling representation of both thematic and spatial data. This system does have a severe drawback in that the handling of spatial data is not optimised as in the dedicated database system above and thus shows rather low performance. For the purpose of the small biotope monitoring system this is, however, compensated by the flexibility of both data representation and access.

How to support spatial analysis

The spatial characteristics of features and, in particular, the spatial interrelationships of features are key elements in most of the analyses the monitoring system must cater to. Therefore, the database system must supply flexible tools for spatial analysis. The design of the spatial data structure is the basic system hook — it determines which analyses are possible and which are not.

The features of the monitoring system — small biotopes, fields, property units and the like — are characterised by being distinct features with sharply defined boundaries as opposed to a continuously varying natural landscape. Consequently, it is important to be able to handle these features and the boundaries between them as coherent objects. This is the main reason for choosing a vector representation of polygons, lines and points over the raster-cell structure, which is often regarded more suitable for spatial analysis.

The database must include sufficient spatial information to enable analysis on characteristics such as calculation of area and length. This implies that the extent of each feature should be represented. However, this is not feasible for all types of features. In the field, the spatial data of the small biotopes are registered on maps in a scale of app. 1: 10,000. Since the smallest features registered are areal biotopes of 10 m^2 and linear features 10 metres long by 0.1 metres wide, the scale used is insufficient to enable a satisfying areal representation of these small features. In general, at this scale it is impossible to represent the width of most linear features and very small areal features (less than approximately 250 m^2). As the linear features on average constitute about one-half of the total area of small biotopes and the main part of non-protected small biotopes, the representation of their area is important — not least from a management point of view.

The benefit of using a mapping scale small enough to cater to such detail does not balance the additional work on field registration nor the digitizing that this would cause. Instead, the width of the linear features and the area of small areal features are represented by 'sketch'-geometry, meaning that these spatial characteristics are treated as thematic data. The spatial characteristics of a linear feature are represented as a row of points defining a line and an attribute describing the width of the feature. Consequently, only a mean width of the feature can be represented. This is, however, not a serious limitation as most linear features, such as field divides and hedgerows, are characterised by a fairly uniform width. The very small areal features, also named 'point' features, are represented by an area attribute attached to a single point.
'Sketch'-geometry is also used to represent linear features which are close together and parallel. A road and ditch with parallel courses are, again due to the scale, linked to the same line on the map.

A subset of the spatial data which is of vital importance for many landscape ecological analyses is the topology (math: non-metric geometry). Within the mathematical tradition, topology describes the spatial relations between features, such as neighbourhood and intersection. The design of the spatial data structure in the database determines which topological relationships are represented and thus accessible.

When existing GIS's claim to support *'full topology'* they refer to the ability of handling neighbourhood analysis, i.e. determining which features are next to each other on a single map overlay (this includes handling of islands). This, for example, enables the study of how the maintenance of small biotopes is related to the agricultural management of the surrounding fields.

Our definition of 'full topology', however, also includes the handling of spatial relationships across map overlays, i.e. handling not only the neighbourhood of features but also spatial overlapping. This is accomplished in our database system by integrating the spatial data of all map overlays into a single overlay, so that all thematic features are referencing the same map. This enables, for instance, an analysis of the spatial correlation between small biotopes and property boundaries. This analysis is based on determining the spatial overlap of small biotopes and property boundaries originally belonging to a land use map and a land property map, respectively.

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13 The use of floristic data to establish the occurrence and quality of ecosystems

Kees (C.) L.G. Groen, Ruud van der Meijden and Han (J.) Runhaar

ABSTRACT - For environmental management, reliable information is needed on the occurrence and quality of ecosystems. A complete mapping of ecosystems in combination with an exhaustive survey is often expensive, especially on a nationwide scale. Therefore, it is worthwhile investigating whether floristic surveys can be a useful alternative.

In this chapter the applicability of a nationwide floristic database for the Netherlands on 1-km^2 grid cells called FLORBASE is discussed. It is compared with a database on land-cover upgraded with information from vegetation relevés, which is set up in the context of the Landscape Ecological Mapping of the Netherlands: LKN.

It appears that floristic information can be used as a rough estimate of the occurrence of ecosystems in terms of presence in grid cells, and that this information is especially relevant for establishing the quality of these ecosystems. Floristic databases have obvious advantages, the most important of which is the fact that they can be filled and updated relatively easily with information gathered by both amateur and professional naturalists.

Introduction

Due to the growing awareness of the importance of protecting and enhancing nature values among national and regional authorities, there is a growing demand for information on the *quantity* and *quality* of ecosystems. What is the surface area covered by certain ecosystem types and what is the quality of these ecosystems in terms of species richness?

F. Klijn (ed.), Ecosystem Classification for Environmental Management, 275–290.