Spatial demands for location of farm woodlands - securing the goals of multi-purpose afforestation

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Abstract

The paper outlines the concept of multi-purpose forestry. The approach taken concentrates on afforestation and covers the most intensively used agricultural areas in Western Europe with a focus on Denmark. Different spatial demands for new woodlands within the concept of multi-purpose forestry are analysed. A scheme describing the spatial issues of three selected aims of multi-purpose forestry (nature conservation, recreation, and landscape amenity concerns) is set up. Implications of these results are discussed in relation to the present planning framework (legislation, planning, and administration) for location of new farm woodlands in the Danish countryside.

Keywords

Multi-purpose forestry, afforestation, farm woodlands, spatial demands, planning frameworks, Denmark.

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Forest studies have traditionally played a minor role in land use and landscape research undertaken at the Institute of Geography, University of Copenhagen. Different approaches have been used, with the common focus of forest being part of a larger comprehensive land use system. De- and afforestation are traditionally analysed as part of observed changes in land use on former agricultural land and heath land (Jensen 1976, Jensen & Jensen 1979), also in the more recent debate on marginalisation (Reenberg 1994, Reenberg & Jensen 1989). At the same time there has been a focus on the importance of spatial issues in landscape research where forest has been analysed as one out of many land use options (for the importance of spatial sampling see e.g. Reenberg 1998). In this paper farm woodlands are analysed as landscape elements through the use of a landscape ecology approach as defined by Forman and Godron (1986). This does not depart significantly from traditional studies of spatial parameters in landscape research at the Institute of Geography. However, it is here considered as a useful framework for analysing spatial configurations in the landscape.

According to The Helsinki resolution H1, signed by a wide range of European countries and national policy statements of the individual member countries of the EU (e.g. Denmark, Great Britain, and Belgium), the forest of today must be multi-purpose (Helsinki Conference 1993, Ministry of the Environment 1989, Forestry Commission 1991, Buysse 1993). This points towards new issues of concern when planning future forest areas of the European landscape. Concerns for, not only the traditional wood production, but also environment, cultural heritage, recreation, landscape amenity, and nature conservation must be taken into account and the planning system must find ways of implementing them if the goals are to be fulfilled.

The purpose here is to analyse the spatial demands for location of farm woodlands that the concept of multi-purpose forestry creates, and further to discuss if these demands are secured through the actual planning framework for afforestation in Denmark. The paper firstly discusses the concept of multi-purpose forestry and outlines the Danish planning framework for afforestation. Secondly, the present knowledge of spatial demands that the concept of multi-purpose forestry creates is analysed. The focus is on three selected issues, namely nature conservation, recreation, and landscape amenity. Thirdly, the results are summarized in a scheme and used as basis for a discussion of the Danish implementation strategy for multi-purpose forestry on farmland.

Multi-purpose forestry

Multi-purpose forestry has a long history in the Scandinavian countries (e.g. Saastamoinen et al. 1984, Hytönen 1995). In Denmark woodlands were for centuries integrated parts of the agricultural production system and served many different functions, e.g. wood for fences and firewood, wood for constructions and as a resource for animal grazing (Fritzbøger 1992). In order to establish profitable forestry, the forests and smaller woodlands were separated from agriculture by a demand of fencing and animal enclosure in 1805 (Fredsskovsforordningen 1805). The forested areas were standardised to optimise wood production, and forestry became an issue of securing the maximum economic output. A strategy that has dominated until quite recently (Fritzbøger 1994). However, forests at the same time also served other functions as wildlife habitat and areas of recreation.

The role as a biological refuge has, with a continuing intensification of forest management, declined and loss of habitat and species has been the result (Ministry of the Environment 1994). At the same time biotopes in the surrounding countryside have suffered from agricultural intensification and many small heath lands, meadows, and bog areas have been turned into intensively used agricultural areas (Asbirk 1995). It can therefore be claimed that the relative biological importance of the remaining forest areas has increased. Concerning the recreational use of forest areas, the increasing urbanisation is believed to create a need for renewed contact with nature (Fritzbøger & Søndergaard 1995). The forest of today therefore has a potential new role of multi-purpose character, emphasing not only wood production but also includes dimensions of nature conservation and recreation.

Afforestation of former agricultural areas became a topic in the EU in the mid 1980s, and member countries were obliged to launch national legislation on afforestation. The afforestation programme was part of the Common Agricultural Policy (CAP) and intended as an alternative to agriculture production on land presumably becoming economically marginal due to reduced agricultural subsidies and increased environmental restrictions (Helles & Linddal 1996).

The new European farm woodlands are to be realised through different governmental statutory and non-statutory initiatives, planning guidelines, and regulations. Although implementation strategies vary between the different countries, the main aim seems to be multi-purpose forestry by optimising a wide range of uses including forests as wildlife habitats and recreational centres (e.g. Forestry Commission 1991, Ministry of Environment and Energy 1996).

The first sign of the Danish Government's interest in multi-purpose forestry came in the late 1980s, when a report about the private forest sector stressed that support and promotion of multi-purpose forestry and considerations to the im-material values of forestry had to be given high priority (Landbrugsministeriet 1986). With The Forest Act of 1989, the Government launched the programme aiming at doubling the Danish forest area within the next 80-100 years. Half of this area is planned to be planted as private forest mainly on former agricultural land and financed through subsidies. A doubling of the Danish forest area from the present 12% to 25% of the land area, within one forest rotation (80-100 years), requires an annual afforestation rate on former farmland of about 5,000 hectares (Helles & Linddal 1996).

In the Forest Act it is further specified that in multi-purpose forestry the following six parameters must be taken into consideration:

- Wood production
- Landscape amenity
- Nature conservation
- Culture heritage
- Environmental protection
- Recreational activity interests

This part of the Act has been further specified in the present Forest Act of 1996 (Ministry of Environment and Energy 1996).

As for the location of new farm woodlands in the landscape, it is the spatial demands of nature conservation, recreation, and landscape amenity that are of main interest in this paper. These parameters depart from the environmental, cultural and productional parameters because they are not, to the same extent, geographically fixed to already existing elements in the landscape. Therefore they depend more on spatial configurations obtained through planning frameworks. Furthermore, they are not included in farmers' traditional financially based decisions concerning the location of woodland areas and are thereby new issues of concern for the planning framework, if the goals of multi-purpose forestry are to be fulfilled.

The potential for other uses of forests than solely wood production has long been recognised and researched, but

it was first with the Forest Act of 1989 that the political responsibility for creating multi-purpose forestry was established. The future challenge for the planning framework therefore has to deal with new spatial concerns in order to secure an optimal location of future private woodlands. In Denmark, the planning framework shapes the overall pattern of future private afforestation by designation of forest areas in a national context. The designation is conducted by each of the fourteen counties. Each county has identified areas where afforestation is desirable, namely afforestation areas (where the highest economic level of grants is given), areas where afforestation is permitted, so-called neutral areas (where a lower economic level of grants is given) and areas where afforestation is prohibited, namely negative areas. These designations are outlined in afforestation maps covering the total land area of Denmark. The grants are administrated by the National Forest and Nature Agency, acting on national level (Miljø- og Energiministeriet 1997). The implementation approach is twofold. Firstly to give grants and tax deductions to initiate establishment of woodlands and secondly to provide a planning framework, the afforestation maps, for regulating the development. In this way the planning system is acting both as initiator and regulator for creating new woodlands that meet the demands of society.

Spatial demands for multi-purpose forestry

If the concerns of multi-purpose forestry are to be achieved, it is here argued that spatial demands for location of new farm woodlands in the landscape exist. Further these spatial demands must be dealt with by the planning framework. In the following, the spatial demands for location of farm woodlands concerning nature conservation, recreation, and landscape amenity are analysed.

Nature conservation issues

The very broad concept of nature conservation is in this paper focused on biological functions related to the spatial characteristics of the landscape. Here landscape ecology offers a framework for analysing relations between landscape function and structure.

Several empirical studies within the field of landscape ecology show that both flora (e.g. Peterken & Game 1984, Zacharias & Brandes 1990) and fauna (e.g. Fahrig & Merriam 1985, Komdeur & Gabrielsen 1995) are affected by the spatial arrangement of the landscape elements. One theory that tries to explain this relation is the metapopulation theory (Levins 1970, further elaborated by Opdam 1991). The theory identifies landscape structure as an important factor for the survival of species richness in a particular area. Although criticised for oversimplification it has, together with other similar approaches (e.g. species-area relationship by island biogeography and the concept of landscape fragmentation), highlighted the importance of the spatial structure in the landscape when discussing biodiversity. Today, there is consensus that each species has its own particular requirements for habitat, its own ability to move and its own behaviour. Thereby it becomes impossible to give a set of general guidelines for an optimal spatial configuration. However, it is believed that guidance can be given for a group of species with similar requirements and that more general principles can be found (Dawson 1994).

There has been extensive empirical research into the ecology of woodlands and the surrounding landscape within the context of landscape ecology. This research has mainly been within the field of biology, but also more general perspectives of planning have been discussed (e.g. Watkins 1993, Ferris-Kaan 1995). From these works different spatial issues important in planning of new forest areas in the landscape can be identified.

The **size** and the **shape** of individual woodland blocks have been subject of much debate concerning their importance for species richness. The overall consensus is that the larger and more curved the blocks of woodland, the better the potential conservation value. Such an approach must, however, take into account the different requirements for interior- and edge- species. Edge species are those primary or only near the border of a spatial element, and interior species are primarily or only distant from a border (Forman 1997). As a consequence they have different preferences concerning size and shape of a forest. Small woodland blocks, on the other hand, function as **corridors** between larger areas of woodlands, they form part of the **network** and thereby the overall **connectivity** in the landscape. Connectivity is a measure of how connected or spatially continuous a corridor, a network, or the matrix is (Forman 1997). Here **distance** between the individual woodlands plays a crucial role. As woods in well wooded landscapes tend to contain a more diverse wildlife community than those in landscapes with little woodland, the woodland **cover** will be of importance. This

can be characterized by the total **number** of woodlands related to the distance between them. The number of woodlands in the landscape also plays a crucial role for dispersal rates from old woodland areas to newly established woodlands.

In Denmark there have been very few empirical studies of species richness and landscape structure. In a study of the vascular flora of sixty-two forests, Lawesson et al. (1998) found a significant positive correlation between the woodland size and total species richness. However, when analysing the different habitat groups the correlation was found to be more complex. For example, by analysing the group of forest species, it was indicated that relatively more forest species are found in small forests than in large ones. This can be explained by early forest fragmentation in the study area, by interior species having little dependence of dispersal, or simply by the fact that these forests are often less intensively managed. In another study (Asferg et al. 1996), the presence of squirrels in small woodlands was found to be mainly determined by three spatial parameters, namely the number of other woodlands within five hundred metres, the distance to nearest woodland over twenty hectare, and the size of the concerned woodland.

As these studies indicate, spatial issues for nature conservation are not easily defined because they are species dependent. However, the following parameters are in general found to be of importance: Woodland size, shape, number, and distance between woodlands. These parameters can be used in order to describe more complex parameters of importance such as woodland corridor, network, connectivity, and cover. Which again can be used in characterising the woodland pattern of a given area.

Recreation issues

Forests have long been used as places for recreation and amenity irrespective the fact that much of its management rationale has little to do with these issues. With the introduction of multi-purpose forestry in legislation a political need for evaluating demands for recreation has emerged. Although different methods have been proposed, the overall approach seems to be evaluating recreational benefits in economic terms. One method is to estimate the economic loss of wood production forestry when providing recreational facilities, another to survey the willingness to pay for, e.g. a forest visit (e.g. Bishop 1990, Bateman 1996, Price 1997).

In Denmark there have been a few studies concerned economic valuation of recreation in forest areas (e.g. Christensen 1988, Dubgaard 1998). However, the scene of recreation studies of forests is dominated by The Forest and People project (latest publication is Jensen & Koch 1997). The project was initiated in 1975 and has been repeated under various conditions with the main aim of evaluating the actual use and preference of forest areas in Denmark. Discussing recreational use of forest areas one has to bear in mind cultural differences. In the context of this paper the Danish results are found valuable when analysing the spatial parameters of importance for recreation.

Unfortunately, only few spatial topics are touched upon in The Forest and People project, so the studies can only give some indications about the spatial issues which determine peoples' recreational use of forest areas. One parameter is travel **distance**. It is found that between 1976/1977 and 1993/1994 both average travel distance and average travel time for visitors to forest areas have diminished. The surveys further show that visits to forests smaller than fifty hectares are less frequent than to larger ones, a tendency that seems to increase in the study period (Jensen & Koch 1997). Thereby, woodland **size** becomes relevant for quantifying recreational use, although not explicitly surveyed. The studies also give some indications of peoples' preferences to future forest areas in the landscape. Almost 50% of the asked persons prefer new forest areas located close to urban centres. Further, when asked about the location of 100 hectares new forest area, 44% answer that they prefer several small forest areas instead of forest areas in connection with existing forest areas (preferred by 23%) or one single forest area (preferred by 19%)(Jensen 1998). So also the **number** of forests in the landscape is of importance.

It is evident that there is still much research needed in the area of determining the spatial parameters of importance for the recreational use of forest areas. However, the analysis indicates that forest size and distance from urban areas to forest areas as well as the number of forest areas are important parameters, which must be taken into consideration when the spatial configuration of new woodlands in the future landscape is planned.

Landscape amenity issues

Within the area of forest research two different kinds of approaches concerning amenity can be identified of relevance for this paper. The first approach emphasises aes-

thetical values within the forest, where the second deals with the landscape, in which the forest areas constitute one element among others. Regarding the first, much emphasis has been on the scenic preferences of different forest management types (e.g. Karjalainen 1996, Jensen & Koch 1997). Regarding the second, this research area has mainly been a subject of landscape architects (Crove 1978, Lucas 1991, Bell 1993, 1995) and has only in recent years attracted attention from other disciplines through landscape ecology approaches (Thorne & Huang 1991, Fry & Sarlöv-Herlin 1995, 1997).

When analysing the spatial perspectives of afforestation, the second approach (where forest is investigated as part of the landscape) is of greatest interest. In Denmark, as in the other Scandinavian countries, this research has mainly been inspired by work of landscape architects from USA and Great Britain (Lindgren 1995).

Following such an approach, here represented by Bell (1995), it is important that new woodlands follow already existing **shapes** in the landscape such as land form, natural vegetation distributions, or the cultivation and enclosure patterns developed by land use over time. The scale of landscapes is generally determined by a combination of land form structure and enclosing elements such as trees and hedges. New woodlands will tend to appear most appropriate if they reflect this. Thereby **scale** and **size** of individual woodlands become important parameters. In order to produce a harmonious whole, where all parts of a landscape are well-balanced with each other, the **unity** of the landscape is important. Many earlier landscape patterns are regarded as having the optimal relation between the different parts in the landscape. New woodlands can be used to integrate new elements (such as buildings and roads) into the landscape in order to make it harmonious. Thus, to provide aesthetic satisfaction, woodlands can be used to add diversity or reduce visual chaos by linking different elements or enclosing them and the landscape **diversity** becomes central.

Recent research seems to concentrate on integrating aesthetical values of the landscape with ecological diversity (e.g. Thorne & Huang 1991, Fry & Sarlöv-Herlin 1997). Thereby, ecology comes in focus of the landscape amenity research. The above must be seen in this context where spatial issues of importance for landscape amenity are found to be woodland size and woodland shape. Further, when woodlands are regarded as part of a landscape, important parameters to consider are scale, unity and diversity. In order to quantify these more complex concepts, spatial parameters such as size, shape, distance and number are considered important.

Discussion

The above analysis of spatial demands concerning nature conservation, recreation, and landscape amenity for new multi-purpose woodlands are summarised in the scheme (Figure 1).

Discussing the location of woodlands in the landscape the scheme addresses only a small piece of the puzzle. However, it is considered useful for highlighting the variation of spatial parameters between the different analysed issues,

	Parameters	Concepts
Nature conservation		
The individual woodland	Size	
	Shape	
The wooded landscape	Size	Corridor
	Shape	Network
	Distance	Connectivity
	Number	Cover
Recreation		
The individual woodland	Size	
The wooded landscape	Distance	
	Number	
Landscape amenity		
The individual woodland	Size	
	Shape	
The wooded landscape	Size	Scale
	Shape	Unity
	Distance	Diversity
	Number	

Figure 1: The three analysed spatial parameters are each divided into two groups, firstly those important in evaluating the individual woodland and secondly those of importance in evaluating the wooded landscape. The different spatial parameters for each of the analysed spatial demands are outlined. In this connection it must be emphasized that even though equally stated the parameters can be different. For example 'distance' under nature conservation is distance between different forest areas while 'distance' under recreation is distance between urban areas and forest areas. For specification see the above text.

and between different spatial levels, as will be exemplified in the following. The scheme is further found valuable in an evaluation of the Danish planning framework for new multi-purpose farm woodlands.

The parameters of the three spatial issues in the scheme are not considered independent of each other. In a discussion of ecological and amenity functions of woodland edges, Fry and Sarlöv-Herlin (1997) conclude that in general there seems to be a good match between ecological functions and the amenity values of woodland edges. The consequence of this is an argument, as Thorne & Huang (1991) express it, for a landscape ecological aesthetic, as a union of landscape ecological integrity and aesthetic appeal. However, others (e.g. Bell 1995) have emphasised that visual diversity may not always be identical with ecological diversity, only at certain scales they seem to be closely related. This underlines the importance of the actual context within which the spatial parameters are analysed. When evaluating the spatial configuration of the landscape, this implies that it is important to be aware of coincidence and differences between spatial demands of different concerns.

Looking at the different spatial parameters in the scheme two spatial levels are indicated. The first level concerns spatial issues of importance for the individual woodland, the second leval deals with issues of importance for the landscape as a whole. Awareness of these two levels has important implications for successful implementation of multi-purpose forestry and in this paper provides important information about the value of the current Danish planning framework for afforestation, as discussed in the following.

The actual scene for private afforestation in the Danish countryside is complex, where many concurrent interests are acting simultaneously. It can, nevertheless, be argued that land available for new woodlands depends on decisions made by individual landowners and managers. The spatial components concerning the individual woodland are to a great extent controlled by the farmer himself. The spatial configuration of the whole landscape which is not in immediate control of the farmer must, on the other hand, be secured by the planning system. But when looking at the actual implementation of the afforestation scheme this seems to be an area of neglect. The county administration produces the afforestation maps while the National Forest and Nature Agency handle the applications for grants. Here a priority list exists where the spatial concerns are focussed on whether an area is in- or outside the afforestation areas identified by the counties, on the size of the woodland and finally on the closeness to urban centres (Miljø- og Energiministeriet 1997). When comparing this priority list with the spatial parameters in the scheme, inconsistencies are revealed. For example, if concerning the spatial demands of nature conservation it is evident that even though the counties have e.g. designated green corridors where afforestation is desired, the actual planning framework provides no opportunities of securing an optimal location of woodland areas within these. If farmers in these areas apply for grants, the only spatial regulation regarding biological concerns on landscape level is whether the area is in or outside a designated afforestation area. There is no way of securing, e.g. the new woodlands distance to other woodlands, and thereby its potential for increasing the connectivity in the landscape. In fact, the priority list of the National Forest and Nature Agency is the only instrument regulating the spatial parameters of new farm woodlands. In this way, many of the spatial concerns on the landscape level cannot be captured by the planning framework, although included in the overall goals of further afforestation.

The current practice facilitates a 'negative' planning approach where in fact the only areas secured are areas protected against afforestation instead of the more positive approach of seeing where the greatest benefit of new woodlands in the landscape could be gained. Such an approach can have wide consequences for the future use of the woodlands established today. A forest is a longterm economic, biological, recreational and aesthetical investment. Therefore, it seems inexpedient that the current planning framework does not establish a practice that secures the most optimal location of farm woodlands in the landscape.

Conclusion

The analysis points out that the location of future woodlands in the landscape has some important spatial implications when taking the goals of multi-purpose forestry into account. Firstly it is found possible to quantify important spatial parameters for multi-purpose forestry secondly two different spatial levels of interest can be identified when analysing the concerns of nature conservation, recreation and landscape amenity. The first level concerns the spatial parameters of importance for the individual woodland (size

and shape), the other considers the whole landscape (corridor, network, connectivity, scale, cover, unity, and diversity). An awareness of these two spatial levels is found to have wide implications for the success of implementing multi-purpose forestry. By discussing the planning framework (legislation, regulation and administration) of private afforestation in Denmark it is found that these spatial levels are not taken into explicit consideration. Further, it is evaluated that this practice can have inexpedient consequences for the achievement of the objectives of the afforestation programme and further for the actual value of future afforestation in the Danish countryside.

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References

Asbirk, S. (1995): Naturens aktuelle tilstand. Pp.12-25 in *Skov- og Naturstyrelsen: Naturen tur-retur, om naturovervågning og naturforvaltning.* Miljø- og Energiministeriet, København.

Asferg, T., Pagh, S., Rosengaard, M. & Bertelsen, J. (1996): Forekomst af egern *Sciurus vulgaris i skove under 20 ha, et eksempel på fragmentering af landskabet i Århus Amt.* Faglig rapport fra DMU, no.184, Afd. for landskabsøkologi, Miljø- og Energiministeriet, København.

Bateman, I.J. (1996): An economic comparison of forest recreation, timber and carbon fixing values with agriculture in Wales: A geographical information systems approach. Unpublished PhD-thesis, University of Nottingham.

Bell, S. (1993): Elements of visual design in the landscape. E. & F. Spon, London.

Bell, S. (1995): New woodlands in the landscape. Pp.27-47 in *Ferris-Kann, R. (ed.): The ecology of woodland creation.* The Forestry Authority, John Wiley & Son, Chichester.

Bishop, K. (1990): Multi-purpose woodlands in the countryside around towns. Unpublished PhD-thesis, Univers. of Reading.

Buysse, W. (1993): Ecological restrictions on the afforestation af valley grounds in Flanders, Belgium: Guidelines for Government Policy. Pp. 191-199 in *Watkins, C.: Ecological effects of afforestation, studies in the history and ecology of afforestation in Western Europe.* CAB international, Wallingford.

Christensen, J.B. (1988): An economic approach to assessing the value of recreation with special reference to forest areas. Reports from Department of Forestry, Series 2: Research 1988, The Royal Veterinary and Agricultural University, Copenhagen.

Crowe, D.S. (1978): The landscape of forests and woods. Forestry Commission, booklet 44, HMSO, London.

Dawson, D. (1994): Are habitat corridors conduits for animals and plants in a fragmented landscape? a review of scientific evidence. English Nature Research Reports No. 94, English Nature.

Dubgaard, A. (1998): Economic Valuation of Recreational Benefits from Danish Forests. Pp. 53-64 in *Dabbert, S. et al (eds.): Economics of landscape and wildlife conservation.* CAB International, Wallingford.

Fahrig, L. & Merriam, G. (1985): Habitat patch connectivity and population survival. *Ecology* 66: 1762-1768.

Ferris-Kaan (ed.)(1995): The ecology of woodland creation. The Forestry Authority, John Wiley & Son, Chichester.

Forestry Commission (1991): Forestry Policy for Great Britain. Forestry Commission, Edinburgh.

Forman, R.T.T. (1997): Land mosaics, the ecology of landscapes and regions. Cambridge University Press.

Forman, R.T.T. & Godron, M. (1986): Landscape Ecology. John Wiley and Sons, New York.

Fredsskovsforordningen (1805): Forordning om skovens udskiftning, vedligeholdelse og fredning i Kongeriget Danmark, 1805.

Fritzbøger, B. (1992): Danske skove 1500-1800, en landskabshistoriske undersøgelse. Landbohistorisk Selskab, Odense.

Fritzbøger, B. (1994): Kulturskoven, dansk skovbrug fra oldtid til nutid. Skov- og Naturstyrelsen, Miljøministeriet, København.

Fritzbøger, B. & Søndergaard, P. (1995): A short history of forest uses. Pp. 11-41 in *Hytönen, M. (ed.): Multi-use forestry in the Nordic countries.* The Finnish Forest Research Institute, Helsinki.

Fry, G. & Sarlöv-Herlin, I. (1995): Landscape design; how do we incorporate ecological, cultural and aesthetic values in design principles? pp. 51-60 in *Griffiths, G.H. (ed.): Landscape Ecology: Theory and application. Proceedings of the fourth annual IALE(UK) conference, held at The University of Reading,* 19-20th. Sept. 1995.

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References

Asbirk, S. (1995): Naturens aktuelle tilstand. Pp.12-25 in *Skov- og Naturstyrelsen: Naturen tur-retur, om naturovervågning og naturforvaltning.* Miljø- og Energiministeriet, København.

Asferg, T., Pagh, S., Rosengaard, M. & Bertelsen, J. (1996): Forekomst af egern *Sciurus vulgaris i skove under 20 ha, et eksempel på fragmentering af landskabet i Århus Amt.* Faglig rapport fra DMU, no.184, Afd. for landskabsøkologi, Miljø- og Energiministeriet, København.

Bateman, I.J. (1996): An economic comparison of forest recreation, timber and carbon fixing values with agriculture in Wales: A geographical information systems approach. Unpublished PhD-thesis, University of Nottingham.

Bell, S. (1993): Elements of visual design in the landscape. E. & F. Spon, London.

Bell, S. (1995): New woodlands in the landscape. Pp.27-47 in *Ferris-Kann, R. (ed.): The ecology of woodland creation.* The Forestry Authority, John Wiley & Son, Chichester.

Bishop, K. (1990): Multi-purpose woodlands in the countryside around towns. Unpublished PhD-thesis, Univers. of Reading.

Buysse, W. (1993): Ecological restrictions on the afforestation af valley grounds in Flanders, Belgium: Guidelines for Government Policy. Pp. 191-199 in *Watkins, C.: Ecological effects of afforestation, studies in the history and ecology of afforestation in Western Europe.* CAB international, Wallingford.

Christensen, J.B. (1988): An economic approach to assessing the value of recreation with special reference to forest areas. Reports from Department of Forestry, Series 2: Research 1988, The Royal Veterinary and Agricultural University, Copenhagen.

Crowe, D.S. (1978): The landscape of forests and woods. Forestry Commission, booklet 44, HMSO, London.

Dawson, D. (1994): Are habitat corridors conduits for animals and plants in a fragmented landscape? a review of scientific evidence. English Nature Research Reports No. 94, English Nature.

Dubgaard, A. (1998): Economic Valuation of Recreational Benefits from Danish Forests. Pp. 53-64 in *Dabbert, S. et al (eds.): Economics of landscape and wildlife conservation.* CAB International, Wallingford.

Fahrig, L. & Merriam, G. (1985): Habitat patch connectivity and population survival. *Ecology* 66: 1762-1768.

Ferris-Kaan (ed.)(1995): The ecology of woodland creation. The Forestry Authority, John Wiley & Son, Chichester.

Forestry Commission (1991): Forestry Policy for Great Britain. Forestry Commission, Edinburgh.

Forman, R.T.T. (1997): Land mosaics, the ecology of landscapes and regions. Cambridge University Press.

Forman, R.T.T. & Godron, M. (1986): Landscape Ecology. John Wiley and Sons, New York.

Fredsskovsforordningen (1805): Forordning om skovens udskiftning, vedligeholdelse og fredning i Kongeriget Danmark, 1805.

Fritzbøger, B. (1992): Danske skove 1500-1800, en landskabshistoriske undersøgelse. Landbohistorisk Selskab, Odense.

Fritzbøger, B. (1994): Kulturskoven, dansk skovbrug fra oldtid til nutid. Skov- og Naturstyrelsen, Miljøministeriet, København.

Fritzbøger, B. & Søndergaard, P. (1995): A short history of forest uses. Pp. 11-41 in *Hytönen, M. (ed.): Multi-use forestry in the Nordic countries.* The Finnish Forest Research Institute, Helsinki.

Fry, G. & Sarlöv-Herlin, I. (1995): Landscape design; how do we incorporate ecological, cultural and aesthetic values in design principles? pp. 51-60 in *Griffiths, G.H. (ed.): Landscape Ecology: Theory and application. Proceedings of the fourth annual IALE(UK) conference, held at The University of Reading,* 19-20th. Sept. 1995.

Fry, G. & Sarlöv-Herlin, I. (1997): The ecological and amenity functions of woodland edges in the agricultural landscape, a basis for design and management. *Landscape and Urban planning,* 37 (1-2): 45-55.

Helles, F. & Linddal, M. (1996): Afforestation experience in the Nordic countries. Nord 1996: 15, Nord. Ministerråd, Kbhvn.

Helsinki Conference (1993): Resolution H1 General guidelines for the sustainable management of forests in Europe. Ministerial conferences on the protection of forests in Europe, Second Ministerial conference in Helsinki, june 1993.

Hytönen, M. (ed.)(1995): Multi-use forestry in the Nordic countries. The Finnish Forest Research Institute, Helsinki.

Jensen, F.S. (1998): Befolkningens syn på skovrejsning og ændret anvendelse af landbrugsjord, *Videnblad, Planlægning* 3: 11-23, Forskningscentret for Skov og Landskab, København.

Jensen, F.S. & Koch, N.E. (1997): Friluftsliv i skovene 1976/77 - 1993/94. Forskningsserien, 20, Forskningscentret for Skov og Landskab, Miljø- og Energiministeriet, København.

Jensen, K.M. (1976): Opgivne og tilplantede landbrugsarealer i Jylland. Atlas over Danmark, serie II, bind I, København.

Jensen, R.H. & Jensen, K.M. (1979): Kulturlandskabet i Borris - Sdr. Felding. *Geografisk Tidsskrift,* 78/79: 61-99.

Karjalainen, E. (1996): Scenic preferences concerning clear-fell areas in Finland. *Landscape Research,* 21,2: 159-173.

Komdeur, J. & Gabrielsen, L. (1995): Effects of forest fragmentation on breeding bird populations in Denmark. Pp. 37 in *Skov F. et al. (ed): Proceedings of the second CONNECT workshop on landscape ecology 1993, principles and tools for the study of landscape ecology potentials and limitations.* NERI technical report no.131, Ministry of Environment and Energy, National Environmental Research Institute.

Landbrugsministeriet (1986): En fremtidig skovpolitik, Betænkning nr.1090. Landbrugsministeriet, udgivet af Dansk Skovforening, *Dansk Skovforenings Tidsskrift,* Særnummer, April, 1987.

Lawesson, J.E., De Blust, G., Grashof, C., Firbank, L., Honnay, O., Hermy, M., Hobitz, P. & Jensen, L.M. (1998): Species diversity and area-relationships in Danish nemorale forests. *Forest Ecology and Management* 106: 235-245.

Levins, R. (1970): Extinctions, in Some mathematical questions in biology. *Lectures on mathematics in life science,* 2: 77-107. *American* mathematical society, Rhode Islands.

Lindgren, C.A. (1995): Forest Aesthetics. Pp.279-293 in *Hytönen, M. (ed): Multi-use forestry in the Nordic countries.* The Finnish Forest Research Institute, Helsinki.

Lucas, O.W.R. (1991): The design of forest landscapes. Oxford University Press.

Miljø- og Energiministeriet (1997): Skovrejsning, vejledning 20. Feb. 1997. Skov- og Naturstyrelsen, Miljø- & Energiministeriet, København.

Ministry of the Environment (1989): Act of Forests-Denmark. National Forest and Nature Agency, Copenhagen.

Ministry of the Environment (1994): Strategy for Natural Forests and other forest types of high conservation value in Denmark. Ministry of the Environment. The National Forest and Nature Agency, Copenhagen.

Ministry of Environment and Energy (1996): The Forest Act 1996. National Forest and Nature Agency, Copenhagen.

Opdam, P. (1991): Metapopulation theory and habitat fragmentation, a review of holarctic breeding bird studies. Landscape *Ecology* 5 (2): 93-106.

Peterken, G.F. & Game, M. (1984): Historical factors affecting the number and distribution of vascular plant species in the woodlands of central Lincolnshire. *Journal of Ecology,* 72: 155-182.

Price, C. (1997): Twenty-five years of forestry cost-benefit analysis in Britain. *Forestry* 70 (3): 171-189.

Reenberg, A. (1994): Marginaljorder og landskabet. Pp.11-19. in *Brandt, J. & Primdahl, J.(eds.): Marginaljorder og landskabet -marginaliseringsdebatten 10 år efter.* Rapport fra et tværfagligt seminar afholdt af Landskabsøkologisk Forening i samarbejde med Institut for Økonomi, Skov og Landskab, KVL, Forskningsserien , 6, 1994, Forskningscentret for Skov og Landskab, København.

Reenberg, A. (1998): Agricultural Systems in Space and Time - The Dynamic Mosaic of Land Use, *this volume,* pp.181-190.

Reenberg, A. & Jensen, K.M. (1989): Marginaljorder i Norden, problem eller mulighed? *Geografisk Tidsskrift,* 89: 1-3.

Saastamoinen, O., Hultman, S.G., Elers Kock, N. & Mattsson, L. (eds.)(1984): Multiple-use forestry in the Scandinavian countries. Proceedings of the Scandinavian symposium held in Rovaniemi and Saariselka, Finland, Sept. 13-17, 1982, Helsinki.

Thorne, J.F. & Huang, C. (1991): Toward a landscape ecological aesthetic: Methodologies for designers and planners. *Landscape and Urban Planning,* 21: 61-79.

Watkins, C. (1993): Ecological effects of afforestation, studies in the history and ecology of afforestation in Western Europe. CAB international, Wallingford.

Zacharias, D. & Brandes, D. (1990): Species area-relationships and frequency, floristical data analysis of 44 isolated woods in northwestern Germany. *Vegetatio* 88: 21-29.

and shape), the other considers the whole landscape (corridor, network, connectivity, scale, cover, unity, and diversity). An awareness of these two spatial levels is found to have wide implications for the success of implementing multi-purpose forestry. By discussing the planning framework (legislation, regulation and administration) of private afforestation in Denmark it is found that these spatial levels are not taken into explicit consideration. Further, it is evaluated that this practice can have inexpedient consequences for the achievement of the objectives of the afforestation programme and further for the actual value of future afforestation in the Danish countryside.

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References

Asbirk, S. (1995): Naturens aktuelle tilstand. Pp.12-25 in *Skov- og Naturstyrelsen: Naturen tur-retur, om naturovervågning og naturforvaltning.* Miljø- og Energiministeriet, København.

Asferg, T., Pagh, S., Rosengaard, M. & Bertelsen, J. (1996): Forekomst af egern *Sciurus vulgaris i skove under 20 ha, et eksempel på fragmentering af landskabet i Århus Amt.* Faglig rapport fra DMU, no.184, Afd. for landskabsøkologi, Miljø- og Energiministeriet, København.

Bateman, I.J. (1996): An economic comparison of forest recreation, timber and carbon fixing values with agriculture in Wales: A geographical information systems approach. Unpublished PhD-thesis, University of Nottingham.

Bell, S. (1993): Elements of visual design in the landscape. E. & F. Spon, London.

Bell, S. (1995): New woodlands in the landscape. Pp.27-47 in *Ferris-Kann, R. (ed.): The ecology of woodland creation.* The Forestry Authority, John Wiley & Son, Chichester.

Bishop, K. (1990): Multi-purpose woodlands in the countryside around towns. Unpublished PhD-thesis, Univers. of Reading.

Buysse, W. (1993): Ecological restrictions on the afforestation af valley grounds in Flanders, Belgium: Guidelines for Government Policy. Pp. 191-199 in *Watkins, C.: Ecological effects of afforestation, studies in the history and ecology of afforestation in Western Europe.* CAB international, Wallingford.

Christensen, J.B. (1988): An economic approach to assessing the value of recreation with special reference to forest areas. Reports from Department of Forestry, Series 2: Research 1988, The Royal Veterinary and Agricultural University, Copenhagen.

Crowe, D.S. (1978): The landscape of forests and woods. Forestry Commission, booklet 44, HMSO, London.

Dawson, D. (1994): Are habitat corridors conduits for animals and plants in a fragmented landscape? a review of scientific evidence. English Nature Research Reports No. 94, English Nature.

Dubgaard, A. (1998): Economic Valuation of Recreational Benefits from Danish Forests. Pp. 53-64 in *Dabbert, S. et al (eds.): Economics of landscape and wildlife conservation.* CAB International, Wallingford.

Fahrig, L. & Merriam, G. (1985): Habitat patch connectivity and population survival. *Ecology* 66: 1762-1768.

Ferris-Kaan (ed.)(1995): The ecology of woodland creation. The Forestry Authority, John Wiley & Son, Chichester.

Forestry Commission (1991): Forestry Policy for Great Britain. Forestry Commission, Edinburgh.

Forman, R.T.T. (1997): Land mosaics, the ecology of landscapes and regions. Cambridge University Press.

Forman, R.T.T. & Godron, M. (1986): Landscape Ecology. John Wiley and Sons, New York.

Fredsskovsforordningen (1805): Forordning om skovens udskiftning, vedligeholdelse og fredning i Kongeriget Danmark, 1805.

Fritzbøger, B. (1992): Danske skove 1500-1800, en landskabshistoriske undersøgelse. Landbohistorisk Selskab, Odense.

Fritzbøger, B. (1994): Kulturskoven, dansk skovbrug fra oldtid til nutid. Skov- og Naturstyrelsen, Miljøministeriet, København.

Fritzbøger, B. & Søndergaard, P. (1995): A short history of forest uses. Pp. 11-41 in *Hytönen, M. (ed.): Multi-use forestry in the Nordic countries.* The Finnish Forest Research Institute, Helsinki.

Fry, G. & Sarlöv-Herlin, I. (1995): Landscape design; how do we incorporate ecological, cultural and aesthetic values in design principles? pp. 51-60 in *Griffiths, G.H. (ed.): Landscape Ecology: Theory and application. Proceedings of the fourth annual IALE(UK) conference, held at The University of Reading,* 19-20th. Sept. 1995.