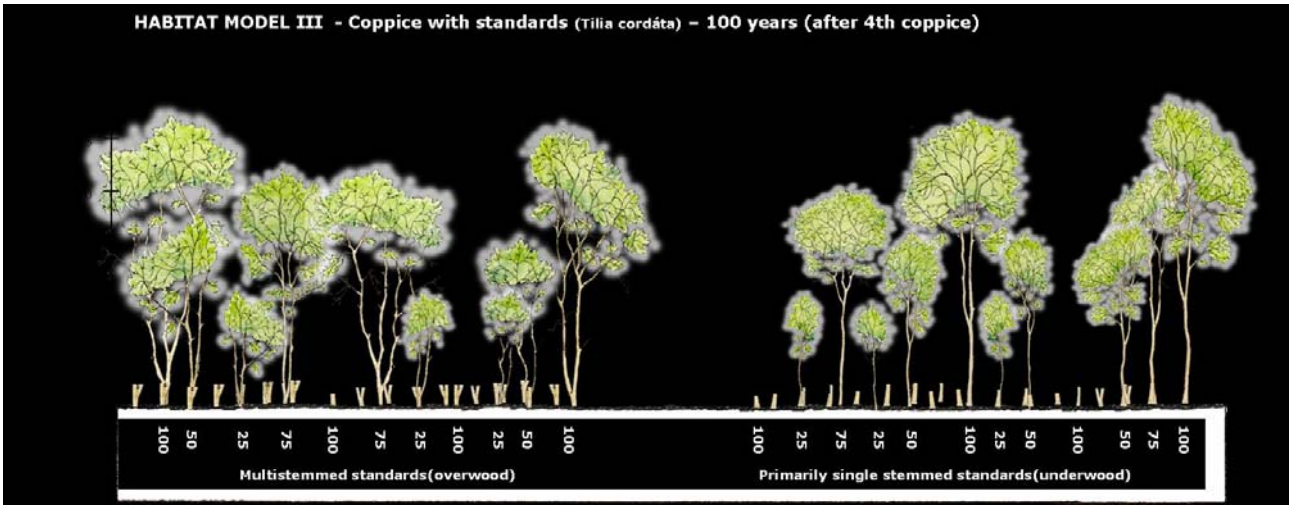
Future perspectives on Urban afforestation in relation to planting design

- Learning from three paradigmatic cases

Thesis finalizing the international master programme in
Urban Forestry & Urban Greening (P0401)



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Preface

This thesis is made as the conclusion of an international master's programme in Urban Forestry & Urban Greening.

The main responsible university has been the Swedish Agricultural University, Alnarp housing this one year NOVA programme. Half the courses have been hosted by the Royal Veterinary and Agricultural University (KVL) in Denmark.

Experiencing and working with students and lecturers from different cultures all over the world has been priceless, educative and fun ..

Since afforestation, as one of the major tools of strengthening the ever endangered urban green room, is a true visionary process my interest in visualising different approaches was woken. Especially in relation to what are the possibilities and that involvement of the public is the quintessence of successful planning. Here the use of profile diagrams is a brilliant tool for further discussion and debate.

I would like to use the opportunity to thank the following characters (not just anonymous persons) - characters because each has with their own energy, wisdom and persona contributed to this project.

- Ph.D. Anders Busse Nielsen (KVL) for pointing me towards this topic and helping me structuring and inspire me in many ways. Anders is a true 1st generation urban forester who can juggle with all the facets that are required and many more. It is solely because of Anders´ beautiful digitized trees that a forester like me, can tread on the dangerous path of making profile diagrams.
- Professor Roland Gustavsson (SLU) for taking time to correct the models according to the Landscape laboratory icons which is one of his own "children" and not the least for being a philosophical beacon and teaching me both to observe a landscape as well as being part of it.
- Professor J. Bo Larsen (KVL) for using time to correct and develop the models for the nature based afforestation and for settling with the general notion that forestry professors are dusty and conservative.
- Landscape architect Carl Aage Sørensen (Municipality of Holstebro) for hosting a fruitful (and wet) trip to the landscape laboratory in Holstebro. As I have worked in a municipality myself, I am really envious of all people that have been his employees.
- Forest & Landscape Engineer (Ranger) Anders Hersø Pedersen (Danish Forest & Nature Agency) for hosting an excursion to the first real nature based afforestation (according to Larsen et al. 2005) project in Denmark. It showed that all the core values of urban afforestation can be handled in a very professional way. There are important lessons to be taught in that plot in the future.

Spending more time doing this project would have been more satisfying in order to delve further into the topic. However being dissatisfied in that matter seems a luxury since my very supporting wife would like to spend more time with me (and visa versa), and deserves gratitude unmeasured. What every person experiences during project work, is a disconnection to the surroundings and an entry into a parallel universe 24 hours a day. So I welcome back sanity and reality once more.

Rasmus Bartholdy Jensen, Copenhagen, June 2006

Summary

Afforestation, as part of remedying the vast exploits of the forest resource in NW Europe, seems to have a high importance on both EU and national level. Due to the fact that this part of Europe is densely populated it is fair to say that a major part of afforestation will be situated within urban influences and is hence future urban forest. Social and Recreational aspects are usually of higher importance than economic aspects in an urban area.

Looking at one important aspect of recreation is visual aspects. Four different visual criteria has been identified (scale, diversity, naturalness and visual accessibility) together with three management criteria (flexibility, knowledge and resources) which all represents essential sides to afforestation design.

In order to relate the criteria to an analysis of different afforestation designs, profile diagrams were used. These profiles were developed as a “snapshot” from 10 years through 25, 50, 90 and some older. Using profile diagrams as a tool made it easy to make a comparative study of three afforestation paradigms - Classical forestry, Nature Based forestry and the Landscape laboratory approach.

By using “high, medium and low” as value in relation to each criteria a comprehensive matrix was made. The analysis made it evident that designing together with proper management gives a wide palette of visual aspects.

When relating to different surveys of forest types and public interests it is clear that the interests are very wide. In a design perspective this gives motivation to keep variation high to accommodate a wide range of users and to keep a flexible system.

KEYWORDS: Afforestation, Urban forestry, Visual aspects, Visual criteria, Management aspects, Management criteria, Planting design, Forest cultures, Nature based forestry, Classical forestry, Landscape laboratory

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1. Introduction

In order to make a frame of the scope and intentions of the present project, a general overview of terms, status and situation is given in this paragraph. This should hopefully give a logical approach to presenting a problem statement and hypothesis which can motivate further scrutiny

1.1 Introducing Urban Forestry and afforestation in a larger context

1.1.1 Urban forests and overall functions

The importance and demand for urban forests is presumed to increase because of the continuously growing urban sprawl. More than 70% of the European population lives in urban areas and at the currant rate this will increase by another 4 percent within the next 15 years. (MCPFE 2003, Ode and Fry 2002, Randrup et al. 2005, Konijnendijk 2005). Urban woodlands (and greening) constitute an important element of cities and their development with a large amount of functions, amenities and values (Randrup et al. 2005). Building and strengthening the green structures through afforestation, is one of the tools that will correlate with the future development as shown in paragraph 1.1.2.

In a spatial context Janssens (2002) mentions Western Europe as a much urbanised area. If taking this into consideration as well, when talking about afforestation, it is assumed that a large part of afforestation projects will be enshrouded in what this project defines as urban forestry.

According to Randrup et al. (2005) the concept of "urban forestry" reached Europe in the 1980´ies. It originated from North America as a term that was including hitherto, in European context, more or less unknown values to the classical terminology surrounding "forestry". Adding "urban" to the term "forestry" has developed a diversified set of definitions since both words has each different uses and meanings correlated to social and cultural backgrounds (not just necessarily language) being used and combining them gives an even wider interpretation.

In spite of all the differences a general agreement seems to contain the following strengths:

- It is integrative, incorporating different elements and values into a whole
- It is strategic, aimed at developing longer term policies and plans for urban tree resources, bridging different sectors
- It delivers multiple benefits including the economic, environmental and socio-cultural goods and services urban forests delivers
- It is multidisciplinary and interdisciplinary
- It is participatory, trying to support and evolve partnerships between stakeholders (Randrup et al. 2005)

The term "peri-urban forest" is often used in the same context as urban forestry and should as such be complementary. The most concrete definition found in the chosen literature is Kowarik (2005) who mentions the term as being woodlands that lie in the vicinity of the city and are deeply imbedded in the landscape encompassing agriculture and village life. Peri-urban areas are mostly subject to increasing urbanisation.

Gustavsson (2002) mentions that when defining what "urban forest" is care should be taken not only to include our modern term of what "woodland" or "forest" is interpreted as; namely as related to forestry practice and timber production. Instead it should also relate to a larger concept where more open types of vegetation that historically belongs to "woodland" are included. This seems to

be an important addition to the concept and is as well adopted into the basic understanding of the present project.

When discussing the overall functions or values of forests the three dimensions of sustainability: economy, ecology and socio-cultural are the foundation (Larsen 2005, Randrup et al. 2005, MCPFE 2003 and Weber 2000). So how do the functions (at least economy and social-cultural) of woodlands correspond to the nearness of urban environment?

The model adopted from Kowarik (2005) (*figure 1*) shows that with increasing proximity to urban areas the higher accessibility for recreation seeking residents grows. Derived from that, so does the social function (Kowarik 2005). He thereby states a sort of reversed proportionality with production and that the spatial characteristic generally corresponds to the different functions of the forests. In short this is a very graphic way of emphasising the social importance and thus the recreational importance, when discussing urban forestry and future afforestation.

Forest Type	Sub-type/description	Spatial characteristics
Urban woodlands	Woodlands within urban areas	Isolated in built-up areas
	Woodlands on the urban fringe	Between built-up areas and the open landscape
Peri-urban woodlands	Woodlands in the vicinity of urban areas	Part of the open (cultural) landscape close to urban areas
Non-urban woodlands	Woodlands from urban areas	Part of the open (near-natural) landscape far from urban areas

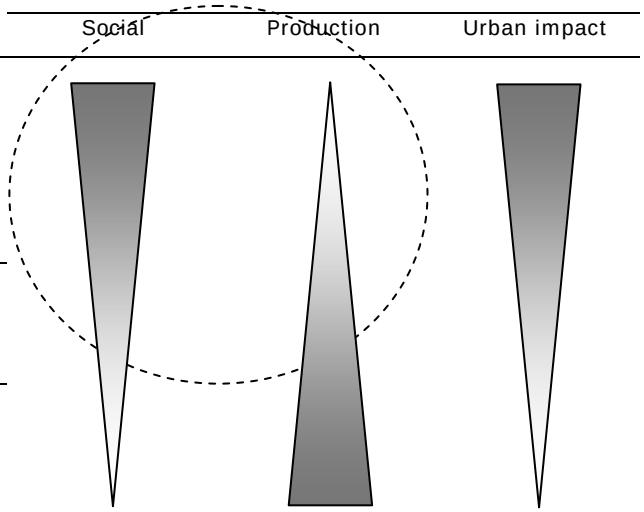

Figure 1: Spatial differentiation of urban, peri-urban and non-urban woodlands according to their location relative to urban areas. (Kowarik, 2005 p.5). The dotted circle indicates the main emphasis on afforestation this project has.

1.1.2 Forests & afforestation in North Western Europe

Urban afforestation has a wide interest on political level in EU mostly because of the primary motivations of Agenda 2000, the Lisbon Resolution and Kyoto agreement (MCPFE 2003, Weber 2000) who all relates in some way or another to the connection between raising new forest and sustainability. In the same instance "recreation", as part of sustainability, is mentioned as an important objective for urban woodland management and planning in EU´s Sixth Environment Action Programme (Ode and Fry 2002).

However it is well known that huge areas in Europe have a high interest in mainly production functions (economy) or if it is related to areas of relative non-urban woodlands *(*according to *figure 1)*. These countries with a high forest cover; like mid/northern Sweden, Finland parts of Germany and France where the forest cover is above 50, 60 or even 70% (FAO 2005) have different needs and can keep the social function at its lowest, and afforestation is likely a matter of lesser importance.

On the other hand countries like Denmark and Iceland has a quite low forest cover where afforestation has a higher priority (www.skovognatur.dk 2006; Kristensen 2005).

Taking all the differences into consideration it is still possible to divide Europe into what could be termed “forest cultures”. The four zones can be seen on *figure 2*. They reflect the climatic and ecological differences, the importance of forests in the national economy and as part of the landscape and the way forests and trees relate to local identity through traditions, forms of recreation, legends and folktale (Bell et al. 2005).

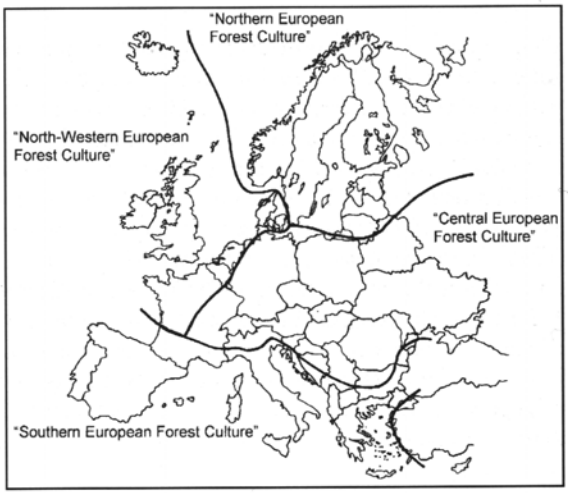

Figure 2: The four different forest cultures in Europe (Bell, 2005 in Randrup, 2005)

The focus of this project will be on the **north-western European forest culture**. This includes Britain, Ireland, Belgium, the Nederlands, Denmark, Southern Sweden, north-east France and Iceland .What characterizes these areas is that they have lost most of their forest cover over the last 3-4 thousand years, so that the present forest cover occupies a small percentage of the land area. The functions of the forests are mainly made with production perspective (plantations). Sometimes forests are seen as alien places and are as such less spiritually connected to them than e.g. people in Finland and northern Sweden (Bell et al. 2005).

When trying to investigate visions of afforestation Mather (2000) states that the complexity of different policies or so-called “drivers” of afforestation makes it doubtful whether useful modelling of European-wide afforestation rates can be achieved in the foreseeable future. At any rate has the author with the help of Anders Busse Nielsen tried to present a overview of what direction the afforestation is taking in the temperate zone of north western Europe *(figure 3).*

It is obvious that afforestation is on the agenda of the presented countries and that there is an intensive afforestation being planned and carried out.

If questioning why Iceland is included it is in fact a highly relevant “member” of the spoken forest culture. When Vikings arrived in 874 Iceland was covered with between 25-40% of forest. The (mis)use of the forest stopped in the 1950´ies when there was only 1% left. They now have extensive and elaborate afforestation programs considering the size (and climate) of the country (Kristensen 2005).

The European forest cover is in general expanding at an annual rate of 0.3% while global forest shrinks (Weber, 2000). As urban forests are expanding and growing in Europe the question is whether any afforestation paradigms of design can be identified and compared and how can this be disseminated and discussed.

Countries in the North West Europe forest culture	Present forest cover in % Total forest area in (1000 ha)	Strategic goal (forest cover)	Afforestation in ha (planned)
Ireland[1]	9,6% (659 ha)	17% in 2030	700.000
United Kingdom[2]	11,6% including Wales and Scotland (2.790 ha)	Double the forest cover (20%?)	~ 2.000.000 12.000 ha/year
Denmark[3]	14% (485 ha)	Double the forests cover in 100 years (20%)	~ 400.000 Goal is 5.000 ha/year – not fulfilled!
Southern Sweden (Scania)[4]	31%. >72% of total land cover (27.134 ha)	More urban forests around major cities	n.a.
Iceland[5]	1% (150 ha)	5% at elevations <400m in 40 years	60.000 1.500 each year
Belgium[6]	10.8% (728 ha)	Positive strategies but no long term number found	13,665
Nederland[7]	11% (375 ha)	75.000 ha new forest starting 1992	75.000
North East France[8]	8-10%. >27% of total land cover (15.341 ha)	The cover is growing but no specific goal could be found	n.a.

Figure 3: Present forest cover in hectares and future perspectives for afforestation in the North Western European

Local residents hold consequences of management on aesthetic and recreational values of the forest in the highest regard. But traditional forest plans consists of thematic maps and numeric data on stand conditions which holds little information on recreational values. New woodlands should fulfil the public's expectations and although the participatory approach in urban forest planning is a value in itself, efficient tools are needed to make the process work (Tyrväinen et al. 2005).

The sharing of knowledge is important both between different professional fields as well as local knowledge in the planning process. The reference landscape or full scale laboratories is of great assistance to create a frame for sharing this knowledge (Gustavsson 2002, Gustavsson and Jönsson 2002). But in order to produce full scale benefits of woodlands the time span of decades, even more than 100 years makes it difficult for the public (and politicians) to comprehend short- and long term goals. So the combination of using full scale relations with the potential in using visualisation for increasing the collaborative planning and design of urban forests in Europe has an interesting angle and is described in Tyrväinen et al. 2005.

[1] Weber, N. (2000), www.forfas.ie, FAO (2005)
[2] England Forestry Strategy (1999), FAO (2005)
[3] Danish Forest & Nature Agency (www.skonognatur.dk)
[4] Rydberg, D. (2006), FAO (2005)
[5] Kristensen (2005), Hagstofa Islands (2002), FAO (2005)
[6] Nachtergaele, J. (2002), FAO (2005)
[7] Van den Berg, R (2002), FAO (2005)
[8] Konijnendijk C. (2006), FAO (2005)

1.2 Framing the project

1.2.1 Problem statement & Hypothesis

With the above presentation of urban afforestation on macro (European) level, meso (country) level a movement towards the micro (forest/stand) level seems natural. The fact that visual aspects are part of recreation, especially in urban forestry, a further study of this is chosen as entry.

The questions asked are then:

"Can a contemporary analogy of some of the paradigms of afforestation show differences in visual qualities?"

"Can general management differences between these aspects be identified?"

and…

"What can be taught from this when put in an urban context and discussed in relation to public demands?"

In order to answer this, the following hypothesis is made:

By using profile diagrams as a tool to visualize three overall paradigms it is possible to give a comparative analysis of different visual qualities as well as touch on some management aspects. As useful references in future urban afforestation both in relation to planning aspects and communication with the public, three paradigms forms a basis:

a) Nature based afforestation,

b) Classical North western European afforestation and

c) The Landscape laboratory approach

1.2.2 Assumptions

It is assumed that the close to nature forest management approach as stated in "Nature Based Forestry (Naturnær Skovdrift) (Larsen et al. 2005)" will constitute one of the key impacts on Danish forestry management in the future and that this paradigm is part of a general movement in the north western European forestry. This is grounded on the fact that sustainable use of forestry has a growing focus on political, management and public level (Randrup et al. 2005, Larsen et al. 2005, and Nielsen 2006).

The approaches used in the landscape laboratories in southern Scandinavia will be used as inspiration especially in relation to recreational and urban forest stands in the future. This will form the paradigm of designed highly recreational forestry in the future.

The classical forestry approach (monoculture) or paradigm is still a strong idiom in forestry terms of today and will probably have a strong influence in the future with some modifications as to choice of species, thinning methods and regeneration.

It is also presumed that many (or more) of the ongoing and future afforestation projects in North West Europe are situated within urban influence.

1.2.3 Limitations

Within (urban) afforestation there are a multitude of facets like interior, soil preparation, edges, hydrology, paths systems, soil condition, selection of tree species and provenance, economic issues,

silviculture, participation, amenities etc. The scope of this project is primarily to suggest a visual value to different afforestation designs and in the same instance give a brief inspection of some management issues. Some of the subtopics will be touched only briefly.

The paradigms will, due to the relative short time, (only) be assessed on the basis of two "criteria pillars": Visual and Management aspects. As these two "pillars" have an abundance of related terms and subjects only a few selected criteria has been chosen as platform.

1.2.4 Definitions

The following expressions are paragon to the meaning of this project and deserve a closer definition.

***Paradigm**:* a set of forms all of which contain a particular element. Also the set of all inflected forms based on a single stem or theme. Synonyms: ideal, standard (Websters 1989). The paradigms discussed in this project will be in relation to afforestation as described above. The three paradigms discussed in this project are: Classical Afforestation, Nature Based Afforestation and Laboratory approach afforestation

If interpreting the word "religion" as a specific fundamental set of beliefs and practices generally agreed upon by a number of persons; then there is a rather short distance to the word "paradigm". It is assumed that a paradigm has an overall influence on managers and planners of afforestation in general and *some* could relate to it as a sort of religion, depending on the individual relation to belief.

***Icon**:* a picture, image, or other representation. A sign or representation that stands for its object by virtue of a resemblance or analogy to it (Websters 1989). The word "Icon" will be used as the set of overall "beliefs" forming a paradigm; e.g. "monoculture" as one icon for Classical afforestation. The icon does have the same sort of "religious" sense as described above and can also be seen as sub-beacons of a whole paradigm. In this sense a paradigm can contain several icons and will constitute an iconography in unison.

***Icon-setters**:* individual persons who will be interviewed as they have had a significant influence on the outcome or creation of an icon.

Manager/Practitioner: individual persons who through practical knowledge has explored different icons or whole paradigms in reality.

***Concept**:*. An idea of something formed by mentally combining all its characteristics or particulars; a construct (Websters 1989). The emphasis here is on the "idea" of the design. The concept is here thought upon as the simplest expression of an idea made without loosing "its" true identity. An "icon" is meant as being built on a set of different concepts or you could call it designs. Randrup et al. (2005) states that "concepts" are to be considered as mental representations of objects within a specialized context or field.

Afforestation: to convert bare or cultivated land into forest (Websters 1989). In this sense planting, sowing and spontaneous regeneration represents the main methods used.

Term			
Paradigm	*Landscape laboratory approach*	*Nature Based forestry*	*Classical forestry*
Icon(s)	Seedling model Gradient model Habitat model	19 different Forest Development Types (FDT´s) the one called "12" is explored later in the project	Plantation forestry
Concepts (examples of..) or designs	Examples of designs or concepts of the Habitat model alone is: Monoculture Coppice with standards The Grove	Natural succession Nature based The forced approach	Monoculture
Icon setter/Researcher	Roland Gustavsson	J. Bo Larsen	As a 250 year old discipline a literature study will support this.
Manager/Practitioner	Carl Aage Sørensen	Anders Hersø Pedersen	

Figure 4: Definition overview

1.2.5 Method

Working through the paradigms started out by identifying and studying relevant literature of the topic. Next step was to create some preliminary profile diagrams of the different icons constituting the paradigm in order to get a "feel" of it and at this stage to put up some visual and management aspects. With this as basis study, three areas were visited in order to see and hear of examples of to what extent the paradigms had been realised. After these excursions the profile diagrams where refined before visiting two researchers of the new paradigms. Here the profiles where presented and discussed and refined again and a general discussion of visual and management topics was commenced. The finalized profiles were then assessed by using different objective visual and management criteria which are valued low, medium and high in order to keep it simple and more credible. Using numbers would make little sense since the criteria, though presumably objective, cannot match a numerical identification made by one person. It relates more to a qualitative measure than quantitative one.

Using profile diagrams

Nielsen (2006) relates to the fact that standard perimeters such as species, age, height, growing stock and site conditions in general is enough for a skilled forester, by the use of intuition, to envision it in reality. However this is mostly related to simple stand structures, such as the monoculture. When it comes to irregular and diverse structures simple numbers comes short.

Gustavsson and Ingelög (1994) uses profile diagrams to give way of creating a common language or communication platform from where management and design issues can be discussed without using a lot of words - *see appendix I (D)*. This is the main motivation of using this instrument in order to promote discussion on visual aspects and management in relation to creating new forests.

The profile diagrams are made on basis of the digital drawings of tree profiles (a tree library) of Anders Busse Nielsen. The theoretical development in year 10, 25, 50, 90 and 120 where necessary has been chosen as good representations of the different steps. The continuing development of the tree height has been made by the aid of the biometric tables of Møller et al. 1990. Concerning the

ages where the different species can be expected to start reproducing has been based on the table of Gustavsson and Ingelög (1994) *see appendix I (B).*

Average growing conditions were chosen in order to give a realistic picture - *see appendix I (A).* The general silvicultural management of the different paradigms has been discussed with respectively Roland Gustavsson (2006) and J. Bo Larsen (2006).

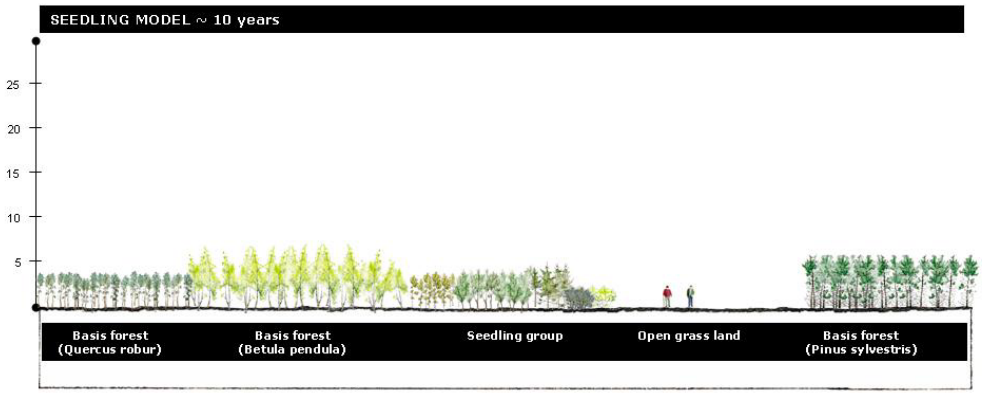

Figure 5: Example of one of the profile diagrams made for the present project. The whole catalogue can be seen in appendix II.

It is important to underline that the paradigms are not restraint to one or more specific tree species. It is the thought and idea behind that is important the choice of species relies solely on the interviews and the "mood" of the author.

Visual and management criteria

The criteria of the visual aspects used to analyse the profile diagrams are founded upon the work of Ode and Fry (2002) and Ode (2003) who has made elaborate studies of the topic based on landscape aesthetics theory and combining this with what is supported by management guidelines.

The management criteria are based on factors as: resources, knowledge and flexibility. This has been presented in the interviews as well. Especially knowledge criteria are based on the work of Gustavsson (2002) and Gustavsson and Jönsson (2002).

With the criteria in hand a, some would call cynical, analysis was made and these results have been set in a short and concise matrix or scorecard in order to give an overview.

Visiting a forest stand and assessing it is in essence not a problem as you relate to a somewhat static picture. The same happens when trying to assess a single profile diagram which is also static. When dealing with afforestation paradigms which are extrapolated into the future in order to see different evolutionary steps the problem arises – should every age step be assessed accordingly? It has been chosen to give an overall evaluation or assessment of the more permanent situation in the stands with the emphasis of the older age, because this is where the full scale values of a forest is expressed (Tyrväinen et al. 2005). The value of the young forest can be extremely high (through the use of creative management (Nielsen 2005c)) butt is more temporal. Aspects of the younger age will be described sporadically in the analysis. It would be to complex to disseminate an analysis of all the ages and difficult to discuss in such a short project.

The simplicity of the matrix or scorecard will be used as the jump board for the discussion.

2. Presentation of the paradigms

Below follows an insight in the different paradigms. Initially a short introduction to the placement of the paradigms in historical context is given. Following is an introduction to the concepts and motivation of the different ideologies. This is ended by showing a case of urban afforestation where the paradigm has been used in full scale. The different icons can be seen visualized in the Profile Catalogue (Appendix II).

When the European Forest Institute defines the overall purpose of new forests, in "Afforestation at the turn of the century" (Weber 2000), they focus on the overall historical trends, characterized by the period before, under and after the Industrialisation in the 19th century.

Period	Function	Regime	The paradigms and their respective placement
Pre-industrial	Multi-functional, Wood, fuel, grazing, fodder, food	Communal	Laboratory approach Nature based forestry
Industrial	Mono-functional, Industrial wood	Private	Classical forestry
Post-industrial	Multi-functional, Recreational, wildlife, amenity, wood	Regulated	Laboratory approach Nature based forestry

Figure 6: Forest paradigms adopted by Mather (1990) in Weber 2000. The three overall paradigms added in the last column show the context and ideological belonging in history.

When looking at the paradigms in *figure 6* and the respective function and period one could argue that we are experiencing a "retro" period in European forestry - or a positive regression. This is at some point true since Larsen et al. (2005), Nielsen et al. (2005 c, d, e) and Gustavsson (2002) all are arguing for using nature and natural processes support the design, goals and visions of forestry and thus afforestation, in order to achieve better stability and a sustainable use of the forest resource . It relates more to the general processes of old forestry systems more than to the general decline of forested areas in older history.

The term "Regulated" under "Regime" in *figure 6* should be interpreted in the widest sense, as a feature of the post-industrial forest. Public demands and benefits are adapted to private ownership through the mediation of some form of regulation. This is according to Randrup et al. (2005) and Weber (2000) usually a combination of incentives and restrictions depending on the ownership of the land/forest.

Adding the paradigms to Mather´s model has been done in order to show where the basic Silvicultural systems derive from. Both the Landscape laboratory approach and Nature based forestry has inspiration in old forestry systems. Some are a direct analogy of old forest system, like coppice forest, but new systems are also explored.

2.1 Landscape laboratory approach

The representative models of this approach can be seen visualized in the profile catalogue pp.3-15

The term "laboratory" was first defined by Humboldt as an experimental meeting place between different knowledge fields (Tyrväinen et al. 2005, Gustavsson 2002). Adding Landscape to the term Laboratory stresses the role of landscape and spatial aspects.

It is the intension to create a local landscape where full scale studies of different landscape systems and forestry stands can be made at the same time as it has the function of being a recreational forest (Nielsen 2005a). Terms like research, demonstration, innovation, expression, education, dissemination, communication and recreation are part of the common language of the paradigm.

Using modern theory at the same time as reinventing old and forgotten management systems the idea is to repeat certain forest structures as well as trying out some new ones in each landscape laboratory. Today three laboratories exist in southern Scandinavia. Two in Scania(Sweden) – one at SLU, Alnarp and one at Snogeholm (40 km south east of Malmö). The one in Denmark is situated at Holstebro, Jutland. (Gustavsson 2002). All three of them challenge the traditional (or classical) afforestation methods. Combining and planting new and old woodland species in new and old ways, using different species and utilizing old and new more creative management methods and tending (Nielsen et al. 2005a,b,c,d and e).

The vision is to create a series of laboratories all over Europe in order to explore local differences and the different development of species.

In relation to afforestation there is no single concept since diversity is important and is a clue in the paradigm. But one thing that can be categorized is the gradient of complexity (complexity ladder) in the stands (Gustavsson 2002, Nielsen et al. 2005a,b). The different aspects of complexity can be seen in appendix I (D) – Gustavsson and Ingelög (1994).

Overall concepts:

- The monoculture; indigenous tree species can be studied in pure stands – for the first time in Swedish and Danish history. One layered crown structure.
- Simple mixtures with 2-3 species; fast growing species works as nurse trees and are supposed to be used the first 20-30 years. One-two layered crown structure
- Mixed plantations with up to 15 different species. Multi layered
- Differentiated planting distance –shifting from dense to open meadows

Figure 7: An example from the seedling model with an "island" of Fagus silvatica, Picea abies and Acer pseudoplantanus among others in an "ocean" of Betula sp. and Pinus silvatica. From Holstebro (Sletten) Denmark, April 2006. Photo RBJ

The Landscape Laboratory of Holstebro

The city of Holstebro decided to balance their urban development in order to keep the distance to the city centre more equal irrespectively of where in the city you lived. In 1997 an area of 160 ha was planned for urbanisation. The name for the project was “Sletten” or in English “The Plain” relating to the relative flat area of primarily farmland.

The idea was to make afforestation integrated to development of 400 houses in a district where people lives and is part of the landscape. This was conceived integrating the basic idea of a landscape laboratory invented by Roland Gustavsson and added with the ideas of Carl Aage Sørensen from the municipality of Holstebro.

Two types of villages have been planned. The ones inside the afforested areas are “Forest villages” each with a green common in the middle and all houses with direct access to the forest. The development plots outside the forest, placed on the meadows, have the character of a fort or “Fortified villages” with townhouses where the orientation is more inward, but they have the view of the plains and forest from each house. This will in time also give an interesting insight whether people have different perceptions on the same landscape – depending if they live in a “forest village” or a “fortified village”.

On *figure 8* three overall icons can be identified they also relate to the three different periods of construction (2000, 2001- 2002 and 2003).

The three colours do not give credit to the diversity of stands. In the green area (Habitat model) alone there are 36 different stands.

Figure 8: An overview of the landscape laboratory of Holstebro, Denmark. The three different colours relates to the three icons of this landscape laboratory: Green = Habitat model Yellow= Seedling model Blue = Gradient model

To the south is situated a major lake concluding the fact that this landscape, with forest as a northern frame and meadows as filling and the lake as a southern frame, is and will be immensely valuable in many ways (Sørensen 2002).

The Habitat model

The main concept is to explore different structures from the monoculture to the multilayered as described above. It is expected that after only 7-10 years several different forest habitats has been established with different complexity. The 36 stands are of a minimum of 0,4 ha. Eight stands are made with exotic species from respectively East Asia and North America. Species like Betula sp., Jugalns sp. Quercus sp,. Tsuga sp., Taxus sp., Syringa sp., Acer sp. and Abies with Larix sp. as nurse tree (Sørensen 2002).

Some stands are monocultures with e.g. Tilia cordata, Acer campestre and Pronus avium. But the main body of stands are represented by multiple species.68 different species has been planted in this model area with a standard planting distance of 1.5x 1.5m. (Sørensen 2002)

Many of the low woodland stands have never been tried in Denmark before.

There is a great potential of investigating new mixtures of species with the rising demand of multi functionality (Nielsen 2005d).

The Seedling model

The yellow area on *figure 8* embodies the concept of letting climax species regenerate under a pioneer forest. This has its basis in seedling biology and landscape ecology where it is the intensions to create a varied environment with an unpredictable regeneration process that will eventually accelerate (*see figure 7*).

Monocultures of pioneer species (or light demanding species) has been planted in approximately equal sized areas with a touch of open grassland in between- species that could be called the basic forest is constituted of: Quercus robur, Pinus sylvestris and Betula pendula (Nielsen 2005d).

Islands of species which represent a mature forest environment have been planted in seedling groups (e.g. Fagus silvativa, Malus silvestris, Picea Abies, Craetagus monogyna). The difference between the monoculture expressions which is interrupted by the varied seedling groups will by time hopefully give an interesting variation (Sørensen 2002, Nielsen 2005d).

The Gradient model

The blue area on *figure 8* plays with the concept of diversity in time and space. In the north is planted a rather complex forest type with a planting distance of 1.2x1.2m in order to create a dense forest environment. This environment changes into a more open forest structure with less complexity and deeper crowns. Here the planting distance is 2.5x2.5m and it ends up with planting distances of 15x15m.On the open meadow groups of 30-50 plants are planted with a distance of 0.3x0.3m in order to follow how self-thinning(auto-thinning) and how multiple stems share one crown. The three (four) gradients should create a variation which is inspired by old forest structures like grazing forest, hay meadows/forest meadows and the English garden. The gradient should in time give valuable knowledge of how different planting distance relates to different forest/meadow characters.

Quercus petrea, Fraxinus excelsior, craetagus monogyna, Coryllus avellana, Rosa sp. and Ribes viburnum are the main species. (Sørensen 2002 and Nielsen 2005d).

Figure 9 : Picture showing Carl Aage Sørensen in a motivated discussion on different management regimes in one of the Habitat stands of Holstebro Landscape laboratory. The scope is a multilayered East Asian forest. But how can the composition of ten different species be expressed even clearer? Larix leptolepis (Japanese Larch) and Juglans mandchurica (Manchurian walnut) can be seen in the background. (18th of April 2006)
Photo: RBJ

2.2 Nature Based Forestry

The representative models of this approach can be seen visualized in the profile catalogue pp.16-22.

When looking at the primary goal of Nature Based Forest Management (Larsen et al., 2005 p.4) statements like, *sustainable wood production* through *site classification, securing the forest climate, improving the soil conditions, improving of wood production, improving potential of regeneration and biodiversity* is presented. All these positive assertions are used as the rationale and argument for using nature based forest management. The founding philosophy behind this idea is to let nature do as much of the silviculture by itself.

When trying to assess the difference between classical forestry, with the even aged monoculture as icon, and Nature Based Forest Management, the movement from more area based considerations towards utilizing the different tree species ability to self thinning and to use single tree considerations for harvesting with natural regeneration as fundament for renewal is the main discrepancy.

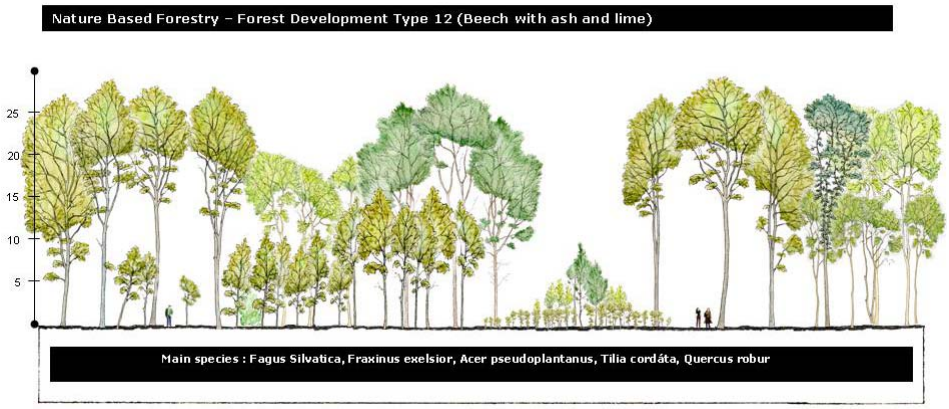

Figure 10: Example of how Forest Development Type no. 12 could look like. Main species are Fagus silvatica, Fraxinus ex. and Acer pseudoplatanus. Secondary species could be Pronus avium, Quercus robur, Carpinus betulus and Tilia cordata.. The growing conditions for this FDT has to be on relative fertile land with a relative high supply of water (see appendix II, Profile Catalogue).

According to Larsen et al. 2005) Nature Based Management relies on Site Classification. As it is a crucial point in this case to create a stable forest it is imperative to take the prevailing growing conditions into considerations. The longevity of a tree depends on two things: 1) Management and 2) Soil conditions, (Nørgård, 2005).

The system of choosing species is based on two indicators or regimes. The nutrient regime, with a classification of 1-6 with six as highest nutrient level and the moisture regime 1-9 with nine as a site with very strong groundwater influence. The combination of these regimes indicates a soil type that subsequently relates to the ecological amplitude of the different tree species as seen in the general forestry of Denmark.

A set of 19 different Forest Development Types (FDT) is presented in Larsen et al. (2005) as overall inspiration for both conversion of classical forestry stands and afforestation. The divergence of the FDT´s moves from untouched forest (no.94) through to grazing forest (no.92) and unto douglas fir with spruce and beech (no.61). They represent icons of different growing conditions on Danish soil.

Nature based afforestation

The overall scope in nature based afforestation is to establish an appropriate mixture of species in order to reach the anticipated FDT. It is argued that it is important not to mix species randomly just for the sake of diversity. A randomly mixed structure will according to Larsen et al. (2005) produce an area where nature will head in all possible (and impossible) directions within the same spot. Random mixtures are often expensive both in establishment and further management – here (Larsen et al. (2005) are practicing strictly economical/practical argumentation.

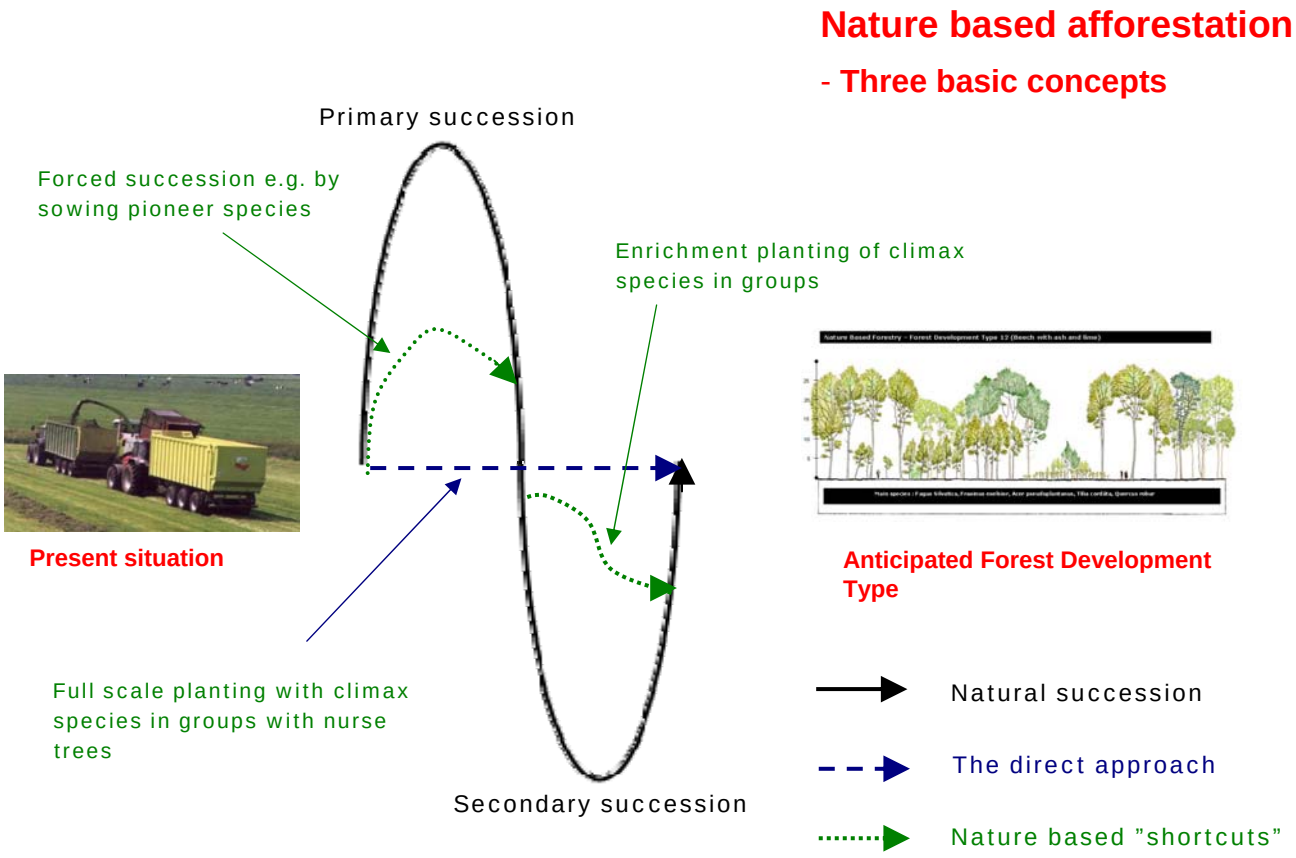

Figure 11: The basic ideas behind nature based afforestation. Natural succession, the direct approach and the nature based "shortcut". Figure translated from Larsen et al. (2005).

Three main concepts of afforestation represent the ideas of nature based forestry (*figure 11*):

- *Natural succession*
- *The direct approach*
- *Nature based "shortcuts"*

An intensity gradient from "*Natural succession*" which is extensive towards "*The direct approach*" which is more intensive shows the span of possibilities and that the three of them can be mixed accordingly.

Natural succession

Utilizing the natural succession for reaching the anticipated FDT has a relative long time span but is the ultimate cheapest way of afforestation. The possible FDT of an area is highly dependant on the

source of potential seedling trees. (Larsen et al. 2005). The system has to go through a pioneer species period in order to make a forest climate with adequate shade/light conditions before the climax species takes control of the woodland.

Tischew and Lorentz in Kowarik (2005) have made studies of spontaneous development on former mining sites in Germany. Some of the results indicate that 50% of the species found within a 30 km^3 plot was able to migrate to the spot and 40% of the species that had migrated were found more than 3km away – so called long distance dispersal. In this perspective, given a certain amount of patience, there are certainly possibilities to create quite a diverse forest by this method.

Tischew and Loretnz (2005) also prove a connection between the amount of nutrients available in the soil and the time span before a dense pioneer forest has entered the site and also the time span of accumulation of intermediate or climax species. On a high nutrient soil a period of 30-60 years will pass until climax species has accumulated in contrast to an extreme site with tertiary sand or silt where even after 60-100 years the woodland is still only persisting thin pioneer woodland.

There are a mass of other factors that influence a natural succession like wind, area size, wild game, moisture level etc. which is outside the scope of this project but worth scrutiny if planning a larger area of spontaneous growth.

The direct approach

Through use of full scale planting and/or sowing with high intensity stand management, with a species composition and the right mixture ratio that aims directly at the anticipated (or chosen) FDT the normal successive steps can be skipped. Usually there is a demand for nurse trees in order to secure the right conditions for the climax species (e.g. Fagus silvatica) (Larsen et al. 2005). The function here is mainly economical because of the need of faster interests in relation to the investment, and the promise of an array of commercial wood and timber products.

Nature based "shotcuts"

This concept exploits elements of the two other approaches. The different concentrated interventions could be the following in solo or unison:

- scarification of the top soil in order top promote seedling in certain areas
- planting/sowing of seedling groups in areas planned for natural or "spontaneous" succession
- using pre-plantation of pioneer species
- enrichment planting of climax species in the a pioneer woodland

This approach is compared to the direct approach very cheap – but then again the time span before getting commercial timber is significant. However it could have a considerable recreational value because the system can be combined to give a huge variety in a relative small area.

Urban afforestation at Næsbyhoved – Broby

Joining several smaller areas of afforestation in a connecting landscape an area of 50ha has been bought by the Danish Forest & Nature Agency outside the town of Næsbyhoved – Broby. What is interesting in this case is that it is probably the first afforestation site in Denmark that has been designed according to the principles of Larsen et al. (2005).

It is part of a larger afforestation plan made between the municipality of Odense, Odense Groundwater Company and the Danish ministry of environment. All in all it will cover 2.000 ha of new forest in order to secure better recreational values for the citizens and for groundwater protection.

The afforestation has been invited for tender and the plant number is 4.400/ha with a spread of 4.200 trees/ha and 200 bush/shrub species/ha on the areas where the "direct approach" has been chosen. The beech has been planted as main specie with 2.100 plants/ha the mixed in species where supposed to be planted in "islands" of 20-40 plants in order to keep the competition down as explained above. It was, however, to advance for the entrepreneurs who have planted them in long rows (2-3) instead of squares (Pedersen 2006).

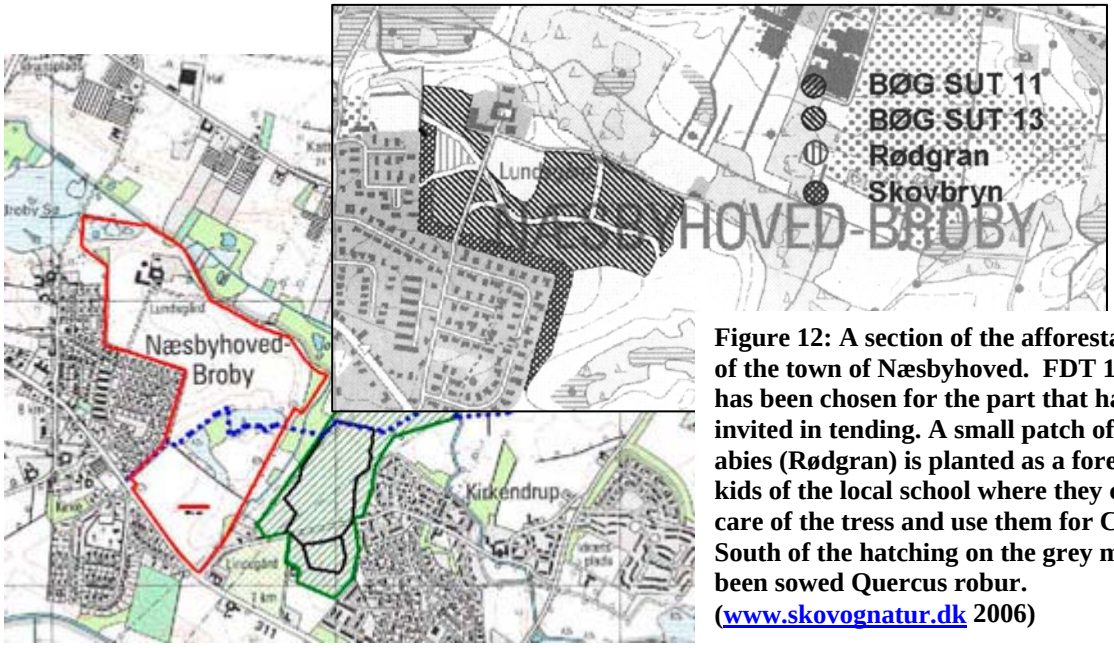

Figure 12: A section of the afforestation plan of the town of Næsbyhoved. FDT 13 (SUT) has been chosen for the part that has been invited in tending. A small patch of Picea abies (Rødgran) is planted as a forest for the kids of the local school where they can take care of the tress and use them for Christmas. South of the hatching on the grey map has been sowed Quercus robur. (www.skovognatur.dk 2006)

Some areas are left for natural succession and some has been sowed with Quercus robur aimed at creating a pioneer like plant society that can later be introduced to climax species (Nature Based "shortcut". On the grey map (*figure 12)* it looks very uniform that a huge area has the same FDT. But bare in mind that eight different tree species and five different bush/shrub species has been planted giving a rich possibility to diverge the expressions. But the main specie will in the long run be beech.

Figure 13: Picture showing the first site in Denmark where the principles of nature based afforestation is used. The planting was done 10 days before this picture was taken hence the plants are difficult to see.
With a careful look patches of conifers can be seen. The anticipated FDT is no. 13 which is Fagus silvatica, Pseudotsúga menziésii and Larix sp. Note the closeness to the housing area. A 30 meter forest edge is planted towards the houses with low bushes and shrub species in order to avoid too much shadow.
From Næsbyhoved, Fynen, Denmark, May 2006. Photo RBJ.

2.3 Classical forestry

The representative models of this approach can be seen visualized in the profile catalogue pp. 8-10 and pp. 23-25

The use of the term classical forestry is quite a broad expression. In order to narrow it down, one has to look upon how the profession of forestry has developed since the 18th century. The dogma was (and still is a lot of places) to structurally intervene in forest ecosystems in order to optimise timber production (Konijenedijk 2000, Gamborg and Larsen 2003 and Nielsen 2006).

Eventually, and mainly because of demands from society on social and environmental values, has words like sustainability and multiple use together with wood production merged in concert into one postulate of "modern forestry". Even so plantation forestry is still a vital management regime for a lot of forest owners the world over. The maybe most extravagant example is the millions of ha of Pinus radiata plantations on New Zealand.

It was a repercussion of the immense exploitation of the forest that, at least in Denmark, reached its climax in the late 18th century where we were left with about 2% of forest cover (Henriksen 1988, Fritzbøger 1994). The systemized plantation system turned the tide.

There are a multitude of silvicultural systems that could be called classical like the irregular shelterwood system, the group system, the uniform system etc. (Matthews 1989) but the clear cutting system is still one of the most used systems especially when it comes to spruce plantations (Henriksen 1988, Matthews 1989). In terms of clarifying different afforestation methods it is also important to show the amplitude of possibilities hence has the monoculture been chosen as representative of "classical" forestry.

Figure14: Two even aged monocultures who are very different but yet so alike. The picture to the left is set in a very urban modernistic environment showing pruned Platanus sp. without any soil showing while the ground is covered with metal plates. The single purpose and function is to enhance the aesthetics expression (Jarmers Square, Copenhagen, DK, May 2006).
The picture to the left is far from any city and shows a 90 year old monoculture of Fagus silvatica. In Danish terms this will not get more classical. When the time comes it will be clear cut and replanted. The forest bed is cleared of any debris because of seed collection which is done by putting out nets. The function of this stand is strictly economical (Petersgaard Estate, South Sealand, DK, April 2006). Which stand is most recreational? Photo: RBJ

Classical afforestation

Making a monoculture in the classical sense is a matter of optimizing timber production (Nielsen 2006).

The knowledge of classical forestry is mainly related to each individual species (Henriksen 1988). In relation to plant number, species and design the primary deciding factor is what kind of future product is intended from the stand.

So condensed into the simplest expression is the optimal of classical afforestation to plant the lowest number of trees that gives opportunity to reach the desired commercial outcome.

In a system that seem so structured and organized as classical forestry it is interesting to note that there are no dominating standard method of planting (even for species like Quercus sp. and Fagus silvatica – Henriksen 1988). Another evolutionary aspect of classical afforestation is that the number of plants has decreased dramatically. In Denmark it was not unusual to see a plant number of more than 20.000 plants/ha of Fagus silvatica. Now it has a reached a level of maximum 9.000 plants/ha. The impacts on the wood qualities are not yet known in full (Henriksen 1988).

Vestskoven - a "classical" urban forest

Figure 15: The contrast between two 30 year old different monocultures can be attractive - Vestskoven, Denmark (november 2005) Photo: RJB

The Danish parliament decided to create a 1.500 ha forest to the west of Copenhagen on the 31st march 1967. Precondition for this were many years of planning. Thoughts about „The green areas surrounding Copenhagen"started already in 1936, where a forest in the west was also taken into consideration.

The State forest district bought areas for Vestskoven since 1967. They bought 1.328 ha in the first 25 years of the period establishing the forest, which were mainly used for farming and market gardens before.

The main aim for establishing Vestskoven was to create a recreational surrounding for the fast growing western part of Copenhagen.

Therefore the state tried to create a landscape that is as diverse as possible.

The vision is that it will become a landscape that includes open forests with huge open plains, an artificial hilly landscape including „mountains", lakes and a lot of ways and streets.

The forest was planted in many small stands that should represent the Danish or southern Scandinavian forest types. This means primarily monocultures of Fagus silvatica, Picea abies and Quercus robur. Today approximately 45% of the forest is covered by deciduous species, 13% is covered by coniferous, while the rest 42% is covered by fields, plain and moor.

As seen on the map of *figure 16* each colour represents a single tree species. Some stands have a mixture with e.g. Quercus robur and Fagus silvatica. In a classical sense this is quite alien since the

beech inevitably out competes the oak unless a serious liberation of the oak take place (which has not been done).

The main strength now is perceived by the author to be the fact that there are stands that are planted in the start of the 1970´ies through to the 1990´ies. All in all it is still a young forest and therefore still flexible to some extent. In any event will Vestskoven be (and is) a nice area with an excellent potential for recreational use.

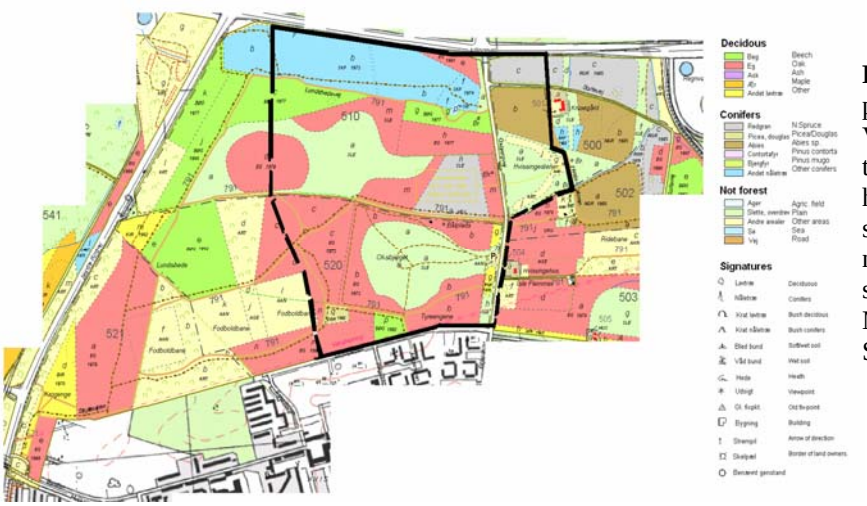

Figure 16: Forest map showing part of the 1.500 ha urban forest of Vestskoven, Denmark, started in the 1970´ies. Landscape architects had a very small influence in the spatial composition and shapes. But not on stand level; hence almost all stands are planned as monocultures. Map scanned from Copenhagen State Forest District (1999).

3. Aspects & Criteria

Here follows an account of the criteria used in the analysis of the different profiles.

3.1 Visual aspects and criteria

The effects or benefits of urban forests have been touched upon briefly in the introduction. What are to be explored currently are the visual aspects.

As argued before recreation as part of the social functions of an urban forest is of high importance. Recreation can be regarded as any activity that refreshes the mental attitude of an individual (Falck and Rydberg 2000).

Ode (2003) has made an analysis of several sources and contained in the Social/individual aspect are several values as seen in *figure 17*.

Social / individual			
Emotional	**Intellectual**	**Socially**	**Physically**
- Freedom - Peace - Solitude - Harmony - Spiritual refreshment - Contemplation	- Human and historical perspectives - Cultural heritage – indicator of historic events - Evoke memories of other times and places - Amenity - Beauty, aesthetic appreciation - Architectural use - Aesthetic use	- A vehicle for community involvement - *Recreation* - Children's play - Contact with nature and wildlife - Environmental amelioration - Education	- Children play and health - Improvement of health, both physiological and psychological - Higher perceived quality of life - *Recreation*

Figure 17: Values with a primary social/individual connection to urban forestry (Ode 2003). Here a survey of different authors has been put into a frame with overall values. *Recreation* is mentioned as a both social and physical aspect. It could be argued whether e.g. *Childrens´s play* is part of *Recreation.*

It is a known fact that green areas (and urban woodlands) have a positive effect on peoples health and that they reduce stress (Randrup et al. 2005).

Our whole perception or registration of our surroundings is based on the dissemination from our senses. Besides the sense of hearing, smell and touch, sight is considered to be the most important, contributing to 80% of our impression of our surroundings (Bruce, Green & Georgeson 1996 in Ode 2003).

If trying to give an analysis of visual aspects of a paradigm it is the intention to find an objective formal way of assessing these to keep the level of abstraction. Ode and Fry (2002) and Ode (2003) work with a set of visual aspects which has a clear definition. These have been chosen for the analysis. They are as follows:

- *Scale*
- *Diversity*
- *Naturalness*
- *Visual accessibility/Mystery*

These aspects relate to the physical appearance of the forest (or stand) and should as such give an indication of time, space, variety and level of visual commodity.

Scale

Ode (2002) tries to work with "scale" on a conceptual level and has a broad definition as it deals with relative size and multiple scales. In a woodland context, the scale relates to both the experienced size of features and the presence of details. Woodlands have an array of multiple scales present.

This project has chosen to focus on the structure and density together with actual size of the different elements. It has been suggested that also the height of the trees influence our perception of scale. Details like single tress that are allowed to stand out are also contained within. (Ode and Fry 2002, Ode 2003). So, in short it describes the experience of size and room and is a spatial expression where clear differences in size and room will indicate a high rate of scale.

Diversity

The concept of diversity is described as "different kind, form and character – even unlike, variety and multiformity (Websters1989) - including complexity and variation. The concept focuses on the perceived variation of the woodland. On stand level the focus will be on the variation in forest density and open areas, structure, different species and ages of the trees.

Naturalness

The concept of naturalness has been shown to be an important factor for explaining preference as ecological aesthetics (Ode 2003). The concept ranges from untouched nature, which has a high degree of naturalness, to the uniform even aged monoculture with a low degree of naturalness.

Naturalness also incorporates aspects of multilayered structures with natural species is of higher value than a monoculture stand of exotic species. Continuity (time aspect) is also important so the presence of old and big trees gives an increase in the perception of naturalness.

Visual accessibility/Mystery

The concept of visual accessibility cover several key concepts like openness, perceived possibility for moving in and out from place to place and depth of view. In short this gives a suggestion that

the more you can see (extent of view) the higher is visual accessibility. A related, and in this context included concept is that of mystery (Kaplan & Kaplan, 1989 in Ode 2003).

"Mystery" relates to the possibility of seeing a continuing room or open area/water through the stand which is attainable. This means that structure and density are the key variables for this concept.

3.2 Management aspects and criteria

Knowledge as inspirations

Knowledge is another aspect chosen for analysing the profile. This is done in order to perceive the underlying tradition(s) and in this perspective it can help to emphasize certain issues in management, strengthening the expression of the stand.

In Danish forestry the "nature based management" has not been used much and the knowledge among foresters is limited (Larsen et al. 2005). This indicates that the further away from the monoculture system we get and closer to the natural systems the less knowledge do we have.

Especially German forestry has the theoretical and practical knowledge of multilayered forestry systems (e.g. Dauerwald) (Henriksen 1988) this is seemingly where some of the influence the concepts Larsen et al. have developed comes from.

Gustavsson (2002) and Gustavsson and Jönsson (2002) divide knowledge into three cultures which will be used as criteria in the analysis:

a) **The forestry tradition** - a forest is a collection of trees, not individuals. Focus is on long term forest dynamics and the qualities of the young "teenager forest" are overlooked. Function is branchless trunks and timber production, highlighting economical and technical aspects. Biodiversity is a new aspect that has entered the forestry tradition.

b) **The park and landscape architecture tradition -** uses spatial aspects and the "uniqueness of a place" along with expressions that humanity, recreation and aesthetics are all part of the landscape architect tradition and context for design. The tension between the interior forest rooms (closed room) and the open room[9] and the development of new interpolations between these are what is important as long with a focus on individual trees (*figure 18*) The merging between these two knowledge cultures (forestry and landscape) can be seen especially at the landscape laboratories in SLU, Alnarp and Snogeholm (Nielsen et al.(c) 2005)

c) **The ecological tradition** – are trained in seeing systems and interactions with the weight on biodiversity and complexity. They stress more open landscapes with grassland and wooded meadows. Natural processes, indigenous species and wilderness are preferred instead of human control.

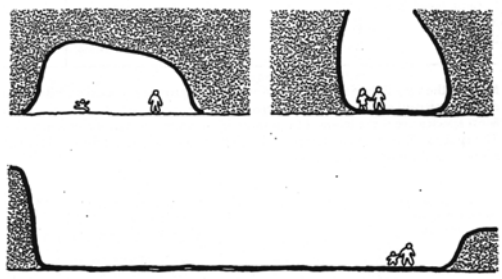

Figure 18: The inner room, the enclosed open room and the wide open room. All important to consider when creating new areas and part of the landscape architect tradition. (Gustavsson and Ingelög1994)

[9] as seen in the Profile Catalogue - appendix II respectively p. 23 and p.3)

Flexibility in an ever changing world

When making a horizontal view on the urban forest design in Europe, national and local scale (macro, meso and micro level) it is imperative to keep in mind that climate, ecosystems and not the least cultural history should make the basis of a rich variety. In this perspective it dangerous to turn to reductionism and standardisation in design which is inappropriate and even undesirable. (Gustavsson and Petersson 2003; Bell 2001, Bell et al. 2005 in Randrup et al. 2005).

Bell et al. (2005) makes a point in integrating design and management because design is all but static and a developing landscape has to have the ability to change and evolve to meet new challenges. In order to keep this flexibility "universal elements" should be used to cope with changes and one approach is to use close to nature principles and not to become too associated with design styles that quickly go out of fashion.

Pre-commercial thinning offers a variety of possibilities for changing or strengthening the stand structure. In classical forestry (even aged monoculture) the thinning promotes a high volume of timber with a good quality. This will not necessarily coincide with aesthetics and recreational demands in urban woodlands where a rich variety and dynamics could be a goal. This underlines that pre-commercial thinning is in fact a powerful way of designing urban forests (Falck and Rydberg 1998).

Supporting the inclinations from above of having a flexible forest system in design matters is the change of management that can be necessary because of the ongoing climate changes.

Some of the main management options available considering a movement towards warmer climate are (Larsen 1991):

- Use of species mixtures instead of monocultures
- Use of provenance mixtures
- Increasing the proportion of storm resistant species
- Promotion of stands with vertical structures (uneven aged)
- Tending and thinning in order to increase species structural diversity
- Change from *classical* mono-species and even aged management to close to nature management (single tree management)

Flexibility also relates to stability. A stable forest usually has a bigger ecological amplitude and therefore has a bigger buffer against change (Nørregård 2005).

Resources - the decisive factor

As economic aspects are an important factor to consider when designing and planning afforestation projects (Bell et al. 2005) this will be included in the analysis. It is certainly not an in depth analysis of the costs but an overall review build on logical assumptions and own experience as a professional forester.

The above rationale gives the explanation on the criteria chosen for the analysis in section 3 namely, **1) Knowledge Tradition (Forestry, Landscape architecture and Ecology)**

2) Flexibility as how the structure can counter external factors like public opinions and needs, tree diseases and climate changes (high, medium and low) and finally

3) Resources needed in the different cases of afforestation.

Along with the four visual criteria these management criteria will represent the foundation of the analysis.

4. Analysis and results of the profile catalogue

In this paragraph the work done in the profile catalogue of appendix II will be analysed by using the criteria accounted for in paragraph 3.1 and 3.2. Unfortuantely there was not enough space to include the profiles in the text.

4.1 Landscape laboratory approach:

Seedling model

Short description: (pp.3-5) Quercus robur, Betula pendula and Pinus sylvestris in small monocultures. Grass land/meadow and seedling group with climax species (Acer pseudoplatanus, Fagus silvatica etc.). Undergrowth is removed from the seedling group in older age, leaving the single "giants" as witness to what they have accomplished and thus celebrating "their" effort.

Scale: Besides from the even aged monocultures which present scale badly, the open grassland together with the diverse seedling group gives a good sense of scale. Especially when the seedling group is liberated as single "giants" and the visitor can see the smaller trees among the big. This gives a **high** degree of scale.

Diversity: Because of the difference of character between open closed areas and high complexity in structures and relative amount of different species the diversity is **high**.

Naturalness: The period until the stand is around 50 years is low in naturalness. This is remedied later as the structure breaks. But it does not have enough "chaos" to achieve the highest score and is therefore **medium** in this perspective.

Visual accessibility/Mystery: The different rooms created in the open space and under the seedling group will create rooms of mystery and contemplation giving a **high** score.

Resources: Because of different species in one small place and small monocultures around as well as reserving space for open areas will result in a relative expensive culture, scoring a **medium to high**.

Knowledge: Because this has all the elements. Design, monoculture and spontaneous natural processes there is a little of everything in it **(Forestry, Landscape architecture and Ecology)**

Flexibility: Having the chance to promote one species before another and with a large selection the flexibility is **high**

Gradient model

Short description: (pp.6-7) Quercus petrea, Fraxinus excelsior, Fagus silvatica, Acer pseudopl. Planted + more on distances from 0.3x0.3.m to 15x15m.

Scale: The ability to relate to different sizes of rooms: closed, medium open and open rooms as well as having different sizes of trees in a lot of aspects, the score is **high**

Diversity: A multitude of different rooms, species, and ages gives it a high grade of diversity

Naturalness: In an early age you have the chance to see solitary trees in solitary freedom as well as a mix of species in different natural successions and the "drama" between them (in the dense forest) with each other – this expression is only enhanced with age - **high** score

Visual accessibility/Mystery: A person can go as far in to the dark and "dangerous" forest as he dares, or the user can hide in a group of trees or look out over the meadows from an ancient oak – a very **high** score indeed.

Resources: Mixing species with different planting distances is expensive and gives an expensive culture **- high**

Knowledge: Working with different rooms, structures and a lot of different habitats from meadows to dense forest has a high relation to **Landscape architecture and Ecology**.

Flexibility: Different structures and a ecotone gradient gives a lot of possibilities to actually "changing horses in the middle of the stream" **- high**

Habitat model I (Monoculture)

Short description: (pp.8-10) Tilia cordatá as a monoculture is rare. The profile shows two different regimes. One favours single stemmed trees and one favours multi stemmed trees.

Scale: As it is only possible to relate to one size (until regeneration) the sense of scale is **low**

Diversity: Only one species gives a **low** sense of diversity. If making a multi stemmed forest the difference between the trees will be more outspoken yet it is still in the low end.

Naturalness: Low – one structure no "life and death" (New and dead trees)

Visual accessibility/Mystery: The feeling of being in a cathedral and being able to se far underneath the crowns gives a **high** score.

Resources: Depending on the species being planted it can be quite expensive. And chances are that because of only planting one species without having a nurse tree can generate a high number of secondary planting **–** but it is still very easy to do on old farmland. **Medium** cost.

Knowledge: This is the domain of **Forestry** – but trying to promote other features like thinning from the middle or promoting multiple stems to give another expression is part of the **Landscape architecture** knowledge

Flexibility: A monoculture has a **low** rate of flexibility.

Habitat model II (The grove model)

Short description: (pp.11-12) Multiple species with trees relating to high forest, middle layer and shrub bush layer 10+ species. Species mixed randomly.

Scale: In a very early age this stand will have a big difference between the heights of the species. But because of many sizes are present at very small areas it can be difficult to discern scales. **Medium**

Diversity: Extremely **high** because of representation of a huge amount of species as well as every possible canopy layer is represented giving a complex structure.

Naturalness: In a "real" grove there should be a mix between ancient trees as well as new seedlings giving a sense of eternity – and the circle of life. **High**

Visual accessibility/Mystery: Because of the dense and complex forest structure the score is relatively low. But a lot of mystery is related to a grove so if this is expressed in liberating an ancient oak it could get higher. **Low-Medium**

Resources: Mixing and handling a lot of different species is expensive **- high**

Knowledge: The concept of mixing species randomly is far from the knowledge culture of a forester (even nature based forestry). As Gustavsson (2006) says "*If you want drama in a stand you mix a lot of species and put them close together and suddenly a fight starts…just like people*" – this relates to knowledge culture of **Landscape Architecture** where social context and new relations

are tested and emphasized. Because of the species richness and all the possibilities for micro habitats to arise this relates to the school of **Ecology**.

Flexibility: As long as a few species does not prevail the flexibility is **high** and the ecological buffer should be high because there will always be a "survivor" in the mixed crowd.

Habitat model II (Coppice with standards)

Short description: (13-15) Monoculture of Tilia cordatá with a 25 year coppice rotation. This stand could off course have more species. Here is shown that the low coppice layer is taken in one action. But that is not necessarily so since a system should be made in order to have fresh coppice each year.

Scale: Because of the ever structured changing differences of high and low an extremely high sense of scale should be obtained in this stand

Diversity: Even though it is a monoculture the difference in structure and ages gives a relative good sense of diversity. If visited more than once and just before and after a coppice- then the diversity will seem very high. But as a static expression it is gets a **medium** score.

Naturalness: This system is renowned for its high biodiversity because of its difference in biotopes (open/closed areas). **High**

Visual accessibility/Mystery: Differs greatly before and after coppice – but in general it is quite dense and has a **low** visual accessibility.

Resources: As it is a monoculture it scores a **medium.**

Knowledge: The coppice system is extremely structured and demands certain techniques giving land to the **Forestry** knowledge culture. The exact same structure relates to different spacing and sense of room and contrast pleading for the **Landscape Architecture** school. Because of most of the entire terrestrial red listed species (exaggeration) can be found in a forest like this the specialty from **Ecology** is nurtured here as well.

Flexibility: The system is in itself quite stable because of the different ages, but as a monoculture it gives a **medium** score.

4.2 Nature based afforestation:

Natural succession

Short description: (pp.17-18) Pioneer species will slowly invade and over time will the more climax related species take over the system in a slow or fast transition depending on primarily soil conditions and what possible seedling trees are present.

Scale: As areas will be kept open for quite a long period and the different species will have quite different heights the sense of scale is **high**

Diversity: A very high diversity is kept here because of different ages, different room sizes and different species - **High**

Naturalness: The score is very **high** because of the fact that man has left the process of afforestation for nature itself.

Visual accessibility/Mystery: In its younger "teenage" period it will have a high degree of visual accessibility. But later this will diminish. If kept as untouched forest it will be wilderness and a

thick bush layer will block for everything. But with a little management it will gain some. – **Medium**

Resources: Very inexpensive (next to free) - **low**

Knowledge: As natural processes are the primary element **Ecology** has a basic knowledge culture related to this. Both the forester and the landscape architect can in theory do little to intervene - only observe and this is not part of either culture.

Flexibility: As all the plants have regenerated naturally the system should be stable and quite easy to turn in another direction because of multiple species and ages. **High**

Succession "Shorcut"

Short description: (pp.19-20) Oak (Quercus robur) is sowed and leaving space for natural succession as well as room for later introduction of climax species. It is the intention to make a rotation of oak in agreement with a transition to the anticipated FDT.

Scale: Leaving areas open and some closed as well as having trees of different structures gives a **high** score. This principle is kept even in the older ages.

Diversity: Different ages, different rooms, different species (both light demanding and shade tolerant spedies) - **High**

Naturalness: As both aspects of natural processes as well as monocultures are handled in this system, the score is **medium to high.**

Visual accessibility/Mystery: The score is high until the natural regeneration from the climax tress commences blocking a lot of the visual aspects. But rooms between the regeneration will add to the sense of mystery. **Low-Medium**

Resources: As aspects of sowing which is inexpensive as well as natural processes and ending up with minor plantings of climax species it is fair to say that it is a rather small investment as well as it stretches over several years**. Low -medium**

Knowledge: The same elements are touched as with the seedling model of the landscape laboratory approach. So **every knowledge culture** is touched upon in this case as well.

Flexibility: Both pioneer as well as climax species are present as well as stable FDT as a goal with a lot of management possibilities - **High**

The direct approach

Short description: (pp.21-22) In order to "jump" past the successions primarily climax species are planted like Faugus silvatica. Gap specialists like Acer pseudoplatanus and Fraxinus excelsior are added in order to make the natural regeneration more successful.

Scale: By using several species in groups with different habitus some sort of scale can be sensed. But the lack of really different and contrasting objects gives it a **medium** score.

Diversity: Since most of the area is covered with the same species and even age the diversity can be changed by mixing in low trees like Carpinus betulus. **Medium-high**

Naturalness: As it is primarily single to two storied and planted in groups it will take a tree generation until it reaches the anticipated FDT until it gets a high natural rate. **Medium** score

Visual accessibility: The visual accessibility is relatively high until the stand reaches maturity where the regeneration will create new forests in the gaps then slowly block the view. But rooms will be created in between for a better sense of mystery. **Medium**

Resources: As handling several species and planting them in patterns is a challenge it can be quite expensive to invest in this culture. But the forest products are quicker to return as you skip the primary succession step. **Medium -High**

Knowledge: As an element of a straight agenda with an economical incentive is the driving force for this approach it relates mainly to the **Forestry** knowledge culture.

Flexibility: As several stable species constitute the backbone of this culture it has **high** amplitude in different management possibilities**.**

4.3 Classical forestry:

The monoculture

Short description: (pp.23-25) Monoculture of Picea abies. Could just as well have been Fagus silvatica but a broadleaved monoculture is shown under the Habitat model pp.8-10.

Scale: Only one unison reference makes a **low** sense of scale

Diversity: Only one structure, one type of room and one specie: **low**

Naturalness: In Denmark and southern Scandinavia Picea abies is not indigenous or at least on its boundary of its natural environment as well as a monoculture is more or less unnatural - at least as an even aged one; giving the lowest possible score. **Low**

Visual accessibility/Mystery: The pillar hall in a spruce stand can be an exceptional experience and relates to a lot of folk lore, trolls and fairytales of especially northern Scandinavia**. High**

Resources: A monoculture is a **medium** investment.

Knowledge: This relates strictly to the **Forestry** knowledge culture.

Flexibility: A spruce stand has an especially **low** flexibility because of its relative unstable period in its older ages.

4.4 Comparing the results

When looking at the horizontal and vertical lines of the matrix below there seem to be quite a lot of different visual aspects connected to the different stands. This indicates that mixing the paradigms will provide a wide range of experiences and recreational amplitude.

Not surprisingly are the mixed stands in general scoring higher than the monocultures because the visual aspects in general terms relate to "differences". The even aged monoculture has its strength by producing a high visual accessibility which also corresponds to aspects of public preferences (se Discussion).

Afforestation Paradigm / Icon		Assessment criteria						
		Visual aspects				Management aspects		
		Scale	Diversity	Naturalness	Visual accessibility / Mystery	Resources	Knowledge	Flexibility [10]
	Landscape laboratory							
	Seedling model	high	high	high	medium	high	Ecology L. architect. Forestry	high
	Gradient model	high	high	high	high	high	L. architect. Ecology	high
	Habitat model (monoculture)	low	low	low	high	medium	L. architect. Forestry	low
	Habitat model (grove model)	medium	high	high	low-medium	high	L. architect. Ecology	high
	Habitat model (coppice forest)	high	medium	high	low-high	medium	Ecology L. architect. Forestry	medium
	Nature based forestry							
	Natural succession	high	high	high	medium	low	Ecology	high
	"Shortcut"	high	high	medium-high	low-medium	low-medium	Forestry L. architect. Ecology	high
	Forced approach	medium	medium-high	medium	medium	medium-high	Forestry	high
	Classical forestry							
	Monoculture	low	low	low	high	medium-high	Forestry	low

There is seemingly a connection between diversity and flexibility; this corresponds agreeably to having different possibilities to work with being: *time, space or species.* These three factors seem to be the three overall considerations to make when *designing* afforestation (economy not included).

Another connection is that more the more complex a stand is designed the higher sense of naturalness and diversity there is.

Utilizing one species (Tilia cordata) as repeated specie in all the Habitat models show the diversity one core specie can have.

[10] Flexibility is in relation to changing function of the stand, like adapting to new trends or reconvert to other species because of climate changes or treediseases

5. Discussion

"**Although antagonists by definition, nature and cities have a much more complex relationship**" (Konijnendijk 2005 p.33).

By starting the discussion with this quote the scene is set for a wide sojourn with a brief stop on four accounts. This is done in order to keep the appearance of some sort of structure -1) *Urban afforestation and public demands 2) Aspects of forest expansion 3) What can be derived from the analysis?* and finally *4) Shortcomings of the present project.*

Urban afforestation and public demands

The forest is, at least amongst Swedes and Danes, the preferred recreational environment (Olsen and Lundhede 2004 in Larsen et al. 2005; Ode 2003; Ode and Fry 2002; Hörnstein, and Lindhagen 2000, Falck and Rydberg 1998). In this perspective there is a high responsibility to the manager and planner of forests that recreational aspects are considered. But what kind of forest is preferred?

As Bell et al.(2005) explains about the people living in the North Western European Forest culture, we are further removed from nature and less inclined to feel comfortable in a dark forest environment than e.g. people of the Northern European Forest culture. Many of the forest icons accounted for in this project rely on natural regeneration often giving general low level of visibility and visual accessibility (*see figure 20*). Does this mean that the most of the paradigms are unsuitable as urban woodland? Here the aspect of diversity and management enters the discussion. Firstly is "diversity" in the experience of different forest structures a very important aesthetical factor (Gustavsson and Ingelög 1994, Gustavsson 2002, Falck and Rydberg 1998, Sørensen 2002, Bell et al. 2005). It also gives a chance to let people who wish to be more self-reliant or find solitude to choose a more dense structure where these wishes can be fulfilled.

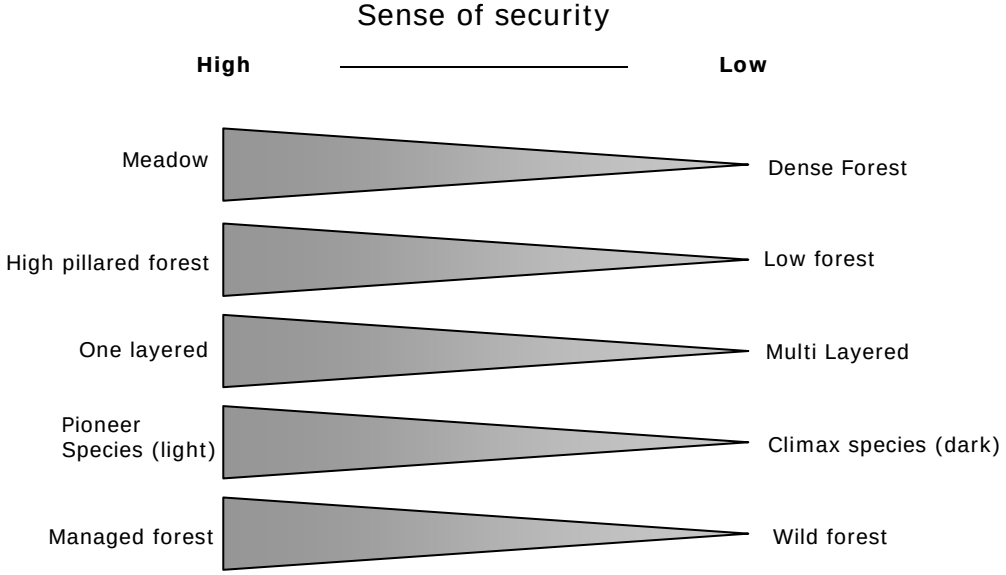

Figure 20: Generalisation of different factors of spatial relationships and the sense of security fitting the North Western European forest culture.

By mixing the paradigms from the monoculture to the multilayered stands, from pioneer species to climax species, low forest to high forest, from open areas to closed areas etc., as the basic structure it is up to the micro management (relates to the single place) to give the final surprise and excitement that gives the visitor a sense of having had a wealth of experiences.

In this case it is important to keep in mind that having a high degree of naturalness is not always perceived as positive for preference (e.g. Lindhagen & Hörnsten (2000) have shown that the virgin forest (and old multilayered forests) is not perceived as particularly positive.

Several public surveys have been made in Denmark that gives the pillar hall of Fagus silvatica a high score in relation to recreation (e.g. Jensen and Koch, 1997, Søndergaard 1995 in Falck and Rydberg 1998). At the same time another Danish survey of willingness to pay in relation to converting monocultures of Picea abies into mixed stands with broadleaved trees, shows that there is a higher recreational/aesthetical value in mixed stands (coniferous and broadleaved) with a diverse structure than pure mixed broadleaved stands (Ladenburg 2006).

According to Sørensen (2006) the profile diagrams of how the forest would look like in the final stage (FDT 13) made by Anders Busse Nielsen were used in poster format to public meetings. It gave a lot of positive feedback and recognition in the future participation and eased the process considerably.

Aspects of expansion

When looking at the different cases of afforestation there is no doubt that the one in Holstebro (and to some extent the project at Næsby) has a very high impact on the relationship between man and nature.

By constructing figure 21 an attempt to show how two apparently opposing forces are at work in the development in the landscape between rural and urban areas. To put it on the edge the peri-urban landscape has the suffix of being introvert (turning the back to nature) while the peri-rural landscape is opening up to (integrating) nature. An excellent example of this is the landscape laboratory of Holstebro where forest and rural landscape is integrated with development and is absorbed in each other.

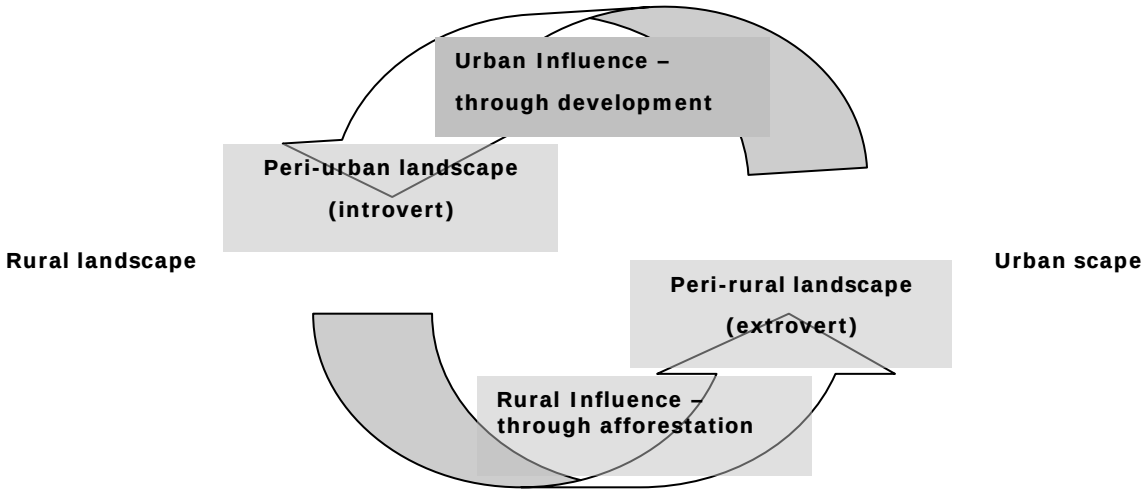

Figure 21: Another view of the forces at work in the expansion of cities into rural areas – and visa versa (own construct)

In order to keep some authenticity in the development of a city the influence of afforestation connected to local history is important. Gustavsson and Petersson (2003) indicates that authenticity has a tight connection to our agrarian culture and this gives an indication that the sense of identity could be strengthened through the use of old management methods like coppice and grazing forests and that the use of the word "rural" could be upgraded.

What can be derived from the analysis?

One aspect that was noticed during scrutinizing "classical forestry" was that the simplest expression of classical afforestation "*optimum is to plant the lowest number of trees that gives opportunity to reach the desired commercial outcome*" can be used in general. This very pragmatic approach is possibly something that all planners or mangers should think about and change "commercial" with "recreational". In this way more forest can be planted for the same money if natural succession is not an option.

Below (figure 22) follows a conceptualized collection of the different aspects on afforestation that has been uncovered during this project. As a sort of "crown projection" it gives another dimension than the profile diagram – it is intentioned to help perceiving what has been the intention with the project – namely to visualize different aspects of afforestation. Other systems can be made probably be made but it gives an overview of the design frames. The comments made to each icon are based on the analysis. All of the systems can eventually be developed into something quite new come time and with the right management.

The overview is inspired by lecture by Anders Busse Nielsen in Urban Woodland Silviculture, KVL 2005.

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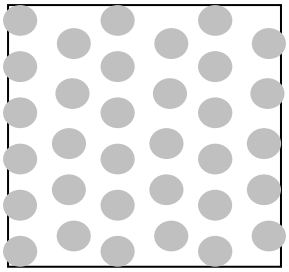
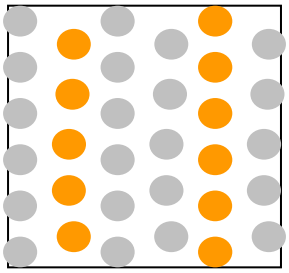
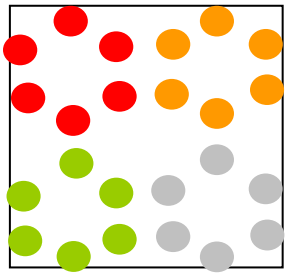


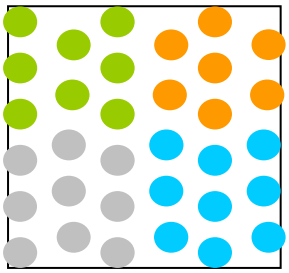
The monoculture (Classical forestry or Landscape laboratory):
- Low diversity of species
- Even aged
- One layered - high visual accessibility
- Low naturalness.
- Primarily economic function though a pillar hall has a high recreational value.
- Medium cost
- Low flexibility
-



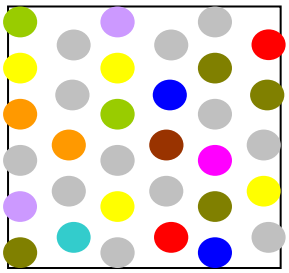
Monoculture with nurse trees or few species mix (Classical forestry or Landscape laboratory):
- Low diversity of species
- Even aged or "biaged" if nurse tress has been planted ahead.
- One or two layered - high visual accessibility
- Low naturalness.
- Primarily economical function.
- Medium cost
- Low flexibility



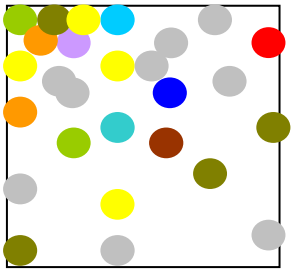
The "designed" culture (Not really incorporated in any of the three paradigms – but could belong to the Landscape laboratory):
- Low to high diversity of species
- Even aged or several ages dependant on the design.
- Structured layers one - many. Low-high visual accessibility
- Low naturalness.
- Primarily recreational, aesthetical function
- Medium to high cost (low plant number but strict designed patterns)
- Low flexibility (probably static in expression)



Multiple species structured culture (Nature based forestry and Landscape laboratory):
- High diversity
- Even aged or several ages if nurse trees have been planted/sowed ahead.
- One to several layers – structured, medium visual accessibility
- Medium to high naturalness.
- Both economical and recreational function
- Medium to high cost
- High flexibility



Mulitple species nonstructured culture (Landscape laboratory):
- High diversity in species and unstructured
- Even aged or multiple.
- Multiple layers. A lot of "drama" between species. Medium-low visual accessibility
- High naturalness
- Primarily recreational.
- High cost
- High flexibility



Gradient culture or natural succession (Landscape laboratory and Nature based forestry):
- High diversity both in species and space(open to closed space)
- Even aged to multiple - high visual accessibility
- One to multiple layers in one area (from meadow to dense forest)
- High naturalness
- Primarily recreational
- Low cost
- High flexibility

Figure 22: Gathering the concepts in one conceptualized model

Shortcomings of the present project

The Criteria

The visual aspects are not connected to a direct preference of the public. Some people, and especially people that fits the north western European forest culture, will weigh Visual Accessibility higher than e.g. Scale because of safety measures. Where as this would be different in the Northern European Forests culture where people are more connected to the forest and thus able to hide and live in dense forest environments and being more comfortable with that, than having e.g. a high Diversity. Attention should be taken to regional differences as well. Even inside the boundaries of a small country like Denmark the forest culture is very different with a gradient going from east to west. Ladenburg et al. (2006) shows that people in the western part of Denmark (sandy soil and heathland and Picea plantations and harsh environment) holds higher value in changing management regime (from clear cutting to selective thinning) than actually changing from coniferous stands to pure or mixed stands of broadleaved trees. People in eastern part of Denmark (or at least areas where broadleaved trees prevail) has a higher connection to e.g. beech and oak than coniferous trees. This should also be part of the planning when making afforestation.

The relation between Scale and Diversity is in some perspectives close. It can sometimes be difficult for a forester, even though trying to be as expressive and colourful as possible, to differentiate between these and a trained landscape architect and ecologist would probably have some arguments for changing some of the scores. The ecologist is expert in diversity and the landscape architect is expert in scale. But the clash of opinions is actually quite intended in the hope of promoting discussion and in order to find new definitions of what the three different knowledge cultures holds as their "own territory". Should new meanings and definitions be born then it is only to the benefit of "urban forestry and greening".

The profile diagrams

The most incisive criticism that has been overheard by the author concerning the profile diagrams (FDT´s) of "Nature Based Forestry" by Larsen et al. (2005) was that "*everything is possible in watercolours…*" Besides from being funny it has a frightening truthful sense to it. It is possible to draw a bridge and build it so it matches (in scale) the drawing, but working with nature is a different matter. So many factors play a crucial part of where the development goes.

Relating the profiles made for the present project a second meeting with the Icon-setters (Larsen and Gustavsson) would possibly change some matters, but stressing that the examples given are made for discussion and attitude promotion.

What next?

Making the analysis a result of quantitative survey instead of a single "quasi-expert" opinion could have been interesting in order to test the criteria. But due to short comings of time this was not possible. What have been done in surveys until now, as far as the author can tell, are static reference pictures and not static pictures put in a developmental context (from seedling to old tree). It would be interesting to see how people react to the teenage periods and what kind of management regime they would prefer.

6. Conclusion

In general there is an intensive afforestation commencing in NW Europe. Looking at three overall afforestation paradigms (Classical forestry, Nature Based forestry and the Landscape laboratory approach) has made it obvious that plating design is important to give different visual experiences.

To sum up some of the important facets the following can be said:

1) Visual aspects like diversity, scale, naturalness, visual accessibility is part of creating urban recreational woodlands and the project has shown that different paradigms of afforestation represents difference in these aspects.
2) Using different planting designs in an afforestation area can prepare an area for future changes e.g. in climate or public opinion, by keeping a flexible, stable and differentiated system.
3) Using a variety of different afforestation paradigms will make it possible to give a wholesome and extremely diverse experience for the public.
4) Using profile diagrams as a tool for showing visual aspects can ease the communication with the public, politicians and professionals.
5) Considering the knowledge culture (Landscape architecture, Ecology and/or Forestry) that relates to the different approaches of afforestation is important in order to strengthen the visual expression. Some structures relate solely to one culture while others combine the schools.
6) The different public opinions related to different forest structures show that relying on a single stand design can be “dangerous” since the perceptions differentiate not only between forest cultures but also between local districts. This also articulates the need for a diverse planting design

Doing a contemporary look on three paradigms of afforestation, three parameters have been discovered to contain most of the aspects concerning design:

Time (age) – planting/sowing species with different ages or waiting to add new species to an already afforested area, using spontaneous regeneration etc.

Space – planting distance, structures, dense/open or creating inner spaces and outer spaces, meadows etc.

Species - monoculture-multi-species, dark tolerant/light demanding, climax/pioneer species, colours, indigenous – exotic, provenance etc.

The overall perspective of afforestation in an urban milieu could probably benefit the most visually if combining the “soft” hand of the landscape architect, with the “merciless” hand of a forester and the “vigilant” hand of the ecologist. The complimentary is off course an urban forestry approach.

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Appendix I (A)

Average tree heights of selected species used in the profile diagrams of the present project.

The growing conditions have been chosen as a medium or average quality in order to give a realistic height on most afforestation sites.

Age (from seed)	Specie	Strategy[11]	Average Height in meters[12]
10	Fraxinus excelsior (Ash)	Pioneer	5
	Fagus silvatica (Beech)	Climax	2
	Betula pendula (Birch)	Pioneer	5
	Acer platanoides (Maple)	Climax	5
	Picea abies (N. spruce)	Climax	3
	Quercus robur (Oak)	"Pioneer"	3
	Pinus silvestris (S. pine)	Pioneer	4
25	Fraxinus excelsior (Ash)	Pioneer	9
	Fagus silvatica (Beech)	Climax	6
	Betula pendula (Birch)	Pioneer	9
	Acer platanoides (Maple)	Climax	12
	Picea abies (N. spruce)	Climax	11
	Quercus robur (Oak)	"Pioneer"	8
	Pinus silvestris (S. pine)	Pioneer	10
50	Fraxinus excelsior (Ash)	Pioneer	18
	Fagus silvatica (Beech)	Climax	15
	Betula pendula (Birch)	Pioneer	13
	Acer platanoides (Maple)	Climax	19
	Picea abies (N. spruce)	Climax	21
	Quercus robur (Oak)	"Pioneer"	15
	Pinus silvestris (S. pine)	Pioneer	17
90	Fraxinus excelsior (Ash)	Pioneer	22
	Fagus silvatica (Beech)	Climax	23
	Betula pendula (Birch)	Pioneer	20
	Acer platanoides (Maple)	Climax	22
	Picea abies (N. spruce)	Climax	28
	Quercus robur (Oak)	"Pioneer"	22
	Pinus silvestris (S. pine)	Pioneer	23
120	Fraxinus excelsior (Ash)	Pioneer	25
	Fagus silvatica (Beech)	Climax	25
	Betula pendula (Birch)	Pioneer	22
	Acer platanoides (Maple)	Climax	23
	Picea abies (N. spruce)	Climax	30
	Quercus robur (Oak)	"Pioneer"	25
	Pinus silvestris (S. pine)	Pioneer	28

[11] Matthews (1989), Henriksen (1988)

[12] The average tree heights are taken from the growth tables of Møller et al. (1990) choosing an intermediary soil/growth condition where these differentiations were made. Where the age/height numbers were not available (especially in the old age categories) an extrapolation of the lower age/height numbers were made.

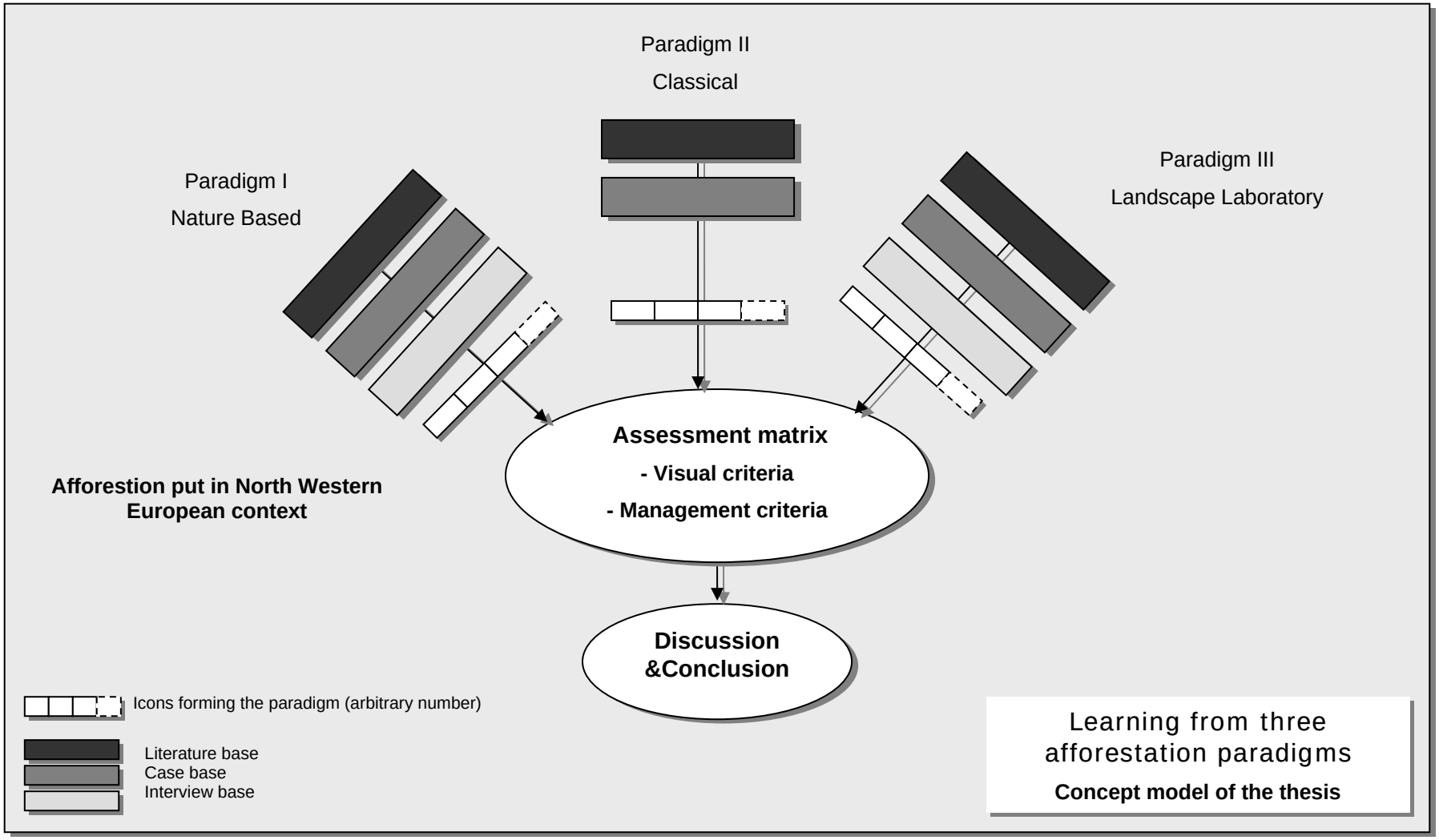
Appendix I (B)

YEARS FROM SEEDLING TO AGE OF REPRODUCTION WHEN PRODUCING FLOWERS AND SEEDS GIVES AN IDEA HOW MANY YEARS TO WAIT FOR FLOWERS AND HOW LONG TIME IT WILL TAKE UNTIL DIFERENT SPECIES WILL SEED THEM SELFS AND GENERATE A NEW GENERATION

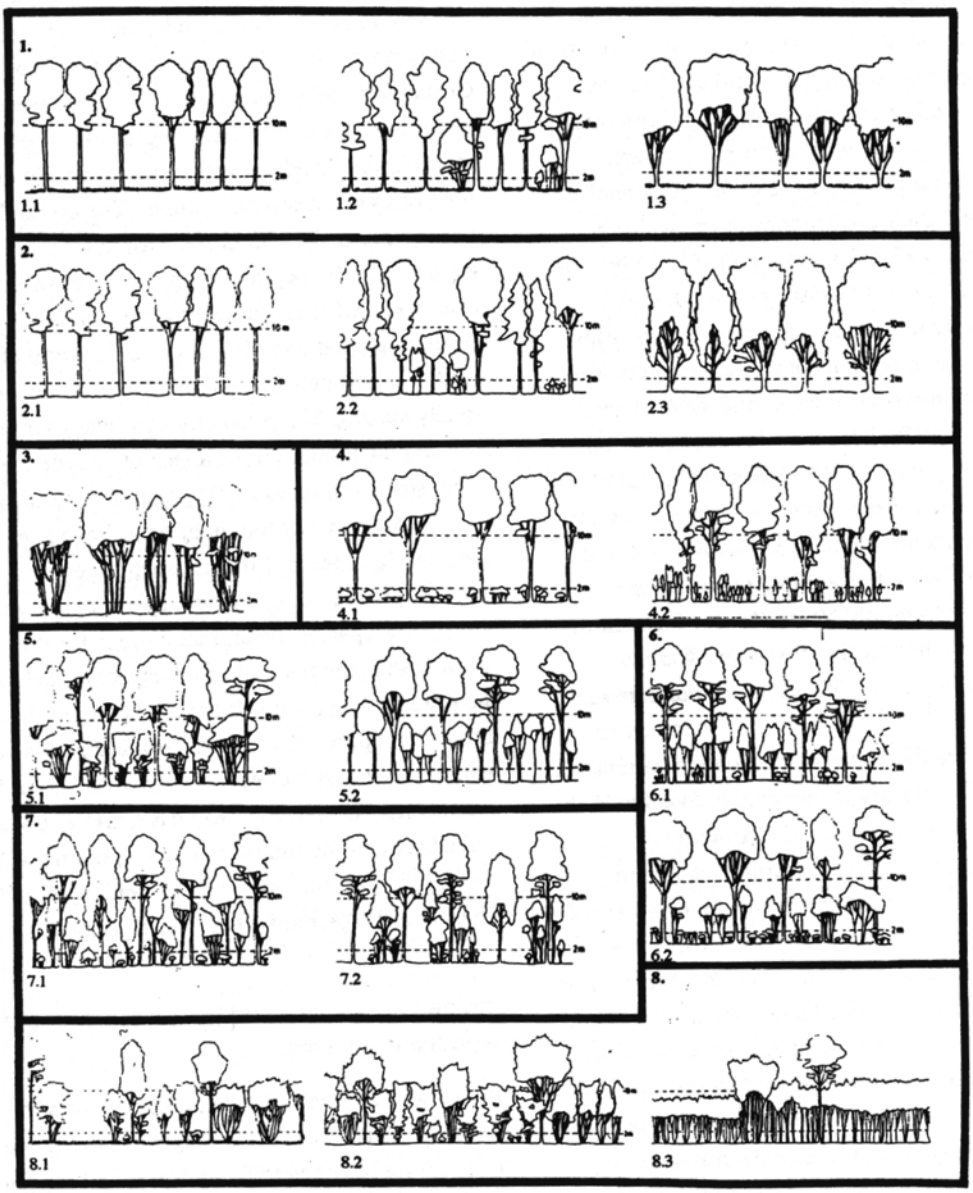
Träd/buskslag * ej inhemska trädslag och buskar	Antal år från frögroning till blomning och frösättning
Naverlönn – Acer campestre	10-
Skogslönn – Acer platanoides	15-25
Sykomorlönn – Acer pseudoplatanus *	10-20
Hästkastanj – Aesculus hippocastanum *	15-
Klibbal – Alnus glutinosa	5-20
Gråal – Alnus incana	5-20
Häggmispel – Amelanchier spp.*	5-10
Björk – Betula sp.	5-15
Avenbok – Carpinus betulus	10-30
Skogskornell – Cornus sanguinea	5-
Hassel – Corylus avellana	5-10
Hagtorn – Crataegus spp.	10-15
Benved – Evonymus europaeus	10-
Bok – Fagus sylvatica	40-80
Ask – Fraxinus excelsior	10-15
Havtorn – Hippophaë rhamnoides	3- 5
Liguster – Ligustrum vulgare	4- 6
Vildapel – Malus sylvestris	2-10
Asp, poppel * – Populus spp.	5-10
Fågelbär – Prunus avium	4-15
Sötkörsbär – Prunus cerasus	5- 8
Hägg – Prunus padus	5-10
Slån – Prunus spinosa	5-10
Päron – Pyrus communis	5-15
Bergek – Quercus petraea	40-
Skogsek – Quercus robur	20-25
Getapel – Rhamnus catharticus	5-10
Brakved – Frangula alnus	5-10
Måbär – Ribes alpinum	3- 5
Svarta vinbär – Ribes nigrum	1- 2
Röda vinbär – Ribes rubrum	1- 2
Rosor – Rosa sp.	2- 4
Sälg, vide – Salix sp.	2-10
Vanlig fläder – Sambucus nigra	3- 4
Druvfläder – Sambucus racemosa *	3- 4
Rönn – Sorbus aucuparia	10-15
Syrén – Syringa vulgaris *	3- 4
Skogslind – Tilia cordata	20-30
Skogsalm – Ulmus glabra	30-40
Skogsolvon – Viburnum opulus	3- 5

Age from seedling to reproduction used as basis for the profile diagrams. (Gustavsson and Ingelög, 1994)

Appendix I (C)


Paradigm II
Classical
Paradigm I
Nature Based
Paradigm III
Landscape Laboratory
Assessment matrix
- Visual criteria
- Management criteria
Afforestion put in North Western European context
Discussion &Conclusion
Icons forming the paradigm (arbitrary number)
Literature base
Case base
Interview base
Learning from three afforestation paradigms
Concept model of the thesis

Appendix I (D)



An overview of different structural types of vegetation dominated by trees and shrubs focussing on high and low woodland types. 1. The dark high woodland; 2. The light high woodland; 3. Multi-stemmed, one-storied high woodland; 4. Two-storied high woodland with shrubs; 5. Two-storied high woodland with well developed middle layer; 6. Three-storied high woodland; 7. Multi-layered high-woodland; 8. Low woodland types

Figure showing an overview of different structures with trees as main element. An excellent source of inspiration when making management decisions Gustavsson, Roland & Ingelög, Thorleif (1994),