MANAGING DIVERSITY

– the Forest Development Types as a Framework for Management within Mixed Forest Systems

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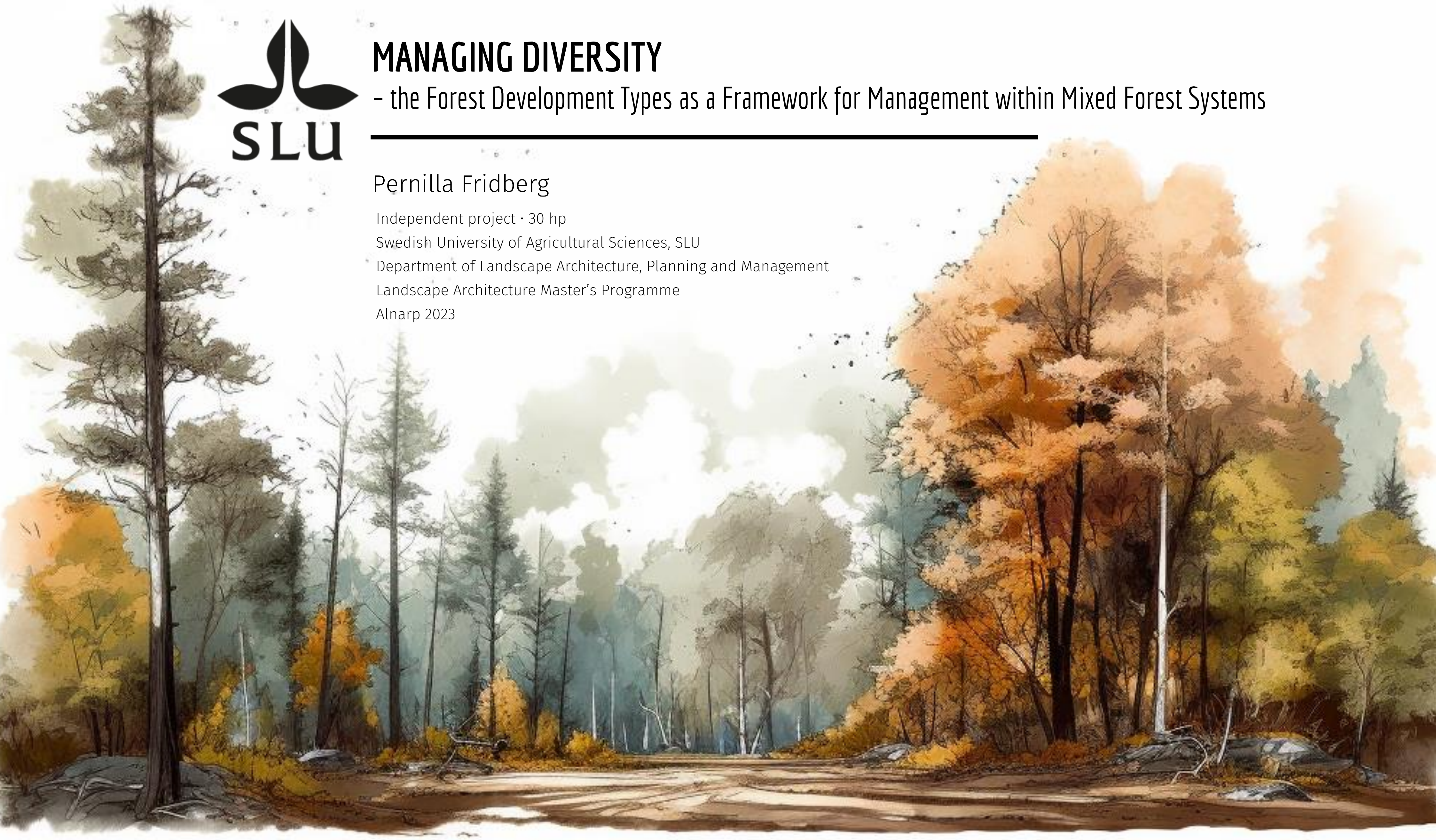

Managing Diversity– the Forest Development Types as a Framework for Management within Mixed Forest Systems

Mångfaldig skötsel - Skogsutvecklingstyper som ett ramverk för förvaltning inom flerskiktade skogssystem

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Abstrakt

Efterfrågan på både biologisk mångfald och rekreativa skogar ökar i takt med att medvetenheten om vikten av att bevara naturen och samtidigt tillhandahålla utrymme för människors rekreation växer.

Naturnära skogsbruk, som syftar till att inkludera naturliga successionsmönster och störningar, anses föredras framför traditionella förvaltningsmetoder för att framhäva både rekreativa och ekologiska värden (Wimberly et al. 2012). Inom naturnära skogsbruk skildrar modellen skogsutvecklingstyper en vägledning för att utveckla lämpliga skötselstrategier som tar hänsyn till regionala förhållanden (Larsen & Nielsen 2012a). Denna uppsats syftar till att tillämpa modellen för skogsutvecklingstyper, i en tätortsnära skog belägen i ett utvecklingsområde i Hässleholm, Sverige. Resultaten visar styrkor och begränsningar med att använda skogsutvecklingstyperna som ett referenssystem för att förbättra hållbara skogar med höga ekologiska värden. Samtidigt belyser uppsatsen behovet av ytterligare vägledning för rekreativa skogar i deras förvaltning efter etablering.

Insikterna som erhållits genom denna undersökning kan ge värdefull vägledning för beslutsfattare, stadsplanerare och skogsförvaltare som strävar efter att förbättra de ekologiska värdena och samtidigt öka återhämtningsförmågan hos tätortsnära skogar, vilket i slutändan bidrar till skapandet av mer levande och hållbara städer.

Abstract

The demand for both biodiversity and recreational forests is increasing. Management methods under the umbrella term Close-to-Nature management, which aims to incorporate natural successional patterns and disturbances, is considered preferable to traditional forest management methods in terms of both recreational and ecological values (Wimberly et al. 2012). Within Close-to-Nature management, the Forest Development Types model provides a guide for developing suitable strategies of regional conditions(Larsen & Nielsen 2012a). This paper aims to apply the model in a peri-urban woodland environment surrounding a new housing development area in Hässleholm, Sweden. The findings demonstrate the strengths and limitations of using the FDTs for as a reference system when enhancing ecological values and long-term resilience in urban woodlands. While also highlighting the need for additional guidance within recreational forests on post-establishment management.

The insights gained from this research provide valuable guidance for policymakers, urban planners, and forest managers seeking to enhance the ecological values and long-term resilience of urban woodlands, ultimately contributing to the creation of more livable and sustainable cities.

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INTRODUCTION

BACKGROUND

As our cities expand, Urban Forestry plays a crucial role in mitigating air and sound pollution, reducing heat islands, enhancing stormwater management, and fostering biodiversity in both flora and fauna. Therefore, it is vital to promote the proper development of forest areas in urban and peri-urban contexts to benefit both nature and human well-being (Larsen & Nielsen 2012a). Climate change poses significant challenges for urban forest management and biodiversity conservation (Bolte et al. 2010; Bellard et al. 2012). Altered temperature and precipitation patterns can impact the tree species distribution and composition, causing shifts in forest structure and dynamics (Bradshaw et al. 2000; Forzieri et al. 2021). Urban forests must be resilient and adaptive to ensure their long-term sustainability.

Historically, forest management practices often prioritized the establishment of monoculture plantations for their perceived simplicity and economic advantages. However, this approach has led to a range of ecological challenges, including increased vulnerability to pests and diseases, reduced biodiversity, and diminished ecosystem resilience. As a result, there has been a growing recognition of the importance of diverse forest systems and the need for management strategies that promote their establishment and conservation. Mixed forest systems, characterized by the coexistence of different tree species within a given area, have gained significant attention in recent years due to their numerous ecological, economic, and social benefits. These diverse forest stands in contrast to monoculture plantations, where a single tree species dominates, have emerged as a promising alternative for sustainable management. Moreover, mixed forests are more resilient to climate change impacts, as the diverse composition can buffer against extreme weather events and mitigate the risk of catastrophic tree loss. Different species have varying tolerances to specific environmental conditions, enabling mixed forests to adapt and thrive in the face of changing climatic conditions.

The concept of "Design with nature", or Close-to-Nature management, initially introduced by McHarg (1992), emphasizes that all design processes should be rooted in natural processes. Designing with nature involves three objectives: nature conservation, sustainable ecosystem establishment, and achieving a natural aesthetic (Sepahi, 2000). However, in current urban forests, there is often a lack of structural complexity, aesthetic variety, and habitat diversity due to silvicultural influences and the fact that many of them are remnants of old silviculture lands. To restore biological and aesthetic values, assessments of habitat attributes should consider local site conditions such as soil structure, topography, location, species composition, as well as social and cultural contexts. The Forest Development Types (FDTs) are a classification system used in Close-to-Nature Forest management which provide a framework for categorizing different types of forest stands. The FDTs aim to capture the natural successional patterns and processes that occur in forests to guide forest management decisions and promote ecological sustainability as well as economic advantages within managed forests.

This essay aims to explore the development of effective management plans specifically designed for mixed forest systems. The method aims to be applicable to both existing mixed forest systems and monoculture stands that can be converted into mixed stands. It will investigate the key considerations, challenges, and practices in managing mixed forests, aiming to provide guidance and recommendations for forest managers, policymakers, and stakeholders involved in sustainable forest management.

AIM

This paper aims to investigate the possibilities of utilizing the Forest Development Types model within Close-to-Nature management to foster resilient and diverse forest systems in urban environments and their surrounding areas. It seeks to assess how this management approach can help municipalities enhance and maintain ecological and recreational values within urban woodlands.

QUESTION OF ISSUE

To what extent can the model Forest Development Types be applied when developing and managing an urban woodland with both rich ecological diversity and recreational values?

- In the context of exploring Close-to-Nature management in a peri-urban forest, is the Forest Development Types model relevant and applicable?
- What implementations and limitations are there when using the model Forest Development Types in the case example?
- What considerations must be done in an urban woodland in relation to the expected climate change?

IMPLEMENTATION AND LIMITATIONS

The paper primarily investigates the ecological values of mixed forest systems within an urban context. It specifically compares traditional management approaches to Close-to-Nature management, which emphasizes ecology and biodiversity. The key factors examined include biodiversity, climate change impacts, succession patterns, management strategies, and forest structures. However, the paper does not delve into topics such as governance, water management, economics or the detailed exploration of insects or fauna associated with different vegetation structures. Similarly, in-depth exploration of paths and edge zones is not included as they are not explained in the Forest Development Types. Instead, they are discussed in relation to the specific stands if they are especially relevant to the stand's goals and subsequent management.

MATERIALS AND METHODS

A case example and literature study were simultaneously undertaken to build the thesis. As challenges emerged in the case example, additional insights from the literature were incorporated. The literature study aimed to explore the planning, management, and significance of the urban forest as well as the obstacles they face, including climate change, fragmentation, and balancing economic and human requirements. Its objective was to establish a strong basis for the case example.

LITERATURE STUDY

The literature study for this paper encompassed a variety of sources, including books, articles, reports, and management plans from academic or professional disciplines such as silviculture, landscape architecture, horticulture, and psychology. Research material was gathered through platforms like Primo and Google search. Focused on applying the Forest Development Types, "Naturnær skovdrift" (Dansk skovforening & Larsen 2005) and the associated article on applying them (Larsen & Nielsen 2012a) served as the primary resources, laying the foundation for this paper. They offered a crucial understanding of forest structures, enhancing the comprehension of various forest stands. Additionally, Gustavsson's (1991) forest structure types described in "Furulunds Fure" provided further insights and were incorporated into the paper, along with Halling's master's paper (2017) featuring case studies of the Forest Development Types. These studies were presented in the courses Urban Forestry and Dynamic Vegetation Design, providing the author with a foundational understanding and a previous introduction to these case studies. Gustavsson's work is often regarded as the founding concept of "forest structures" and is widely utilized throughout the Landscape Architecture discipline. Therefore, these sources were chosen as they not only contribute valuable insights but also align with the foundational concepts integral to the field of Landscape Architecture.

Furthermore, lectures and examples from the mentioned courses served as significant resources, illustrating various management plans, historical harvesting systems, and different forest types. They also provided valuable references for identifying and locating relevant literature. The supervisor, Allan Gunnarsson, made substantial contributions to the literature review process, aiding in the exclusion of non-relevant information, thereby enhancing the comprehensiveness of the paper.

Figure 1 Location of the municipality of Hässleholm county, where the case example is carried out.

CASE EXAMPLE

A request was sent out to different municipalities and nature reserves within the Scania region, asking if there were any urban forests in need of development or restoration. This led to the identification of Garnisonen, a peri-urban forest surrounding the new housing development area located outside Hässleholm's central region in Sweden (figure 1 and 2).

Once a military training facility, Garnisonen boasts remnants of its military past, as well having a rich cultural heritage, and diverse forest structures, all intersected by scenic hiking trails that connects it to its neighboring recreation areas along with its proximity to Lake Finjasjön which adds to its allure. The forest vegetation in Garnisonen aligns with the typical species found in the region. The northern outskirts are part of the forestry landscape, while the overall composition within the project area consists of native species. The management methods employed have led to mainly even-aged systems, with contrasting stands that have seen limited to no management actions.

While the municipality of Hässleholm recognizes the area's potential for development, efforts are being made to strike a balance between human needs and the preservation of natural elements, to create a more harmonious and human-scale environment that seamlessly integrates buildings and green qualities.

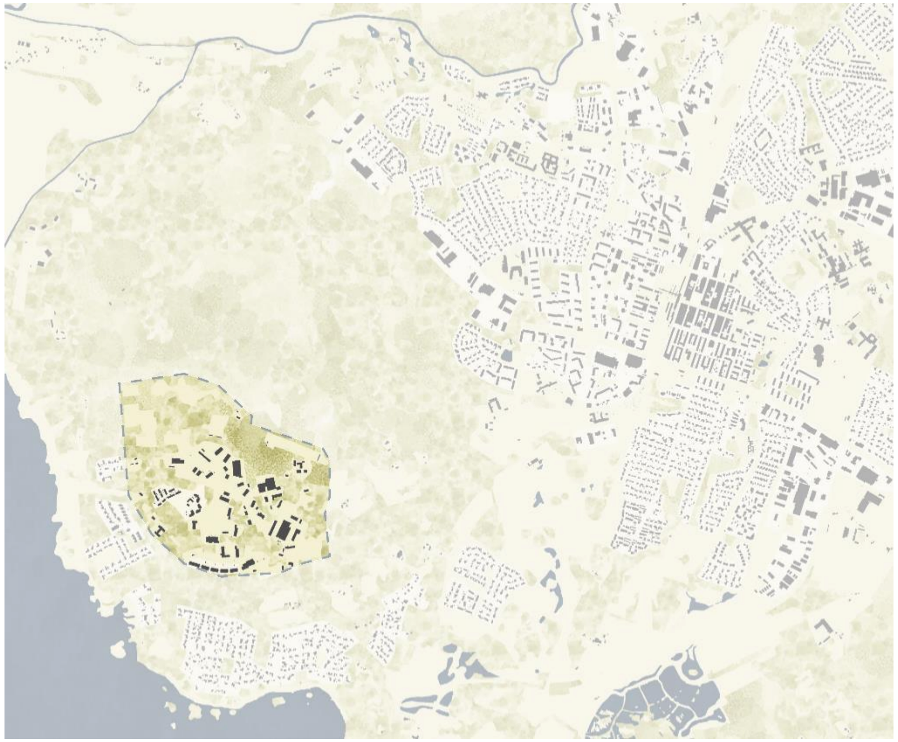


Figure 2. The project area Garnisonen in relation to central Hässleholm.

INVENTORY METHODS AND THE PRODUCTION OF MANAGEMENT PLANS

During the initial phase of the study, a field trip was carried out to conduct an overall inventory and analysis of the project area. The aim was to gain a comprehensive understanding of the site, including its distinct features, stand structures, along with interviews with people living inside the project area. Extensive research was then undertaken to explore the area's historical background and current conditions. This information was translated into a detailed written description and supplemented with a GIS analysis to identify the most valuable areas for preservation within the housing development.

To refine the focus, a smaller area was selected based on an arc-GIS analysis. Another field trip was organized to conduct a more detailed inventory, specifically identifying the species present in different stands and assessing the current settings and environmental aspects. This allowed for a comprehensive evaluation of the site's limitations and challenges. The

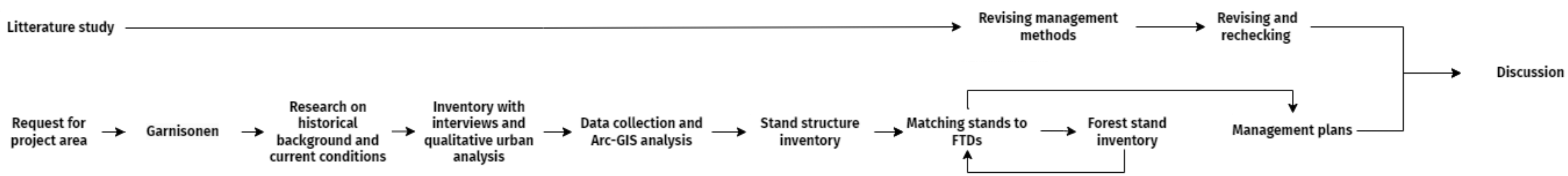


Figure 3.The flowchart illustrates how the thesis work combined the literature study and case example in parallel, highlighting the need to revise the literature study due to its insufficient provision of background information for the case example.

forest stand inventory followed established methods, considering factors such as crown cover and canopy density, in accordance with Påhlsson's (1998) guidelines.

The Forest Development Types (FDTs) were originally used as the foundation for describing the stand characteristics. In addition, "Växt- och Ståndortskännedom" (Wahlsteen 2018) was utilized as a guide to navigate through various forest types, their habitats, and the species typically found within them. However, it became evident that the existing FDTs were insufficient in providing precise management directions and stand types that aligned with the site conditions. To address this gap, additional research was conducted on silviculture methods, including the Swedish Forest Management Series (skogsskötselserien) considering successional stages within specific forest types. In order to encompass a broader range of possibilities, the study incorporated not only the Danish FDTs, which are suitable for southern Scandinavian conditions, but also the British FDTs.

Following the data collection on the different stand types, a subsequent field trip was carried out to further document the species compositions within the stands and edge zones. This information served as a foundation for developing management plans, which aimed to integrate various resources such as the Forest Development Types, the Swedish Forest Management Series, and other relevant literary sources. Additionally, the guidance and expertise of supervisor Allan Gunnarsson played a significant role in shaping and refining the management plans.

ANALYZING METHODS

To comprehend the site's requirements and the presence of green infrastructure, a range of analysis techniques has been employed. This involved narrowing down a smaller area with significant conservation values. The methodologies utilized for inventorying the project area included qualitative city analysis, "The image of the city," and a multi-criteria analysis.

Qualitative urban analysis aims to capture the “Genus Loci” of a place by examining its spatial structure and character, considering elements such as paths, edges, districts, nodes, and landmarks. It relies on field studies and interviews to gain insights into the mental image and perception of the site. The concepts described are derived from Kevin Lynch's seminal work "The image of the city" (1960) and have been incorporated to enhance the understanding of the are within the case example (Schibbye 2001).

Multi-criteria evaluation analysis serves as a valuable tool for mapping desired attributes in a specific area. It involves establishing criteria that can be evaluated as true or false statements in relation to the intended question. In this case, the question revolves around determining the conservation value of an area. The criteria are assigned values representing the extent to which they contribute to conservation, and then weighted against each other. By applying these weights, areas can be ranked based on their preservation scores, helping identify those with the highest conservation value. The approach outlined here draws upon the work of Eastman (2005) and offers a systematic method for assessing and prioritizing conservation efforts.

The combination of qualitative urban analysis and multi-criteria analysis helps define the overall area, while "the image of the city" approach has been used to describe the less delineated portion, which subsequently received a management plan.

QUALITATIVE INTERVIEWS

To gain a deeper understanding of the points of interest that are worth preserving and developing, interviews were conducted with three individuals from the nearby area who frequently engage recreationally with the forest in their daily lives. The interviews followed a semi-structured qualitative interview format, which focuses on the perspectives and experiences of the interviewees rather than the specific interests of the interviewer (Bryman 2018). Prior to the interviews, introductory questions and a map highlighting the limited area of the case example were shared with the interviewees. This provided them with some context before the actual meeting, which took the form of a walk around the perimeter of the area. During the interviews, the answers were written down and additional questions were posed, both those prepared in advance and those that arose during the conversation, to gather more insights and information.

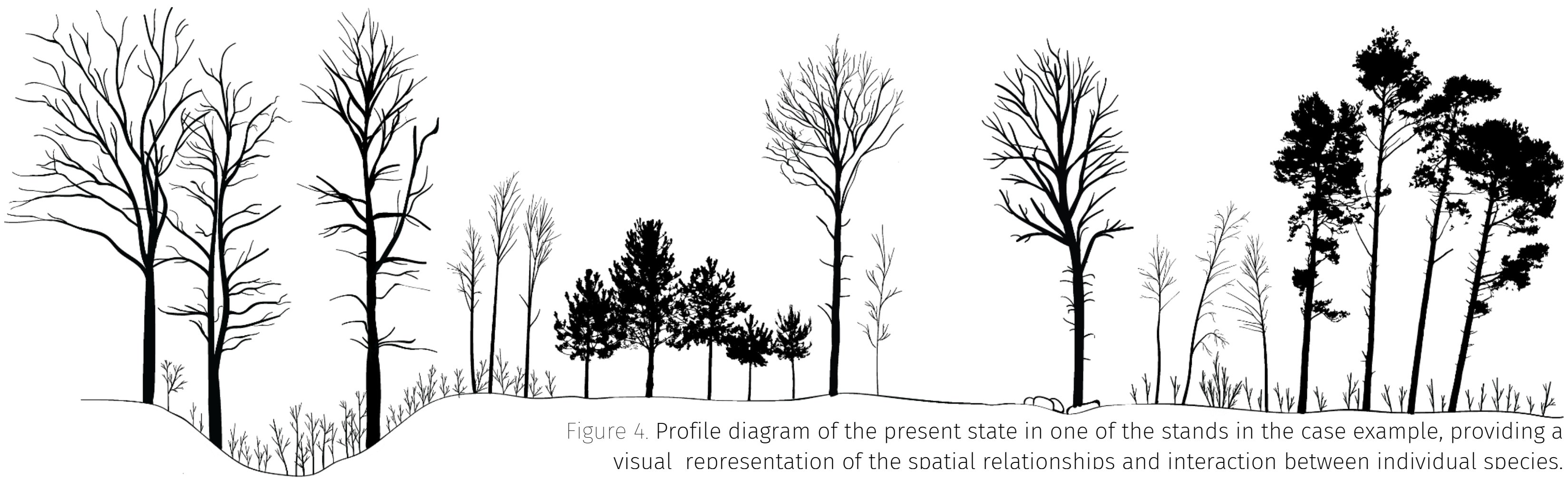


Figure 4. Profile diagram of the present state in one of the stands in the case example, providing a visual representation of the spatial relationships and interaction between individual species.

LIMITATION AND DIVISION OF THE VARIOUS STANDS

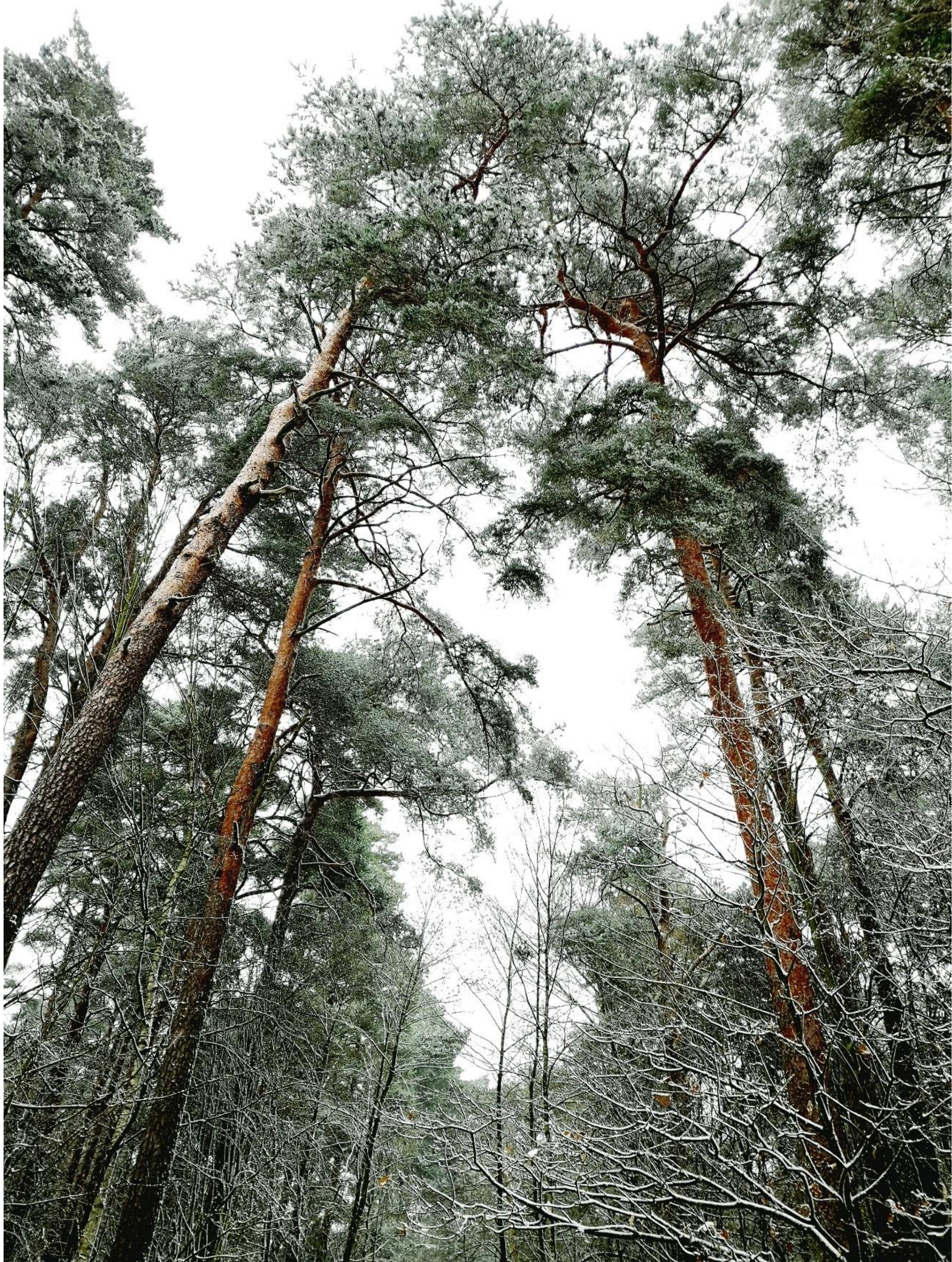
The selected area, chosen through the various analyzing methods, exhibited noteworthy attributes in terms of biodiversity, recreation, and culture. The division of the stands was based on species structure and natural paths that separated the stands. The naming of the stands followed Påhlsson's (1998) recommendations, where the primary species within the stand structure was reflected in the name. Additionally, the main specie was required to have a crown coverage or base surface of at least 70%, although it is important to note that mixed forest systems often do not adhere to a 7/10 distribution.

PROFILE DIAGRAMS AS A METHOD OF COMMUNICATION

Profile diagrams have been employed as a visual tool to communicate the structures and dynamics within a forest stand (figure 4). They effectively convey the long-term management and development objectives for different stand structures. Unlike photographs, which provide a sense of the present surroundings, profile diagrams capture information that conventional measurements and two-point perspectives cannot. These diagrams provide a single visual representation of a cross-section through a forest stand, revealing the spatial relationships and interactions between individual species. They also aid in predicting future challenges or issues within the forest stand (Gustavsson 2009).

LITERATURE STUDY

This literature study investigates the interconnected aspects of urban forestry, human perception, management regimes, climate change, and vegetation structure in the context of developing effective management plans for peri-urban forest environments. Understanding the complex relationships among these factors is crucial for sustainable forest management and ensuring the resilience of peri-urban forests in the face of ongoing environmental changes.



URBAN FORESTRY

The definition of Urban Forestry can vary across countries and professions. As illustrated in figure 5, it can encompass a range of activities, from planting individual trees within urban areas to managing forests located near cities. The broader definition includes the design, planning, establishment, and management of forested biotopes within urban environments (Konijnendijk et al. 2006). These biotopes can be natural, semi-natural, or man-made, and they can include various systems such as water bodies, wetlands, semi-open areas, and open nature types (Larsen & Nielsen 2012a). The common element in these definitions is that Urban Forestry focuses on the presence of trees in connection to cities, providing ecosystem services to nearby residents (Konijnendijk et al. 2006). Typically, the management of urban forests prioritizes recreation and nature conservation, with timber production playing a secondary role (Larsen & Nielsen 2012a).

Figure 5. The illustration depicts the urban forest with its various contexts within a projected area in Bergen, Oslo. The trees in the foreground, near the waterbody, belong to a smaller-sized urban forest, while the larger forest near the city is located in the background.

THE HISTORY AND CONTEMPORARY INTERPLAY OF URBAN FORESTRY

The urban forest has a long history, predating the term itself. Initially, gardens and parks were exclusive to the upper classes for recreational activities like hunting (Forrest & Konijnendijk 2005). However, in the late nineteenth century, it became evident that green spaces were essential for the health and well-being of all citizens, especially those residing in densely populated cities where housing conditions were associated with diseases (Nylander 2018). Leisure time and access to green spaces became more accessible to all social classes during this period (Tyrväinen et al. 2005), leading to the creation of numerous public green spaces. Previously, tree planting was primarily done in private parks and by forest owners (Forrest & Konijnendijk 2005). By the late 1800s, around 80% of people in Britain lived in urban areas, and this number is projected to increase to 7 billion by 2050 (Ritchie & Roser 2018).

During the late twentieth century, forestry practices led to decreased biodiversity in forests. Today's forests, compared to those in the 1950s, are drier, younger, and contain fewer deciduous trees. Drainage systems have altered the topography of forests, interrupting natural water flows. Grazing animals are less prevalent than machine harvesting, and forests are harvested at younger ages, with over half of the forest areas in Sweden being less than 40 years old. Grazing pressure from ungulates (moose and deers) and active control of deciduous trees have contributed to the decline of deciduous species since the 1970s. However, the areas of deciduous forests have increased due to the abandonment of meadows, pastures, and old fields. These biotopes are significant for biodiversity, highlighting the importance of restoring coniferous forests to deciduous forests alongside grassland restoration (de Jong 2002).

The fragmentation of landscapes over the past century has resulted in some biotopes becoming too small, remote, and isolated to support interactions between plants and fauna. Illustrated in figure 6, agricultural lands, highways, roads, and other types of physical barriers interrupts the natural connectivity and continuity of the forest, creating smaller isolated patches of vegetation. Wind-pollinated species with lightweight seeds and birds are often the only ones capable of dispersing within these fragmented areas (Gustavsson 1994). However, new diverse biotopes can emerge if key biotopes are connected to restored or planted environments. The key challenge lies in the disappearance of these key biotopes due to landscape fragmentation (de Jong 2002). In central urban areas, approximately 80% is covered by pavement or buildings, leaving less than 20% for green structures (McKinney 2002). Therefore, it is crucial to prioritize the establishment of flexible systems in various sizes that can adapt to climate change, along with the creation of green corridors (Ekelund 2007).

Sustainable development rests on minimizing environmental impact and the use of limited natural resources. This includes the protection of vegetated areas during construction projects to prioritize biodiversity (Florgård 2000). However, a case example in Stockholm, Sweden, revealed that the despite political ambitions to preserve nature, the region's green infrastructure had decreased by half since the mid-1970s due to urban expansion (Colding 2013). Green areas have often been converted into residential development sites, resulting in the destruction of habitats with rich biodiversity for economic reasons. Vegetation and topsoil, which support biodiversity and wildlife, are typically removed during

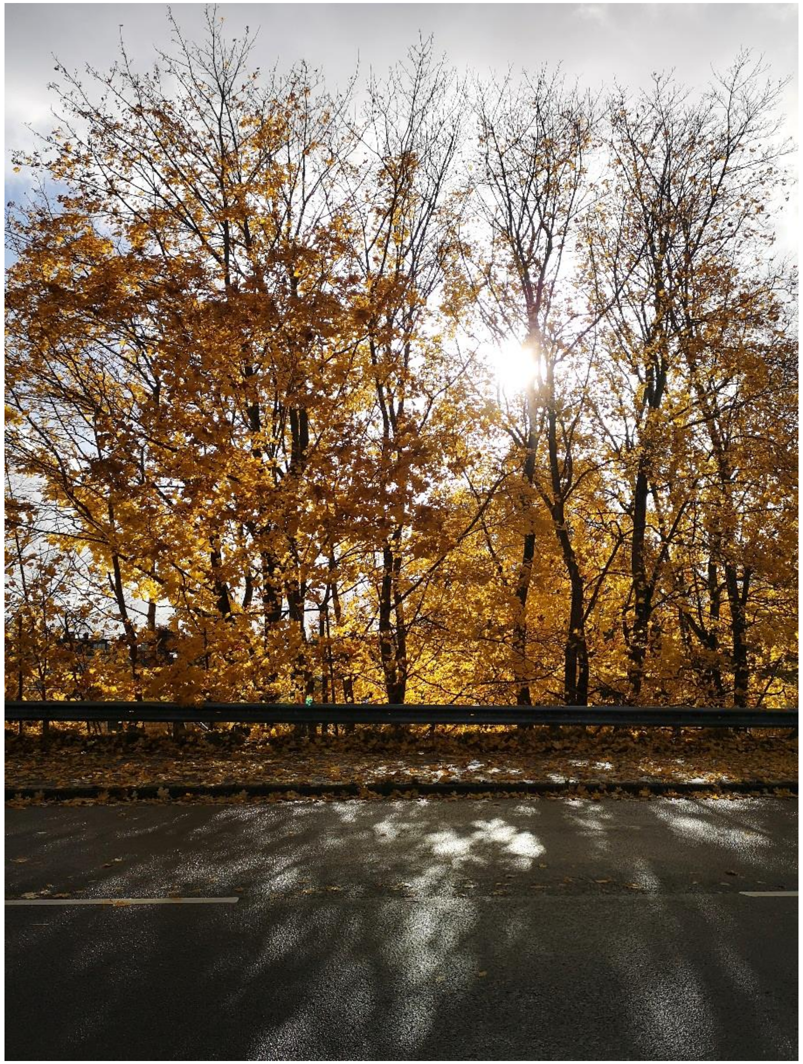


Figure 6. Over the course of the past century, fragmentation has led to the reduction in size, remoteness, and isolation of these important habitats. As a result, the ability of plants and fauna to interact and thrive within these fragmented biotopes has been greatly compromised.

construction, and non-native species are often planted in the remaining green areas (McKinney 2002). While construction may take only 1-5 years, the restoration of vegetation and ecological systems can take decades or even centuries (Löfvenhaft et al. 2002). reserving green areas not only conserves current biodiversity and aesthetic values but can also reduce construction and maintenance costs if healthy trees are selected, since they can act as seed sources (Florgård 2000).

Traditionally, in Scandinavian cities, the urban forest has provided recreational and aesthetic benefits, while in other parts of Europe, it has been used to mitigate climatic conditions. However, due to climate change, the utilization of wind shelter, shading, and cooling effects in the urban forest is expected to increase. The recreational goals associated with urban forests may pose a risk to biodiversity due to trampling. One approach to mitigate this is by informing people about fragile ecosystems and red-listed species in the area and making certain areas inaccessible except for designated paths (figure 7). However, increasing green spaces closer to residential areas is also advocated, as studies have shown that proximity to green space is critical for people to utilize them (Tyrväinen et al. 2005).

The maximum distance people are willing to walk to reach a green area is typically around 10 minutes, translating to approximately 300-400 meters for children and the elderly (Koppen et al. 2014) Areas located further than one kilometer are more likely to be used by car owners rather than pedestrians (Schipperijn et al. 2010).

Boverket (2022) recommends that residents should live within a proximity of 20-300 meters from green areas, additionaly a study in the United Kingdom showed that two hectares was the smallest woodland size that people were willing to visit regularly (Coles & Bussey 2000). From a biodiversity perspective, a study in Brussels, Belgium, demonstrated that stands closer to urban areas have a higher likelihood of hosting ancient forest species and rare species (Alvey 2006). On a more local scale, in Stockholm, urban green areas are estimated to harbor two-thirds of the region's red-listed species (Colding et al., see Alvey 2006).

Urban woodlands have frequently been overlooked or mishandled, but if individuals are to begin making use of these spaces once more, restoration efforts are necessary. This restoration process extends beyond cleaning and thinning for creating paths; it may require revising the entire layout, structure, and composition of these stands (Bell et al. 2005). As cities continue to expand, it is crucial to preserve natural habitats, not only for biodiversity but also for the well-being of urban residents. Choosing land-development techniques that retain natural vegetation instead of removing it should be a priority (McKinney 2002).

Figure 7. Informing individuals about fragile ecosystems and endangered species in urban forests, and restricting access to designated paths or implementing signage, can help mitigate the risk to biodiversity posed by recreational activities.

HUMAN PERCEPTION, EXPERIENCE AND SOCIAL CONSEQUENCE

Human preferences are strongly influenced by cultural, regional, contextual, and subjective experiences. However, close-to-nature forest management is generally favored in all these contexts due to its ability to maintain a more natural appearance over time by minimizing the number of trees cut down at once. This approach also promotes biodiversity (Larsen & Nielsen 2012a). Mature, old forest stands are generally preferred over young, sparse stands. However, a two-layered stand with a lower canopy of smaller trees can enhance the visual qualities of the forest (Tyrväinen et al. 2005). The mixed forest system, which includes close-to-nature management, provides a variety of close, semi-open, and open areas that are important for orientation, unity, and coherence in the landscape experience (Kaplan 1995; Bell et al. 2005), Additionally, it caters to the diverse preferences of forest users (Larsen & Nielsen 2012a). While variations within a stand are significant, variations between stands are equally important. A forest would become monotonous without diverse biotopes and stand structures across the landscape (Filyushkina et al. 2017). The recommended sizes for individual stands vary, and a good guideline is that stands should be large enough for visitors to fully experience their character before entering a new stand. Recommended sizes are 0.1 hectares for coppice and low shrub forests, 0.25 hectares for mixed forests, and 1 hectare for monoculture stands (Gustavsson 1991).

In comparison to parks, urban forests can meet additional demands that park elements cannot. According to Tyrväinen et al. (2005), urban woodlands have a relatively large "social capacity" per hectare and can provide a stronger sense of separation from the urban landscape (Tyrväinen et al. 2005). To achieve this, it is recommended by Bell et al. (2005) to enhance the naturalness and wilderness of the forest landscape, which creates a sense of solitude and separation. Furthermore, high perceived naturalness in green spaces has been associated with increased activity, higher aesthetic values, and greater well-being for local residents (Ode Sang et al. 2016).

When managing recreational forests, the selection of trees primarily focuses on individual trees. The criteria for selection often prioritize unusual trees that have developed a distinct habitus, contributing to landscape variation and serving as key elements. Other selection traits could include species that exhibit distinctive flowering patterns or other exceptional traits. Examples of such species include Sorbus aucuparia, Populus tremula, and Prunus padus, Additionally, clearing of stands can be directed towards uncovering ancient remnants such as large boulders or rock formations. Creating welcoming entrances with easy access to the forest interiors is also crucial, and individual trees can be used as landmarks to facilitate locating these entrances (Hannerz et al. 2016).

> "A good physical environment is fundamental to a population's health [...] And in this environment nature is also included, which means a lot to people's need for recovery and relaxation. The proximity to accessible nature areas and parks also affects the possibility of physical activity and interest in outdoor activities. When we are children or old the local environment is particularly important. Linking environmental work with health work is important. When protecting plants and animals from risks it is often also healthy for us humans."
>
> Swedish proposal to the public health law in 2000 (SOU 2000:91).

Figure 8. Safety within forested areas is often a perceived rather than real sense of security. People want to see others while remaining unseen themselves. However, in truth, our presence in the forest is not solely about observation but also about establishing a connection with the natural environment. When we enter the forest, we seek not only to observe but also to be acknowledged by the forest itself, recognizing our role as active participants in its ecosystem.

VISIBILITY AND SAFETY

According to Tyrväinen et al. (2005) there are few physical attacks within the forest, therefore safety within green areas is often a perceived safety rather than a real one. Clearing the understory is often done to create a sense of safety by allowing visitors to have a broader view of the forest. The image on the left clearly demonstrates a sightline that extends into the open field beyond the tree line. In contrast, on the far-left side, the presence of Picea abies trees obstructs the sightline, limiting visibility into the surrounding area. Jansson et al. (2013) suggest that the ideal environment is where individuals can see others but not be seen, especially along paths and in darker areas of the forest where people tend to move during darker hours. According to Ode Sang et al. (2016) there is also an indication that perceived safety increases in areas with a high sense of naturalness. However, this can be a challenge in young stands, as they need to be dense before reaching maturity (Bell et al. 2005).

OPPOSING FORCES

When restoring or developing the urban landscape that is already in use of inhabitants, the balance between social and biological values within the landscape emerge. In the Pine Lake Park, an urban forest, located in San Francisco showcase an example where compromises were made between the county and its inhabitants. During a lake survey, the endangered species western pond turtle (*Clemmy marmorata)* was spotted in the area. To promote the turtle, many of the trees supposedly had to be removed, the shore had to be fenced of, a children's day camp had to be closed down during mating season, and dogs had to be banned despite the area being popular for off-leash dog play. These actions where highly protested before they could be set into motion, the county was instead forced to come up with a plan that relocated the turtles to a larger lake in the nearby area (H. Gobster 2012). Within the case example of this paper, a similar conflict has emerged, that is yet to be resolved. Two apartment buildings with four stories and a retracted attic started construction on the site, the municipality issued a start notice for the project before the Supreme Land and Environmental Court issued its verdict. Even though both the detailed description and the detailed plan (Hässleholms kommun 2018) for the area stated that trees and topography must be preserved, the area were excavated, and trees removed, including an inventoried tree worthy of protection. Only three trees remained adjacent to the previously existing residential buildings. On top of this, the plan description stated that all ancient monuments had to be safeguarded. However, an ancient monument, a boundary stone was relocated to make way for the new apartment buildings (Önell 2022).

The tenant-owner association attempted to overturn the ruling, but the county administrative board ruled that a plan description is not legally enforceable and that tree felling, and excavation are not prohibited (Önell 2022). Throughout the interview walks done by the author, the residents demonstrated how the forest veil that once surrounded the dwellings had vanished. Instead, the new apartments are now located about 10 meters away from the current residences. Despite the small size of the previous tree barrier, it made the inhabitants feel close to nature, they had previously spotted foxes and deer along the path and bicycle path (nell 2022b). Now, there is only a pedestrian and bicycle path between the residential areas, and the existing residents now hope that the municipality will replace the path with trees.

"Resource management will only be successful if it is ecologically possible, socially acceptable and technically feasible."

(Oliver et al. 2012).

CUES TO CARE

Maintaining a balance between human preferences and biological values within forest systems can pose challenges, as what benefits biodiversity may not always align with human aesthetic preferences. Over time, cultural maintenance and design efforts have shaped our perception of nature, leading to a preference for well-maintained landscapes rather than natural, untouched environments (Nassauer 1995). This has led to the concept of "cues to care," as mentioned by Nassauer (1995), which seeks to accommodate human preferences while also considering biodiversity needs.

"Cues to care" involves designating specific areas within the forest that are tailored to human preferences and creating other areas that prioritize biodiversity conservation. For instance, ecological values within a forest stand often necessitate the presence of dead wood, which plays a crucial role in supporting various species. However, humans may perceive it as unattractive or unsafe (Nassauer 1995; Sheppard 2001; Bell et al. 2005). As a result, areas along pathways or heavily frequented forest stands can be regularly cleared to maintain a neat and cared-for appearance, aligning with the concept of "cues to care" (Sheppard 2001; H. Gobster 2012). This approach ensures that certain areas meet human expectations while allowing for the preservation of ecological values in other parts of the forest. When it comes to dead wood, small stems, typically a few centimeters in width, tend to wither after a few years, while cut material larger than 5 cm in width is preferably removed from the site or gathered into piles placed far from paths to minimize their visibility (Tyrväinen et al. 2005). Additionally, it is important to consider the preferences of children when designing forest landscapes. While the positive view of a well-maintained forest is often seen from an adult perspective, children have different needs and desires.

When designing for children, the primary goal should be to create structural diversity within the forest. This diversity stimulates their imagination and provides opportunities for play. Children enjoy a range of forest structures, including open areas, dense thickets, and stands with plenty of dead branches and smaller stems for play and building (Tyrväinen et al. 2005; Hannerz et al. 2016). They are particularly drawn to dense, wild, and hidden environments. Furthermore, children who have opportunities to play and form connections with the natural environment are more likely to carry those connections into adulthood (Bell et al. 2005). Therefore, considering the preferences of children and providing engaging forest environments can foster their connection with nature from an early age.

CUES TO CARE

NEATNESS		STEWARDSHIP		NATURALNESS	
Attractive	Unattractive	Attractive	Unattractive	Attractive	Unattractive
Trees in rows	Dead or rotten	Conservation	No conservation being used	Development blends in	Too formal
Clean	No flowers	No erosion	Erodible land	Habitat	Too much concrete
Neat	Not landscaped	Pasture	Overgrazed pastures	Native vegetation	Too open
No junk	Cluttered	Terraces	Plowing up the hills	Natural	Bare
Well kept	Messy	Windbreak	Runoff	Trees	Flat
	Abandoned			Wildlife	Monotonous
	Neglected				No trees

Cues to care according to (Nassauer 1995).

MIXED FOREST SYSTEMS

A mixed forest system is characterized by the coexistence of two or three different tree species within a forest unit (Bravo-Oviedo et al. 2014). Natural forest systems rarely consist of only one tree species and are typically found in extreme sites. In Sweden, the natural monoculture consisting of Fagus Sylvatica is often the prime example that comes to mind (Spiecker 2003). Mixed forest systems provide more ecosystem services compared to monocultures due to their higher diversity. According to the "insurance hypothesis," mixed forests respond and recover faster from disturbances, making them more resilient to pests, diseases, and climate change (Konijnendijk et al. 2006; Bravo-Oviedo et al. 2014). In contrast, monoculture coniferous stands have higher mortality rates under various circumstances such as drought, wind, snow, ice, and are more susceptible to fungi and insects (Spiecker 2003) Additionally, low plant diversity is associated with erosion, trampling, pollution, invasive species, and the need for mowing and pruning (McKinney 2002).

Urban forests, according to Larsen & Nielsen (2012) often lack structural complexity, visual variation, and habitat diversity due to silvicultural traditions. Silviculture primarily focuses on high-quality timber production, leading to stereotypical monoculture plantings and consistent maintenance models with thinning every other tree (Larsen & Nielsen 2007). By adopting practices that retain trees with specific characteristics, creating multi-layered forests, and developing natural habitats suited to the site, urban forests can enhance diversity in habitats and visual qualities, resulting in more interesting forests. Mixed forest systems are complex and ever-changing, consisting of various woody species that intermingle in different forest layers, resulting in a greater variety of forest structures. These mixed forest systems are also more appreciated from a user perspective (Sang, 2021). When designing landscapes, it is important to consider both the passage of time and the selection of species to create sustainable systems that are valued by the public (Gundersen & Frivold 2008).

Manipulating ecosystems and increasing biodiversity can be achieved through vegetation. Species richness among mammals, amphibians, reptiles, birds, and insects is correlated with vegetation richness (McKinney 2002), and appropriate selection of vegetation or biotopes can guide animals and insects to their habitats (McPherson et al. 1994).

Studies indicate that rare or red-listed species tend to naturally occur near each other, and common species found in species-poor habitats are often present in species-rich habitats as well. The relationship between these factors can be represented as a value pyramid, illustrated in figure 9, with uncommon species at the top and common species at the bottom. A strategy for conservation is therefore to preserve and restore existing natural habitats that can also serve as corridors for species survival and dispersal (Länsstyrelsen Skåne 2015; Webber et al. 2022).

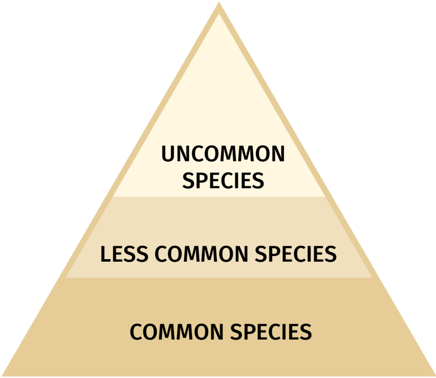


Figure 9. Value pyramid with uncommon species at the top and common species at the bottom

PRESERVING URBAN FORESTS IN THE ERA OF CLIMATE CHANGE

To ensure the development of resilient forests, it is crucial to understand the impact of climate change on ecosystems in the future. According to *Climate Change 2022: Impacts, Adaptation and Vulnerability* many ecosystems are nearing their tipping point in terms of adaptability, especially those already influenced by human activities such as silviculture, pollution, and biological disturbances, making them highly vulnerable to climate change (Staudt et al. 2013).

In many parts of southern Sweden, the traditional concept of meteorological winter, characterized by an average daytime temperature of 0.0 degrees or lower, is disappearing. These regions are experiencing a shift from winter to an extended autumn, with temperature rise continuing (SMHI 2022). *Climate Change 2021: The Physical Science Basis* presents probable climate response scenarios until the year 2100. The scenarios with lower greenhouse gas emissions are expected to result in a temperature increase of 1-1.8°C, while the worst-case scenario with doubled emissions could lead to a temperature increase of 3.3-5.7°C (SMHI 2021).

The potential consequences of temperature rise are significant. If the temperature increases by 1.5°C, it is likely that 3-14% of species in terrestrial ecosystems may face extinction. At a 2°C temperature increase, this figure rises to 29%, and at 5°C, it reaches 48% (Pörtner et al. 2022). Moreover, studies show that higher temperatures, humidity, and drought can benefit pests, diseases (Forzieri et al. 2021), and invasive species (Weeks et al. 2022). These factors may allow introduced species to establish a stronger presence in Sweden, potentially replacing local species (Willis et al. 2010).

As a result of climate change, there is an increased risk of:

- heat waves
- mosquitos, tics, bacteria & mold
- extreme rain falls
- flooding
- landslides and erosion
- worse quality in water resources
- prolonged pollen season
- longer droughts-periods

(Ekelund 2007)

Despite Scandinavia's stronger tradition of preserving natural and semi-natural urban forest systems compared to the rest of Europe (Gärdenfors, 2000) the biodiversity within these forests has declined over the past 50 years (Karlstrom and Sjogren-Gulve, 1997, Gothnier et al., 1999) primarily due to landscape fragmentation (Löfvenhaft et al. 2002). Fragmentation disrupts green corridors, patches, and forests, hindering the movement of species and organisms through the landscape (Crow 2012). As one moves from rural areas into the city core, the density of roads, human presence, air and noise pollution, temperature, soil compaction, and soil alkalinity increases, while the detection of native species decreases while detection of native species decreases (Löfvenhaft et al. 2002; McKinney 2002). An increase in temperature due to climate change is expected to extend growing seasons by 1-2 months, which could potentially benefit silviculture and agriculture. However, the benefits of prolonged growing seasons are contingent upon mitigating risk factors. While natural changes in nature occur slowly, the rapid temperature rise in worst-case scenarios presents uncertainty regarding the extent of its impact on ecosystems (Ekelund 2007). Nevertheless, substantial evidence suggests that biodiversity conservation is at risk in the near future, with Northern Europe and old trees particularly vulnerable to rapid temperature changes (Forzieri et al.

Invasive exotics and garden escapes

Humans have played a significant role in spreading exotic and invasive species across landscapes, often unintentionally through planting and transportation (Berlin & Niss 2019). One major concern with using exotic species is that they may lack natural enemies, and those introduced to Sweden are typically from warmer climates, making them prone to establishing themselves in response to climate change and the heat island effect found in cities (Alvey 2006). In the urban core of Sweden, there are few native species that can thrive in the challenging urban climate (Sjöman et al 2016). In Adelaide, Australia, data collected since 1836 has shown a significant increase in the number of plant and animal species, with 648 new species introduced and at least 132 species becoming extinct between 1836 and 2002 (Tait et al. 2005). Garden escapes, where plants spread beyond cultivation, are more common in urban areas, particularly near the urban core, with exotic species comprising over 50% of the vegetation compared to 5% in rural areas (McKinney 2002 However, a study in Brussels, Belgium, found that stands closer to the urban core were more likely to support ancient forests and rare species (Alvey 2006).

2021). When faced with climate change, species have three options: adapt, move, or face extinction. Adaptation can occur through increased tolerance to drought or adjusting the timing of budding, flowering, and fruiting (Bellard et al. 2012). Generalist species are favored in changing habitats because they can survive across a wider range of biotopes, while specialist species dependent on specific climates and biotopes have a reduced chance of survival as habitats change due to climate change (Pöyry et al. 2009). The effects of climate change on species distribution are already visible in the Scania region of Sweden, where heat-, nitrogen-, and shade-tolerant species are increasing. A study conducted in Sweden indicates that rising temperatures and changes in precipitation patterns have already led to the decline of field layer species. Species adapted to the southern regions are increasing, predominantly in the south of Sweden, likely due to reduced winter snow cover (Jörg 2015).

As average temperatures rise, climate zones in the northern hemisphere will shift northward. For instance, a temperature rise of 5°C would result in the climate zone of Berlin, Germany being found in Stockholm, Sweden, which could potentially enable the establishment of Fagus Sylvatica, a species not naturally found in the area. Additionally, Picea abies requires a colder season, and Stockholm faces the risk of losing winter days below -10°C, potentially causing the suitable habitat range to shift further north in Sweden (Ekelund 2007). In Scania, the influx of new species from the north, including the potential establishment of Mediterranean plants like Quercus ilex, reflects this changing pattern (Hall et al. 2015).

In urban settings, climate change is leading to an increase in heat waves (Pörtner et al. 2022). Trees play a vital role in mitigating this effect, as they provide energy savings through temperature regulation, shading, and acting as wind barriers. In terms of cooling, urban woodlands and parks are the coolest areas within an urban context, with temperatures 2-3°C lower than built-up areas. They can also help lower temperatures in transition zones by up to 400 meters on windless days when the heat island effect is strongest (Tyrväinen et al. 2005).

FUTURE PROSPECTS

According to Sykes (2007), advancements in technology are projected to result in a reduction of agricultural lands, while the expansion of forests, particularly deciduous forests, is expected. This expansion is attributed to the anticipated northward shift of the boundary between the northern coniferous forest and the southern deciduous forest. Additionally, Sykes suggests that the future landscape may resemble the observed during the post-ice age period. This is due to the elevated levels of atmospheric carbon dioxide, which have not been as high since the last ice age twenty million years ago and are continuing to rise. The increased carbon dioxide levels have a fertilizing effect on vegetation and reduce plant water requirements during droughts. This alteration in water dynamics can impact plant competition, as different species possess varying abilities to store and utilize available water. Consequently, we may witness unprecedented changes in vegetation patterns and landscapes. Furthermore, rising temperatures expose seedlings and young trees more during the spring season due to reduced snow cover.

During the last ice age, Scandinavia's flora was completely wiped out, leaving Sweden with only 30 native species. Unfortunately, climate change and plant transportation between countries have increased the risk of pest and disease outbreaks, which can have devastating effects on the health and longevity of these native species, and in the worst case, lead to their extinction. Currently, sixteen of Sweden's thirty native species are at high risk of being severely impacted by diseases and vermin outbreaks, with three families, including Ulmus sp., Alnus sp., and Fraxinus sp., being infected with dangerous fungi (Sjöman et al. 2016).

While it is impossible to predict how native Swedish species will respond to climate change, some insights on their potential responses are available. However, the provided table on the following page does not address the potential spread of diseases that are currently emerging in warmer regions worldwide. It is also highly likely that evergreen trees and shrubs, such as Ilex aquifolium and Prunus laurocerasus, will increase in Sweden, with Ilex sp. already spreading rapidly in the southern and eastern parts of the country (Sykes 2007).

According to Sæbø et al. (2003) tree species within urban forests should align with the selection for commercial forestry but with a broader range of species. As future forest conditions may change rapidly, species selection within urban settings, where conditions can be more stressful due to factors such as heat islands, air and soil pollution, wind, and drought, could impact rural areas. Native species might not always be viable choices within urban environments, and it is likely that species will spread into rural areas and adjacent urban forests. As previously mentioned, species have already begun infiltrating natural systems, and even if control measures are desired, they may not always be feasible. However, by striving to establish sustainable forest systems and actively managing their development, rather than leaving them to fate, some degree of control can be maintained (Sæbø et al. 2003; Sjöman et al. 2016).

Forests have evolved over millions of years to cope with occasional extreme weather events like strong winds, droughts, and heavy rainfall. However, these events are now happening more frequently, becoming regular disturbances that forests struggle to adapt to (Forzieri et al. 2021). When it comes to understanding how native, nonnative, and invasive species will respond to changing temperatures and disturbances, our knowledge is limited. This makes it challenging to predict with certainty when planning and developing urban forests (Dukes et al. 2009). That's why it's crucial to create diverse and flexible forest systems that include a variety of species, as they are more likely to adapt to these changes (Pörtner et al. 2022). In a mixed forest, if one species dies, another will take its place (Ekelund 2007). Additionally, studies have shown that having a high biodiversity is beneficial in preventing the extinction of vulnerable species (Weeks et al. 2022). By planting and managing forests intentionally, we can guide them in the desired direction (Ekelund 2007).

Table 1 Native Scandinavian trees with potential intolerance to climate change.

SPECIE	TOLERANCE AND PREDICAMENTS
Acer campestre Acer platanoides	Highly susceptible to the Asian longhorned beetle (Anoplophora glabripennis) and the Citrus longhorned beetle (Anoplophora chinensis). They also have a high potential for infection by eutypella canker (Eutypella parasitica) (Sjöman et al. 2016)
Alnus incana Alnus glutinosa	These species have a higher tolerance to wind due to their development of stable root systems and the ability to resprout (Wolf et al. 2004). However, they are very susceptible to Phytophthora alni, a pathogen that poses a significant threat to their health (Sjöman et al. 2016)
Betula sp.	Very susceptible to the bronze birch borer (Agrilus anxius) (Sjöman et al. 2016)
Betula pubescens	Wind sensitive, but have high chances of regeneration in gaps that appear from storms (Sykes 2007).
Crataegus laevigata	Highly susceptible to fire blight (Erwinia amylovora) (Sjöman et al. 2016)
Fagus sylvatica	In recent years, there has been a notable increase in outbreaks of Phytophthora citricola, P. cambivora, and P. cactorum in Europe, affecting a growing number of beech trees (Sjöman et al. 2016). While Fagus sylvatica is expected to benefit from rising temperatures, it may face a decline in certain regions due to increased drought conditions. In such areas, Tilia cordata, Quercus robur, and introduced species like Acer pseudoplatanus have a higher likelihood of survival (Sykes 2007).
Fraxinus excelsior	The Emerald ash borer (Agrilus planipennis) is established in Russia and is expected to eventually spread to the Scandinavia. This invasive beetle poses a significant threat to ash trees. Additionally, the European ash is currently experiencing a widespread outbreak of ash dieback caused by the pathogen Chalara fraxinea. This disease has resulted in extensive damage to European ash populations (Sjöman et al. 2016).
Picea abies	With rising temperatures, Picea abies (Norway spruce) is expected to migrate to northwestern Scania in the next 50 years (Sykes 2007). While climate change has favored Fagus sylvatica over Picea (Bolte et al. 2010) as fires become more common, Pinus species are likely to benefit. In silviculture, Scania County is advised to shift focus from Picea abies (Bradshaw et al. 2000).
Pinus sylvestris	The pinewood nematode (Bursaphelenchus xylophilus) poses a serious threat to the boreal forests of northern Europe (Sjöman et al. 2016), however, Pinus sylvestris will likely be favored due to its wide range of suitable growing conditions(Sykes 2007).
Quercus petraea Quercus robur	Sudden oak death (Phytophthora ramorum) has the potential to cause extensive tree losses in the two native oak species. Oak wilt (Ceratocystis fagacearum) poses a serious threat, particularly for Q. robur (Sjöman et al. 2016). While somewhat sensitive to wind, these oak species have a large and deep root system, providing them with greater stability (Sykes 2007).
Ulmus glabra Ulmus minor Ulmus laevis	The Dutch elm disease (Ophiostoma novo-ulm) has resulted in the death of thousands of Ulmus species in Scandinavia (Sjöman et al. 2016)

REALIGN, NOT RESTORE

The concept of restoration, as defined by the Swedish encyclopedia (2022) involves rebuilding something to its original condition. Landscape restoration, according to The Society for Ecological Restoration (2004), is the intentional process of recovering a degraded, damaged, or destroyed ecosystem. However, in an urban setting, landscape restoration can be challenging due to factors such as climate change, garden escapes, exotic species, human presence, and historical land use practices, which have had a significant impact on the landscape and may hinder restoration efforts.

Crow (2012) argues that instead of aiming to restore landscapes to their historical conditions, we should focus on *realigning* them by looking ahead. Uncertainties related to future population pressure, values, and the impacts of climate change make it difficult to fully anticipate and replicate historical contexts. Wimberly et al. (2012) emphasize that future trends in these areas can only be speculated upon. When restoring forests, the concept of resilience becomes crucial. Resilient forest systems can adapt to natural changes and disturbances while maintaining diversity, health, and productivity within their ecosystems.

Landscape restoration requires careful consideration of various factors, including site-specific analysis, historical context, species composition, economic feasibility, and climate change projections. By embracing the concept of realignment, restoration efforts can be guided towards creating sustainable and adaptable ecosystems.

SITE ANALYSIS FOR LANDSCAPE RESTORATION

In assessing options for realigning specific sites, Lamb et al.'s (2012) site analysis for landscape restoration provides a useful tool and considers the following factors:

Environmental conditions: Soil structure may have been altered by agricultural fertilizers and erosion, microclimates may have changed due to agricultural drainage systems, and natural fire regimes may have been disrupted.

Insufficient historical records: Prolonged human occupation and land alterations can make historical records misleading or inadequate.

Species composition: Extinct species and naturalized exotic species may make restoration impossible or challenging.

Economic constraints: Limited funds may restrict restoration options, and the focus may shift towards cost-beneficial alternatives or species with commercial value.

Climate change: Long-term Forest restoration efforts need to consider both present and future changes in temperature, precipitation, and extreme events associated with climate change.

THE DISTURBANCE-SUCCESSION CYCLE

Disturbances and succession are the primary factors influencing the behavior of a forest ecosystem. When aiming to conserve, restore, or develop forests for biodiversity, the Disturbance-succession cycle serves as the foundation for creating robust systems (Kuuluvainen 2009).

In the succession cycle, there are two types: primary succession, which occurs when nature starts anew on newly formed land, and secondary succession, which happens when there is a disturbance in the existing vegetation. Unlike primary succession, secondary succession benefits from the presence of established seeds and plant material in the soil. The driving force behind succession is primarily the competition for light among different species.

During the early stages of secondary succession, pioneers establish themselves. These light-demanding species can withstand winds and often form a messy and unorganized stage consisting of shrubs such as Prunus spinosa, Malus sylvestris, Crataegus monogyna, Rosa dumalis (Sjöman & Slagstedt 2015), Rosa canina, Rubus fruticosus, Corylus avellana, Ligustrum vulgare, and Cornus sanguinea (Robinson & Wu 2016). Shrubs in this stage typically have their green volume concentrated in the upper parts of the shrub (Sjöman 2018), with thorns, twigs, and protective features like hair or wax layers to defend against grazing and regulate temperature and water retention (Newton & Goodin 1989).

In the next phase of succession, semi-pioneers establish themselves, often found in edges (Fieldhouse & Hitchmough 2004). Trees and shrubs work symbiotically, with trees providing shade and protection to the shrubs, and shrubs offering wind protection to young trees (Sjöman & Slagstedt 2015). Common species in this stage include Cornus sp., Prunus sp., Viburnum sp. (Phillips 1989), Betula sp., Alnus glutinosa, Populus tremula, Salix caprea, Quercus robur, Prunus avium, and Sorbus aucuparia (Sjöman & Slagstedt 2015).

The final succession phase involves the establishment of secondary species, which thrive in protected environments and naturally grow under existing tree and shrub stands (Sjöman & Slagstedt 2015). Shrub species in this phase exhibit an even distribution of green volume from top to base and include species such as Hamamelis sp., Acer sp., Ilex sp., Taxus baccata, Corylus avellana, and Viburnum sp (Sjöman 2018). Tree species in this phase include Picea abies, Ulmus glabra, Acer platanoides, Fagus sylvatica, Carpinus betulus, Tilia cordata (Sjöman & Slagstedt 2015), as well as species like Quercus robur, Fraxinus excelsior, Acer platanoides, and Prunus avium, which can be categorized as both semi-pioneers and secondary species (Vollbrecht & Karlsson 1999).

The different successional phases in a forest stand have notable impacts on its visual appeal, biological characteristics, and user experiences. During the secondary succession phase, the stand may offer favorable conditions for recreational activities, while a mature stand provides distinct experiences. When planning for a forest's qualities, the focus is often directed towards a time frame of approximately 50-75 years into the future. This approach allows for the management of different successional stages to create a diverse range of experiential values. Biologically, this can be achieved by maintaining trees of various ages, ensuring a natural replacement process as older trees die off (Sjöman & Slagstedt 2015).

An example of maintenance from a successional perspective in a dense sly forest on nutrient-rich soil is described by Sjöman & Slagstedt (2015). If thinning is carried out sparingly, it results in a Pillar Hall effect where there is intense competition among trees. As a result, the trees will grow tall, thin, and close to branchless, forming a dense canopy. This limits the understory development due to the lack of light penetration. On the other hand, if thinning is conducted more aggressively, particularly targeting the taller trees, the forest stand becomes brighter. This increased light availability allows for the growth and development of other trees and shrubs in the understory. The more open canopy enables a greater diversity of species to establish and thrive.

By adjusting the intensity and frequency of thinning, forest managers can manipulate the structure and composition of the stand, promoting specific successional stages and enhancing biodiversity. It highlights the importance of considering successional dynamics and employing appropriate management techniques to achieve desired ecological outcomes in forest ecosystems.

MANAGEMENT METHODS

To develop effective forest management plans, it is important to recognize the strengths and limitations of various management methods. This enables a more comprehensive and flexible approach to forest management. By considering different approaches, such as sustainable practices, replication of natural processes, and ecological reference systems, forest management can plan to develop systems that prioritize biodiversity conservation, ecological integrity, and user preferences.

SILVICULTURE

Most peri-urban forests are remnants of old silviculture practices (Larsen & Nielsen 2012a). Even aged-forests, agricultural forests or “classical” forests are all synonyms with silvicultural traditions that have characterized forest management worldwide, see figure 10 on the following page (Larsen & Nielsen 2007). However, the methods employed in silviculture have led to low biological diversity, both within and among species, increasing their susceptibility to pests and diseases (Schütz et al. 2011). Silvicultural practices often involve short rotation cycles, which differ significantly from natural ecological cycles. As a result, young forests lack red-listed species, and the negative impacts on cryptogams and invertebrates are particularly notable. These organisms rely on closed forest stands, abundant deadwood, and intact soil structures over extended periods. Additionally, certain species require natural disturbances such as grazing, fires, and tree felling (de Jong 2002).

In 1713, Hans Carl von Carlowitz introduced a sustainability program for forest production known as rotation forest management (RFM). RFM is based on a rotation cycle that involves planting, thinning, and clear-cutting over a period of up to 100 years. The aim of RFM is to establish even-aged monoculture stands. Silviculture proponents argue that clear-cutting is a natural forest management practice, similar to natural disturbances like fire (Schütz et al. 2011). However, this claim has been repeatedly disproven, as natural disturbances preserve standing dead trees and complex soil structures, allowing new seedlings to germinate (Sidoroff et al. 2007; Kuuluvainen 2009).

Conifer species, particularly Pinus sylvestris and Picea abies, have been favored in silviculture due to their cost-effectiveness, easy establishment, and good timber production, resulting in coniferous forests expanding beyond their natural range and displacing broadleaf species like Fagus sylvatica and Quercus robur (Spiecker 2003). *Quercus* sp. has a strong cultural heritage in landscapes characterized by wooded pastures. Quercus sp. are not only a keystone species but also provide several niches for up to 1,500 species within flora and fauna. In addition, 80% of the red-listed insects are linked to Quercus species, making them the most valuable tree for biodiversity (Colding 2013).

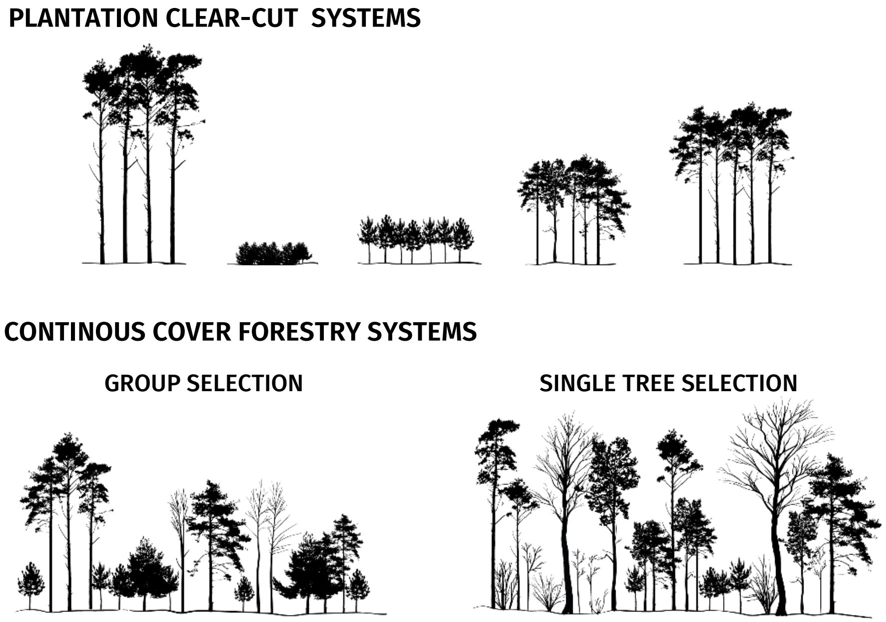


Figure 10. Different types of management systems can be found within silviculture, the classical approach illustrated at the top of the picture, involves clear-cutting of the entire stand once desired sizes are achieved. In contrast, Continuous Cover Forestry shown in the lower two images, involves selecting either groups or individual trees, creating gaps in the forest system where new trees can be established through planting, seeding, or natural regeneration.

CONTINUOUS COVER FORESTRY (CCF)

In the field of silviculture, new management branches have emerged with the aim of promoting sustainable options. One such approach is Continuous Cover Forestry (CCF), as depicted in figure 10. CCF places a primary emphasis on avoiding clear-cutting practices and instead advocates for the limited removal of a maximum of 0.25 hectares of forest at any given time. The goal of CCF is to maintain a continuous canopy cover and promote natural regeneration while ensuring sustainable forest management practices. Thinning in CCF follows a similar process to that of young stands managed under the RFM system. Initially, thinning is carried out to reduce competition and promote the growth of desired trees. As the stand matures, financially mature trees are selectively thinned, simulating the natural decay and creation of open spaces that occur in nature. This promotes the development of a diverse understory vegetation.

Supporters of CCF argue that this approach is more financially viable compared to the traditional RFM system. This is because the intervals between artificial regeneration events are longer in CCF, allowing for longer-term financial returns. Additionally, retaining smaller trees in CCF ensures their growth and regeneration, thus contributing to future income generation. (Schütz et al. 2011).

In the peri-urban context, most urban forests have originated from commercial forests where the significance of the urban forest and the ecosystems they provide have been disregarded and underestimated. When crafting management and development plans for these areas, stronger emphasis should be placed on values from the user's perspective, with a focus on recreation and nature protection. Consequently, the use of traditional forest management, which primarily concentrates on timber production, is not suitable for these situations (Larsen & Nielsen 2012a).

CLOSE-TO-NATURE MANAGEMENT

In practice, close-to-nature management seeks to replicate what humans perceive as both natural and desirable. It can be argued that close-to-nature management has a limited scientific foundation and is partly an attempt to meet public demand for forests with a naturalistic appearance (Löf et al. 2009).

Figure 11. A recreational forest in Markaryd, Småland, Sweden, with close-to-nature management in a reference stand consisting of Quercus robur, Pinus sylvestris and Fagus sylvatica.

To develop urban forests with high potential for nature conservation, ecosystem protection, and a natural aesthetic, silvicultural methods should be employed in a manner that closely resembles natural forest structures, processes, and dynamics (Larsen & Nielsen 2012a). In deciduous forests, this can involve creating patches of rejuvenation to simulate the natural fall of individual trees (Löf et al. 2009). These practices, known as "nature-based silviculture" or "close-to-nature forest management," are more sustainable in terms of conservation and biology. They require a deep understanding of natural disturbance regimes and successional processes and ecological reference systems are necessary to establish guidelines within management approaches and goals for close-to-nature management (Larsen & Nielsen 2012a). However, our knowledge of natural forest dynamics and reference points is limited. It is challenging to recreate a forest because it is influenced by a combination of climatic conditions, grazing, and human activities (Löf et al. 2009). Simply studying past or present changes in forest systems is insufficient since future climate changes will impact these systems in unique ways. Therefore, forest design needs to incorporate flexibility to withstand such changes. The most effective approach is to base forest management and design on natural processes and close-to-nature principles. Management aims to transform natural disturbances into human disturbances, such as through thinning (Larsen & Nielsen 2012a). These ecological reference systems should include variables such as dominant species, stand age, successional stage, stand structure measurements, and disturbances like fire, wind, pests, diseases, as well as climate, topography, soil, and seed dispersal (Wimberly et al. 2012).

THE FOREST DEVELOPMENT TYPES (FDTS)

In this paper, both Danish and British Forest Development Types (FDTs) have been utilized, as they are linked to the regional conditions (natural forest systems and disturbances) of each country's regions. The Danish FDTs can preferably applied in southern Sweden, but due to the lack of species compositions in the Danish types, they have been supplemented with the British FDTs.

To maintain management as close to nature as possible, the FDTs were developed by combining expertise in silviculture, ecology, and landscape architecture (Larsen & Nielsen 2012a; Haufe et al. 2021a). The FDTs focus on both native species and a range of exotic species, with the argument that it will create more resilient forests (Larsen & Nielsen 2007). According to Pauleit et al. (2005) northern European cities have limited species choices due to harsh climatic conditions, which is one of the reasons why many exotic species are used in cities and subsequently escape into nearby forests.

The Danish and British FDTs consist of 19 respectively 68 different forest types, all of which are described in more detail on the following pages in Table 2. These reference landscapes are based on site analysis involving soil conditions, drainage, and species inventory. They serve as flexible planning tools while also providing long-term goals for ecological, economic, and social/cultural values. Since uncertainties can arise in nature or in a social context over time, the FDTs should not be used as goals for specific stands but rather as a desired or expected direction for a specific stand. The FDTs are also broadly defined and need to be adjusted based on the possibilities and limitations within each stand and management options (Larsen 2005). When applying Forest Development Types, species selection should not be based on creating a broad mixture for the sake of it. Instead, species should be carefully chosen from nearby seed sources, potential species within the stand, and their natural habitat, taking into account the topographical conditions of the site and the intended purpose of the forest. For instance, translucent stands with light-demanding species should not be planned as islands near darker stands dominated by Picea abies and Fagus sylvatica, as this would result in an ongoing struggle for dominance. The goal of the FDTs is to maintain self-rejuvenating forest systems, so it is crucial to choose species based on their long-term qualities (Dansk skovforening & Larsen 2005).

The FDTs can be applied at different scales (stand, coupe, or block level) and aim to use only compatible species. The specific management guidelines in the FDTs are developed for individual tree species within each stand. However, since most stands within the FDTs consist of more than one species, it is generally recommended to refer to multiple FDTs. Furthermore, the British FDTs specify whether the management regime should follow continuous cover forestry (CCF), rotational (clear-fell-and-restock), or LIMA (lower intensity management approaches). The latter allows for clear-felling and restocking of areas ranging from 0.25 to 2 hectares, where rejuvenation is achieved through natural seed dispersal, coppicing, seed trees, or other methods that do not maintain the continuity of the forest microclimate (Haufe et al. 2021a). On the other hand, the Danish FDTs offer three different approaches. The first is the direct path, where only the species composition within the types is planted. The second is nature's way, which involves natural regeneration, allowing species to establish themselves where they would naturally grow, and is considered the best option. However, this process can take a considerable amount of time if starting from an open space. Lastly, there is nature's shortcut, which combines the previous two approaches and utilizes natural processes. Desired species can be planted or sown in groups, serving as seed sources (Dansk skovforening & Larsen 2005).

Table 2. The Danish and British Forest Development Types with distribution of species, soil habitat, structure, and dynamics. In the latter, minor species are categorized as A: suited to site conditions and non-invasive, B: meeting criteria A and not interfering with light-demanding trees, and C: meeting criteria A and being native to the area (Haufe et al. 2021).

THE DANISH FOREST DEVELOPMENT TYPES			
FDT	*SPECIES DISTRIBUTION*	*SOIL HABITAT*	*STRUCTURE & DYNAMIC*
11 Fagus sylvatica	Fagus sylvatica: 70-80 % Quercus sp., Fraxinus excelsior, Acer pseudoplatanus & Prunus avium: 20-30% Conifer trees: >10%	Medium-rich, well-drained soil with good water availability.	Relatively homogeneous stands with trees in groups or individually. Gradual removal of dominant trees while maintaining horizontal structure. Other tree species appear as isolated individuals or small groups. Forest development type resembles traditional beech cultivation methods. such as group-wise or even-aged regeneration.
12 Fagus sylvatica, Fraxinus excelsior & Acer pseudoplatanus	Quercus robur: 40-60% Fraxinus excelsior & Acer pseudoplatanus: 30-50% Prunus avium, Carpinus betulus, Quercus sp., Tilia cordata & other: >20%	Rich, well-drained soil with good water availability.	Species-rich and structurally diverse mixed woodland with clustered and individual occurrence of associated tree species. Varying group sizes and age development contribute to horizontal variation in forest structure. Vertical structuring with distinct canopy layers in areas dominated by light-demanding species. Regeneration occurs in gaps created by individual trees or small groups.
13 Fagus sylvatica, Pseudotsuga menziesii & Larix decidua	Fagus sylvatica: 40-60 % Acer pseudoplatanus: >20% Pseudotsuga menziesii, Larix decidua, Picea abies: >20% Betula sp., Pinus sylvestris, Quercus sp. & other: >10%	Medium-rich, well-drained soil with moderate to good water availability.	Beech trees are regenerated in groups or smaller clear-cut areas, while some individual trees can be found in distinct clusters. Mosaic-like mixture of Douglas fir, larch, and Norway spruce. Associated tree species intermixed with conifers or forming separate groups.
14 Fagus sylvatica & Picea abies	Fagus sylvatica: 20-60% Pseudotsuga menziesii, Abies alba, Abies grandis, Picea abies, Picea sitchensis: >60% Larix decidua, Acer platanoides, Betula sp., Pinus sylvestris, Quercus sp., Tilia codata: 10-30%	Poor to medium-rich, well-drained soils with moderate to good water availability.	Beech tree as dominant specie, with groups or patches of spruce trees with vertical structural variation and a rich understory. Regeneration of subclimax and climax species in mixed smaller groups or individual trees for creation of larger gaps for light-sensitive species. Uneven regeneration during the mature stage, with shade-tolerant species beneath light-tolerant species.

21 Quercus robur., Fraxinus excelsior & Carpinus betulus	Quercus robur: 50-70% Fraxinus excelsior, Carpinus betulus, Tilia cordata, Prunus avium: 20-40% Corylus avellana, Acer platanoides: 10-20%	Rich, well-drained soil with good water availability. This type also tolerates clay soils with limited water drainage.	Structurally diverse oak forest with single- or multi-layered composition. Ash and lime grouped on pseudogley soils, sycamore and bird cherry on well-drained soils. Forest edges with wild apple, pear, and native shrub species. Active harvesting, including selective logging, to promote hornbeam regeneration. Regeneration of ash, hornbeam, and sycamore in smaller gaps. Regeneration of wild cherry requiring larger areas.
22 Quercus robur., Tilia cordata & Fagus sylvatica	Quercus robur: 60-80% Tilia cordata & Fagus sylvatica: >30% Betula sp., Carpinus betulus, Populus tremula, Sorbus aucuparia: >10%	Poor to medium-rich, well-drained soils with poor to moderate water availability. It also tolerates soils with limited water drainage.	Multi-layered with scattered occurrences of lime, birch, Scots pine, aspen, rowan, and beech. The understory includes shrubs such as dryad, hawthorn, elderberry, and others. Forest edges and boundaries feature hawthorn, blackthorn, wild apple, juniper, and other species. The forest development represents the transition from oak scrub to tall forest, with a potential shift towards beech dominance. Selective harvesting of beech trees from the upper canopy and logging in groups or smaller areas is carried out to promote oak regeneration. Measures are taken to prevent the encroachment of coniferous species, such as spruce, in the open canopy through their removal to avoid competition.
23 Quercus sp., Pinus sylvestris & Larix decidua	Quercus sp. 50-60% Pinus sylvestris: 20-50% Larix decidua: >20% Betula sp., Populus tremula, Sorbus aucuparia: >10%	Nutrient-poor soil with poor to moderate water availability. It also tolerates soils with limited drainage.	The forest landscape consists of clusters or larger patches of pedunculate oak, winter oak, birch, Scots pine, and occasional stands of larch. The understory is characterized by species like wood sorrel, wood anemone, and other plants. Oak and Scots pine are dominant species in the upper canopy, creating a light-filled understory for the growth of small trees and native shrubs. Natural regeneration occurs in areas with increased light, promoting a diverse mix of tree species. Active logging in the form of group cuttings or smaller clearings is necessary to enhance the regeneration of pioneer species. Coniferous species that can outcompete the established system should be removed to maintain the desired forest composition.
31 Fraxinus excelsior & Alnus glutinosa	Fraxinus excelsior: 50-70% ALnus glutinosa: 20-40 % Quercus sp., Tilia cordata, Acer platanoides, Carpinus betulus, Betula sp.: >20%	Rich to medium-rich soil with a high water table, as well as soils in periodically standing water.	Multi-layered stand where the vertical structure is characterized by groups of different sizes and ages. Red alder dominates in wetter areas, while ash is more prevalent at the transition to higher ground. Regeneration of the forest is based on group regeneration of the light-demanding species ash, supplemented by scattered regeneration of other species. Managing the understory during the rejuvenation phase is essential to ensure the successful establishment of light-demanding species.
41 Betula pendula, Pinus sylvestris & Picea abies	Betula pendula.: 60-90% Pinus sylvestris, Alnus glutinosa, Picea abies, Picea sitchensis: >40% Sorbus aucuparia, Quercus sp., Salix sp., other: >10%	Peatlands and nutrient-poor soil with a high water table or periodically waterlogged soils.	Birch dominates the wetland floor in patches, with intermixing of other tree species such as Norway spruce, Scots pine, red alder, tamarack, rowan, and pedunculate oak. Following disturbances, birch proliferates extensively, followed by the establishment of spruce. Scots pine occurs in groups within the forest. Regeneration in larger areas. On drained bogs, birch returns after significant disturbances, while on undrained or restored bogs, birch persists through periodic natural collapses.

51 Picea abies, Fagus sylvatica & Acer pseudoplatanus	Picea abies, Picea sitchensis, Pinus sylvestris, Larix decidua, Pinus contorta: >60% Fagus sylvatica, Acer pseudoplatanus: 20-30%. Betula sp., Sorbus aucuparia, Fraxinus excelsior, Populus tremula, Pinus sylvestris, Quercus robur, Acer platanoides: 10-20%	Nutrient-poor to medium-rich, well-drained soil with moderate to good water availability.	Mixed structure with coniferous trees as dominant species and beech playing a supporting role. Intermixing species are found in groups or individually. Horizontal structure arises from groups of varying sizes and ages. Beech is present in the lower and middle canopy layers and scattered throughout the forest. Coniferous species regenerate in clusters, with spruce regenerating in smaller clusters and Douglas fir and larch in larger clusters. Beech trees also regenerate in clusters or beneath the canopy. Pioneer species like birch, Scots pine, rowan, and aspen establish themselves in gaps and initiate succession towards climax and sub-climax species.
52 Picea sitchensis, Pinus sylvestris & deciduous trees	Picea sitchensis, Picea alba, Pinus sylvestris, Larix decidua, Pinus contorta: 60-80% (no individual species exceeding 40%). Betula sp., Quercus sp., Sorbus aucuparia, Fagus sylvatica, Acer pseudoplatanus: 20-40%.	Nutrient-poor to medium-rich, well-drained soils with moderate to good water availability.	The forest development type can vary depending on the emphasized species locally. Sitka spruce, noble fir, Scots pine, larch, and lodgepole pine are present in groups or smaller patches, with scattered intermixing of birch, oak, rowan, aspen, and beech. Over time, the proportion of deciduous trees increases while lodgepole pine gradually disappears from the stand. Regeneration dynamics follow a coarse-grained pattern due to clear-cutting, natural disturbances, or storms. Each group or small area is regenerated with one or two conifer species and a few deciduous trees. Harvesting activities range from individual tree selection to clear-cutting of small areas up to 0.5 hectares. Preventing the dominance of lodgepole pine in the regeneration process is important. Lodgepole pine should not be introduced if it is not already present.
61 Pseudotsuga menziesii, Picea abies/grandis/alba & Fagus sylvatica	Pseudotsuga menziesii: 40-60% Fagus sylvatica: 20-40%. Picea abies and/or Abies gandis, Picea alba: >20%. Acer pseudoplatanus, Betula sp., Sorbus aucuparia, Pinus sylvestris: >10%	Moderately rich, well-drained soils with moderate to good water availability.	Douglas fir and beech exhibit group-to-small-patch dynamics occasionally intermixed with red spruce or grand fir. Successional groups of light-demanding trees like birch, oak, and Scots pine emerge after significant canopy openings. Beech naturally establishes itself under mature Douglas fir trees, providing shade and a favorable environment for regeneration. Regeneration of shade-tolerant species requires larger openings in the canopy, which can be created through logging or smaller-scale wind disturbances.
71 Picea abla/Picea grandis & Fagus sylvatica	Picea alba/Picea grandis: 40-50%. Fagus sylvatica: 20-40%. Picea abies/ Picea sitchensis. Pseudotsuga menziesii, Larix decidua: >20% Acer pseudoplatanus, Betula sp., Pinus sylvestris, Quercus sp.: >10%	Moderately fertile, well-drained soil with moderate to good water availability.	Beech and noble fir exhibit a group-to-selective harvesting structure, with intermixing of Douglas fir, larch, and/or red spruce/sitka spruce, as well as alder. Red spruce is absent in dune areas affected by salt deposition. Beech, noble fir, and grand fir regenerate in small clusters, while red fir and Douglas fir form larger clusters or smaller patches. Companion species establish themselves in areas that meet their specific regeneration requirements. Alder colonizes smaller canopy gaps, while light-demanding tree species occupy areas following logging or windthrow disturbances.

81 Pinus sylvestris, Betula sp. & Picea abies/ Picea sitchensis	Pinus sylvestris: 30-50% Betula sp.: 20-40% Picea abies/ Picea sitchensis: 10-30% Populus tremula, Sorbus aucuparia, other: 10%	Very nutrient-poor to nutrient-poor soil with high water availability, respectively, on soils with insufficient drainage.	The typical Scandinavian mixed forest consists of grouped Scots pine with intermixing of red spruce, birch, and aspen. Group sizes can vary, ranging from small patches of one species and age. Regeneration group sizes depend on various factors such as disturbances, logging, collapses, and forest fires. Norway spruce follows the light-demanding species in the succession process. Clear-cut areas of a certain size (up to 0.5 hectares) are important for promoting pioneer species regeneration.
82 Picea mugo	Picea mugo: 60-80% Quercus sp., Betula sp., Sorbus aucuparia, Populus tremula, other: 20-40% Salix sp., Juniperus communis: >10%	The most nutrient-poor soils with low to high water availability, respectively, on soils with inadequate drainage.	The forest type consists of single-layered Scots pine with scattered intermixing of other species. Regenerative groups occur in clusters, influenced by natural collapses, logging, or forest fires. It originates from pure stands of Scots pine on outer dunes, with other species suppressed by wind and salt. Over time, Scots pine stands break into groups, followed by bare ground and regeneration. Rowan, aspen, and birch regenerate in smaller gaps. Natural dynamics, including collapses and open areas, contribute to regeneration. Scots pine is the prominent pioneer species. In protected sites, the forest transitions into true high forest.
91 Coppiced Forest	Oak coppice: Quercus sp., Tilia cordata, Corylus avellana, Populus tremula, Betula sp., other. Hazel coppice: Corylus avellana, Fraxinus excelsior, Querucs sp., Alnus glutinosa, Acer pseudoplatanus, Prunus padus, other. Alder coppice (wetland forest): Alnus glutinosa, Fraxinus excelsior, Betula sp., Salix sp., Prunus padus, other.	Quercus: On intermediate soils. Corylus: On nutrient-rich sites with high water availability. Alnus: On intermediate to nutrient-rich soils with periodically standing water.	Coppiced forest is a management practice that involves dividing the forest into low forest and intermediate forest. In low forest, all trees are regularly cut back, while selected trees are left as overstorey trees in intermediate forests. The purpose of coppiced forest is to produce small-dimensioned timber for various purposes. The forest is periodically clear-cut to the ground, with the entire forest gradually harvested over a rotation period. Ideally, coppiced forests consist of equally sized sub-areas, each with light-demanding trees of the same age that regenerate vegetatively. The species composition in coppiced forests can vary depending on the location and forest history. The goal is to achieve a uniform distribution of different age classes in coppiced forests. Coppicing is carried out in plots ranging from 0.25 hectares to 1 hectare at a time. The rotation period in coppiced forests varies depending on the purpose and tree species. Combining coppicing with grazing can be beneficial. Different regions have different rotation periods, such as 20 to 40 years for alder swamps in eastern Denmark and 40 to 60 years for oak scrublands in central and western Jutland. Willow plantations and energy forests are coppiced at shorter intervals.

92 Grazed Forest	Trees: Quercus sp., Fagus sylvatica, Tilia cordata, Betula sp., other. Shrubs: Crataegus sp., Juniperus communis, Prunus spinosa, other.	Grazed forests occurs on all types of soils but can only be maintained through high browsing pressure.	Grazing forests aim to integrate livestock grazing with timber production and tree-related fodder. The landscape consists of open grassland with scattered trees and bushes. Tree species in grazing forests are typically light-demanding, such as oak, with some shade-tolerant species like beech. Shrub species like hawthorn and juniper are chosen for their ability to withstand intense grazing pressure. Grazed forests create a diverse and dynamic landscape that benefits both livestock and sustainable forest management. In areas with high grazing pressure, natural regeneration is limited, and planting and fencing are used to facilitate regeneration. Some trees may establish themselves with the protection of browse-tolerant shrubs. Controlling grazing pressure and considering the grazing species (livestock or wild deer) are important for successful regeneration. Tree harvesting, including thinning, is conducted to promote stability and growth of individual trees.
93 Wooded meadow	Sparsely distributed light-demanding tree species, with shrubs that can withstand high browsing pressure (Crataegus sp., Juniperus communis, Prunus spinosa, other).	The wooded meadow occurs on all types of soils, but it can only be managed through grazing or mowing practices (such as riverside meadows, hay meadows, hard grassland, wet meadows, marshland, etc.).	Historical wooded meadows have influenced the importance of forest clearings in future naturally managed forests. The need for permanent clearings arises due to the disappearance of large clear-cut areas and the dominance of shade-tolerant trees. Forest clearings provide ecological and recreational spaces and support light-demanding wildlife and plant species. Clearings should be established and expanded while conserving valuable cultural environments. Clearings enhance biodiversity, offer recreational opportunities, and preserve historical and cultural value. Dense and diverse grasslands can be created through annual harvesting and leaving some vegetation after cutting. After-grazing may be suitable for moderately moist meadows, but permanent fencing and grazing are inefficient for small and scattered meadows in publicly accessible forests. Selective clearing, protecting natural regeneration, and planting local provenances are recommended practices. Regeneration primarily occurs through coppicing, while larger deciduous trees can be preserved through crown lifting or periodic coppicing to ensure sufficient light penetration.
94 Untouched Forest (Free from human involvement from a specific point in time)	The species present in the forest depend on the species that were already there when humans stopped managing it, and the regeneration will reflect the habitat conditions suitable for species survival.	All types of soils.	Untouched forests resemble primeval forests with diverse structures and tree species. Natural processes occur in untouched forests, supporting a complex ecosystem. Fallen logs and decaying wood enhance biodiversity in untouched forests. Preserving untouched forests is vital for conservation and ecological research. Untouched forests offer aesthetic and recreational value. They restore the local water balance and contain diverse vegetation and species, including deadwood. The dynamics of vegetation in untouched forests are random and unpredictable, depending on initial conditions. Forests with natural structures resemble natural processes more closely and show a more predictable pattern of development compared to monoculture plantations.

THE BRITISH FOREST DEVELOPMENT TYPES

FDT	*SPECIES DISTRIBUTION*	*SOIL HABITAT*	*STRUCTURE & DYNAMIC*
111 Picea sitchensis	Picea sitchensis: 90-100% Minor species A: <10%	Loamy brown soil, brown cleys, surface water cleys on wet-damp with poor to moderate nutrient levels	Minor species falling under category A, including remnants of nurse crops, will be incorporated in single-story stands. The management approach for these stands will primarily involve a clearfell-and-restock regime, allowing minor species to naturally regenerate.
112 Picea sitchensis	Picea sitchensis: 80-90% Minor species A: 10-20%	Gravelly or sandy, loamy brown, brown cleys with very moist – slightly dry with poor to moderate nutrient levels.	Single to multi-layered stand with category A minor species which are mixed in individually or in groups.
113 Picea sitchensis & Pseudotsuga menziesii	Picea sitchensis: 60-80% Pseudotsuga menziesii: 20-40% Minor species: <10%	Gravelly/sandy, loamy brown, brown greys with moist – slightly dry with moderate-rich nutrient levels.	The stands will consist of mixed forests that can have various structures, including even-aged, single storied, or complex structures. The mixing of species will be done intimately, either in small or large groups, or in patches throughout the stands.
114 Picea sitchensis & pinus sylvestris/Larix decidua	Picea sitchensis: 60-80% Pinus/Larix: 20-40% Minor species A: < 10%	Gravelly/sandy, loamy brown, brown cleys, surface water cleys with wet-slightly dry and very poor – moderate nutrients.	Mixed stands often utilize larch or pine as nursing trees. They can be even-aged and single-storied or have complex structures. Management focuses on developing individual tree vigor and stability in young stands. Dense natural regeneration may require respacing for species composition and tree stability.
115 Picea sitchensis & shade tolerant conifers	Picea sitchensis: 60-80% Shade tolerant conifers: 20-40% Minor species A: <10%	Gravelly/sandy, loamy brown, brown cleys surface water cleys, very moist- slightly dry Poor-moderate nutrient	The stands can either be even-aged and single-storied or develop into complex structures. The species can be mixed intimately, in small or large groups, or in patches. These management practices are suitable for a wide range of sites where the presence of shade-tolerant secondary species is desired to meet specific objectives.

116 Picea sitchensis & Fagus sylvatica	Picea sitchensis: 70-90% Fagus sylvatica: 10-30% Minor species A: <10%	Gravelly/sandy, loamy brown, brown cley. Moist-slightly dry. Poor-rich nutrient	The stands can either be single storied or develop into a complex structure. The species can be mixed intimately or in small groups. The faster growth rate and taller final height of Sitka spruce are balanced by the higher shade tolerance of European beech. Consequently, it is expected that most stands will eventually develop two distinct canopy layers over time.
117 Picea sitchensis & long-lived broadleaves	Picea sitchensis: 70-90% Long-lived broadleaves: 10-30% Minor species A: <10%	Gravelly/sandy, loamy brown, brown cleys, surface water cleys. Very moist-slightly dry Poor-rich	Even-aged, single-storied, or stands, developed into a complex structure which can be mixed in small or large groups based on light requirements and microsite conditions. To address the fast growth rate and taller final height of Sitka spruce, it is recommended to position broadleaves in groups. Stands that originate from dense natural regeneration may need respacing to manage species composition and promote tree stability.
118 Picea sitchensis & short-lived broadleaves	Picea sitchensis: 70-90% Short-lived broadleaves: 10-30% Minor species A: <10%	Gravelly/sandy, loamy brown, brown cleys, surface water cleys Wet- slightly dry Poor-moderate	Even-aged, single-storied stands are commonly the result of infilling broadleaves within Sitka spruce plantations, primarily with species like Birch, Willow, Aspen, and Rowan. The presence of broadleaves in these stands is often due to partial restocking failure of Sitka spruce.
121 Picea abies	Picea abies: 90-100% Minor species A: <10%	Gravelly/sandy, loamy brown, brown Very moist-slightly dry Poor-moderate	Single-layered mixed stands, either with species planted individually or in groups. These mixed stands should be used in situations where clearfell-and-restock scenarios with Norway spruce are planned. This approach is suitable when it aligns with site-specific management objectives or when there is insufficient natural regeneration of Norway spruce.
122 Picea abies	Picea abies: 80-90% Minor species A: 10-20%	Gravelly/sandy, loamy brown, brown Very moist-slightly dry slightly poor-moderate	Single- to multiple-layered stands, with species admixed individually or in groups. These stands are typically found in suitable microsites and areas that are challenging to access. This FDT is specific to stands of Norway spruce growing on better sites compared to FDT 1.2.1. The objective is to achieve greater structural diversity by utilizing LIMA/CCF techniques.
123 Picea abies & Picea sitchensis	Picea abies: 70-90% Picea sitchensis: 10-20% Minor species A: <10%	Gravelly/sandy, loamy brown Moist- slightly dry Poor-moderate	Norway spruce stands are interspersed with individual trees or small areas of Sitka spruce that occupy wetter parts. The horizontal structure of these stands can vary, ranging from even-aged and single storied to complex structures. The species within these stands can be mixed intimately, in small or large groups, or in patches.
124 Picea abies & shade tolerant conifers	Picea abies: 60-80% conifers: 20-40% Minor species A: <10%	Gravelly/sandy, loamy brown, brown cleys Very moist-slightly dry Poor-rich	The stands can either be even-aged and single-storied or develop into a complex structure. The mixture of species within these stands can be intimate, occurring in small or large groups, or in patches.

125 Picea abies & Fagus sylvatica	Picea abies: 50-70& Fagus sylvatica: 20-40% Minor species A: 10-20%	Gravelly/sandy, loamy brown, brown gley Moist-slightly dry Poor-rich	The stands consist of vertically structured arrangements of Norway spruce with small groups or small areas of European beech. Beech is managed in groups to promote straight stem growth and natural self-pruning. Spruce and beech are highly compatible when grown in mixture, with the faster growth rate of Norway spruce being balanced by the superior shade tolerance of beech. However, to optimize timber quality, it is recommended to grow beech in groups rather than in an intimate mixture with other species.
126 Picea abies & & long-lived broadleaves	Picea abies: 60-80% broadleaves: 20-40% Minor species A: <10%	Gravelly/sandy, loamy brown, brown gley, surface water gley Vert moist-slightly dry Slightly poor- rich	The stands can range from single to multiple layers. Complementary species are predominantly found in riparian zones and on microsites that are unsuitable for Norway spruce. These complementary species are typically present in small or large groups within the stands.
127 Picea abies & short-lived broadleaves	Picea abies: 70-90% broadleaves: 10-30% Minor species A: <10%	Gravelly/sandy, loamy brown, brown gleys Very moist-slightly dry Poor-moderate	The stands consist of even-aged stands of Norway spruce with the presence of short-lived broadleaves interspersed. These broadleaves are likely the result of infilling within spruce plantations. Complementary species can be mixed individually or in small to large groups within these stands.
211 Pinus sylvestris	Pinus sylvestris: 80-100% Minor species B: <20%	Rankers/shingle, gravelly/sandy loamy, podzols/ironpan soils Damp-very dry Very poor-poor	The stands are single-story and even-aged, consisting of Scots pine trees. These stands are specifically found growing on low fertility sites.
212 Pinus sylvestris LIMA/CCF	Pinus sylvestris: 70-90% Minor species B: 10-30%	Rankers/shingle, gravelly/sandy loamy, podzols/ironpan soils Slightly moist-very dry Very poor-poor	The stands are vertically structured and primarily dominated by pine trees, growing on low fertility sites. In these stands, structural diversity is desired, and therefore, two or more layers and multiple-aged trees are present.
213 Pinus sylvestris & shade tolerant conifers	Pinus sylvestris: 60-80% conifers: 20-40% Minor species B: <10%	Gravelly/sandy, loamy brown Moist- dry Poor-moderate	The stand consists of a multi-layered structure with Scots pine as the overstorey and shade-tolerant conifers as the understory. The horizontal mixture type can vary from intimate mixing to patches within the stand. This FDT is specifically designed for sites where natural regeneration of Pine is less likely. The inclusion of understory plants serves to enhance productivity and structural diversity while helping to control ground vegetation.
214 Pinus sylvestris & light demanding conifers	Pinus sylvestris: 60-90 Larix decidua & other Pinus sp. 10-40% Minor species B: <10%	Gravelly/sandy, Loamy podsols/ironpan soil, loamy brown Moderate-dry Poor-moderate	The stand is single-storied and consists of a complementary mixture of species that can be arranged intimately, in small or large groups, or in patches. This FDT is specifically tailored for sites where natural regeneration of Scots pine is less likely to occur naturally.

215 Pinus sylvestris & Quercus robur	Pinus sylvestris: 50-70% Quercus robur: 20-40% Minor species B: 10-20%	Gravelly/sandy, loamy brown Moderate-dry Poor-moderate	The FDT involves creating a mosaic pattern consisting of single-layered large groups or patches, along with complementary individual trees or small groups. The objective of this FDT is to establish a small-scale mosaic of more or less even-aged cohorts of Scots pine and common oak on sites that are suitable for both species.
216 Pinus sylvestris & Fagus sylvatica	Pinus sylvestris: 60-80% Fagus sylvatica: 20-40% Minor species <10%	Gravelly/sandy, loamy brown Moist-dry Poor-moderate	Two-layeredstand of pine as overstorey and beech as understory. The horizontal structure may range from intimately mixed to patches. Likely to originate from pine underplanted with beech. Beech adds productivity and structural diversity whilst controlling ground vegetation.
217 Pinus sylvestris & Betula	Pinus sylvestris: 60-90% Betula: 10-40% Minor species B: <10%	Rankers/shingle, gravelly/sandy, Loamy podzols/ironpan soils, podzolic gleys/peaty ironpan soils Very moist-very dry Very poor-poor	The FDT aims to create a mosaic pattern with a combination of single-layered large groups or patches, as well as complementary individual trees or small groups. The primary objective of this FDT is to establish a small-scale mosaic of more or less even-aged cohorts of Scots pine and Birch on sites that are suitable for both species.
221 Pinus nigra transition to shade tolerant conifers	Pinus nigra: 30-70% conifers: <70% Minor species A: <10%	Gravelly/sandy, loamy brown and brown gleys with or without high base status Very moist-dry Poor-very rich	The stands consist of a black pine overstorey and an shade tolerant conifers as understory layer, but they are expected to become more structurally diverse over time. This type of stand is typically a result of underplanting beneath dwarf pine and represents a transitional stage towards a different Forest Development Type (FDT). In such stands, multiple conifer species, including emerging species, are often present. In these cases, management objectives and the future FDT will need to be reviewed while maintaining some flexibility.
222 Pinus nigra transition to Pinus sylvestris/Larix decidua	Pinus nigra: 30-90% Light demanding conifers: 10-70% Minor species B: <20%	Wide range of different soils from acidic to base status Very moist-very dry Very poor-rich	Mixed even-aged stands where Corsican pine is expected to be gradually phased out by the end of the current rotation. The species within these stands can be mixed intimately, arranged in rows, small or large groups, or in patches. The purpose of this FDT is to facilitate the transition from mixed stands affected by Dothistroma Needle Blight (DNB) to other conifer species. Management practices should focus on gradually phasing out Corsican pine while developing the remaining conifer component into a sustainable and viable stand.
223 Pinus nigra transition to broadleaves	Pinus nigra: 30-70% Long-lived broadleaves: 30-70% Minor species A: <10%	Wide range of different soils from acidic to base status Very moist-dry Very poor-very rich	The stands consist of a black pine overstorey and broadleaves as understory, being more structurally diverse over time. Likely the result of underplanting beneath Pinus nigra and represents a transitional stage towards a different FDT. In these cases, management objectives and the future FDT will need to be reviewed while maintaining some flexibility. The stands should be managed with the goal of enhancing structural diversity and transitioning towards a more suitable FDT.

231 Pinus contorta	Pinus contorta: 90-100% Minor species B: <10%	Preferably on Podzolic gleys/peaty ironpan soils, unflushed peaty gleys/deep peats. But can survive on a larger range Very wet-moist Very poor-poor	The stands are even-aged and single-storied, growing on wet and peaty soils with low fertility. In these challenging site conditions, is the suitable species for achieving management objectives and no alternative options are available. Lodgepole pine is able to thrive and meet the requirements of these difficult site conditions, making it the preferred choice for these stands.
232 Pinus contorta, Pinus sylvestris & Betula	Pinus contorta: 50-70% Pinys sylvestris & Betula: 30-50% Minor species A: <10%	Preferably on Podzolic gleys/peaty ironpan soils, unflushed peaty gleys/deep peats. But can survive on a larger range Very wet-moist Very poor-poor	The stands are characterized as even-aged and single layered, providing a uniform structure. Within these stands, there is flexibility in the mixing of species, which can range from intimate mixing to arrangements in small or large groups, or even in patches. This allows for a diverse composition and distribution of species within the stands, contributing to their ecological and aesthetic value.
241 Larix decidua & Pinus sylvestris	Larix decidua: 60-90% Pinus sylvestris: 10-40% Minor species B: <10%	Gravelly/sandy, loamy brown soil Moist-dry Poor-rich	Even-aged stands consisting primarily of larch, with an additional component of Scots pine and category B minor species. The mixture pattern in these stands can vary from intimate mixing of species to small areas where different species are grouped together
242 Larix decidua & shade tolerant conifers	Larix decidua Minor species	Gravelly/sandy, loamy brown soil Moist-dry Poor-rich	Initially, these stands are characterized by a larch overstorey and a shade-tolerant conifer understory. However, over time, they are expected to develop into more structurally diverse stands.
243 Larix decidua & Fagus sylvatica	Larix decidua Minor species	Gravelly/sandy, loamy brown soil Moist-dry Poor-rich	Initially, the stands are characterized by a two-layered structure with a larch overstorey and a beech understory. This configuration is likely the result of intentional underplanting of beech trees beneath the larch canopy. However, as the stands mature, they are expected to develop a more complex and diverse structure.
244 Larix decidua & Quercus robur	Larix decidua Minor species	Gravelly/sandy, loamy brown soil Moist-dry Poor-rich	Mosaic of single-layered large groups or patches of larch and oak of variable ages, with individual trees or small groups of category B minor species.
311 Pseudotsuga menziesii	Pseudotsuga menziesii: 90-100% Minor species A: <10%	Gravelly/sandy, loamy brown Moist-dry Poor-rich	Single-layered Douglas Fir stands with category A minor species, admixed individually or in groups on microsites unsuitable for Douglas fir. This FDT should be used where clearfell-and-restock scenarios with Douglas fir are envisaged, either because this suits the site-specific management objectives or because sufficient natural regeneration of DF cannot be expected. In the latter case a review of the FDT may be required.

312 Pseudotsuga menziesii	Pseudotsuga menziesii: 80-90% Minor species A: 10-20%	Gravelly/sandy, loamy brown, with or without high base status Moist-dry Moderate-very rich	The Forest Development Type (FDT) involves single to multiple-layered stands of Douglas fir, occurring individually or in groups. These stands primarily occupy the understory and other suitable microsites, including areas that are difficult to access. This FDT is designed for stands of Douglas fir growing on better sites compared to FDT 3.1.1. Here, greater structural diversity can be achieved by utilizing LIMA or CCF practices. These management approaches promote a more diverse forest structure and composition, enhancing the ecological and economic values of the stands.
313 Pseudotsuga menziesii & shade tolerant conifers	Pseudotsuga menziesii: 60-80% Shade tolerant conifers: 20-40% Minor species A: <10%	Gravelly/sandy, loamy brown with or without high base status Moist-dry Poor-rich	Mixed stand of Douglas fir and one or several shade-tolerant conifer species. The stands can be either even-aged and single-storied or develop into a more complex structure over time. The mixing of species can occur in an intimate manner, small or large groups, or in patches, providing variations in composition and arrangement. This FDT, referred to as 'Douglas fir with added diversity', focuses on enhancing the diversity within Douglas fir stands by incorporating shade-tolerant conifers, thereby promoting a more ecologically resilient and diverse forest ecosystem.
314 Pseudotsuga menziesii & broadleaves	Pseudotsuga menziesii: 70-90% Long-lived broadleaves: 10-30% Minor species A: <10%	Gravelly/sandy, loamy brown with or without high base status or calcerous	Single to multiple-layered stands of Douglas fir, with the inclusion of small to large groups of broadleaves and category A minor species. The compatibility between the components of the FDT may vary depending on the specific broadleaf species.
3 2-9 placeholders for any other shade tolerant conifers from Pacific North-West America except spruces			
4 1-7 placeholders for any other shade tolerant conifers except spruces			
481 Other shade tolerant conifers			
491 Other light demanding conifers			
511 Quercus robur & Carpinus betulus	Quercus robur: 70-90% Carpinus betulus: 10-30% Minor species C: <10%	Gravelly/sandy, loamy brown/brown gleys with or without high base status or calcerous Damp-slightly dry Moderate-very rich	Two- or multi-layered stand where oak is the dominant species in the overstorey, with hornbeam admixed in the middle and understory as a single tree to small group mixture. These stands are likely the result of underplanting hornbeam in existing oak stands. It is important for oak, as the more light-demanding primary species, to always dominate the overstorey. The presence of hornbeam adds ecological diversity and contributes to the overall health and resilience of the stand.
521 Quercus petraea & Betula sp.	Quercus oetraea: 50-80% Betula sp.: 20-50% Minor species C: 10-30%	Gravelly/sandy loamy brown Damp-dry Poor-moderate	Single to multiple-layered stands of dominant common oak with Birch in individual tree to small area. Spatial separation in groups to small areas is preferable for timber quality while maintaining ecological diversity.

522 Quercus petraea & Pinus sylvestris	Quercus petraea: 50-70% Pinus sylvestris: 20-40% Minor species C: 10-20%	Gravelly/sandy, loamy brown Moist-dry Poor-moderate	Mosaic of single-layered large groups or patches consisting of variable-aged common oak and sots pine, accompanied by individual trees or small groups of complementary species. The combination of oak and pine in this mixture is highly compatible, with the faster growth rate of pine balanced by the slightly higher shade tolerance of oak. This approach allows for a diverse and balanced stand structure while taking advantage of the strengths of both species.
531 Quercus sp. & Fagus sylvatica	Quercus sp.: 60-80% Fagus sylvatica: 20-40% Minor species C: <10%	See previous FDTs depending on Quercus sp.	Two- or multi-layered stand where oak dominates the upper canopy, while beech is mixed as single trees to small groups mainly in the middle and understory layers. In some cases, beech groups may also be present in the overstorey. Additionally, the stand includes interspersed single trees or small groups of complementary species.
532 Quercus sp. & long-lived broadleaves	Quercus sp.: 50-70% Broadleaves: 30-50% Minor species C: <30%	Gravelly/sandy, loamy brown, brown cleys with or without high base status/calcerous Very moist-slighty dry Moderate-very rich	This multi-layered stand consists of dominant oak trees accompanied by a mixture of ash, sycamore maple, lime, and other tree species. Beech, hornbeam, and hazel are also present, primarily occupying the middle and understory layers. Additionally, light-demanding category C minor species fill gaps and edges within the stand. It is likely that this stand originated from oak stands underplanted with hornbeam or beech. It is important to note that common oak is more tolerant of drier sites, while sessile oak is preferred for wetter soils.
533 Quercus sp. & Corylus avellana coppice	Quercus sp.: 80-100% Corylus avellana Minor species: <20%	Gravelly/sandy, loamy brown, brown cleys, with or without high base status Very moist-slihgtly dry Moderate-rich	The FDT is specifically designed to support hazel coppice scenarios under the canopy of oak, and occasionally other broadleaved trees. Oak and broadleaved species are managed as an even-aged stand over multiple coppice rotations. The compatibility of mixture between oak and broadleaved species may vary depending on the specific species involved. Less competitive species may require additional interventions and generally benefit from being established in groups rather than in intimate mixtures. It is important to note that common oak is more tolerant of drier sites, while sessile oak is preferred for wetter soils.
5 4-9 placeholder for other Quercus speciesv			
611 Fagus sylvatica	Fagus sylvatica: 90-100% Minor species A: <10%	Gravelly/sandy, loamy brown, with or without high base status/calcerous soils Moist-dry Moderate-Calcearous	This single-layered stand consists primarily of shade-tolerant minor species, which occupy the middle and understory layers.
612 Fagus sylvatica	Fagus sylvatica: 80-90% Minor species A: 10-20%	Gravelly/sandy, loamy brown, with or without high base status/calcerous soils Moist-dry Moderate-Calcearous	Multiple-layered beech stand with complementary species interspersed as individual trees or groups. It is specifically designed for scenarios where LIMA or CCF approaches are employed, promoting natural regeneration, and aiming for increased structural diversity.

613 Fagus sylvatica & shade tolerant conifers	Fagus sylvatica: 50-70% conifers: 30-50% Minor species A: 10-30%	Gravelly/sandy, loamy brown, brown cleys with or without high base status/calcerous soils Moist-dry Moderate-very rich	In this multiple-layered stand, the mixture of species can vary from individual trees to small areas.
614 Fagus sylvatica & long-lived broadleaves	Fagus sylvatica: 50-70% broadleaves: 30-50% Minor species A: 10-30%	Gravelly/sandy, loamy brown, with or without high base status/calcerous soils Moist-dry Moderate-Calcearous	In this multiple-layered stand, the dominant species is beech with a mixture of admixed broadleaf species such as ash, sycamore maple, lime, wild cherry, and others. These broadleaf species can be found in large groups to small areas, and occasionally as dominant individual trees. It is worth noting that, unlike other FDTs, the higher economic value is expected to be in the secondary broadleaf component.
711 Betula sp.	Betula sp.: 70-100% Minor species A: <30%	Gravelly/sandy, loamy brown, brown cleys, (B. pendula flushed peaty) Very wet-dry Very poor-moderate	Generally, a single-layered stand dominated by Birch, with the inclusion of complementary species. This FDT is designed for even-aged stands where Birch is the dominant species and aligns with specific management objectives. It also encompasses scenarios where BI is used as an interim solution and underplanted with other species, leading to a transition to a different FDT.
712 Betula & short-lived broadleaves	Betula sp.: 50-70% broadleaves: 30-50% Minor species C: 10-30%	See previous FDT	Generally, a single-layered stands dominated by birch, accompanied by a high proportion of native broadleaves such as aspen, rowan, willow, and category C minor species. The mixture type within these stands can vary, ranging from individual trees to small areas. This FDT promotes the integration of various native broadleaf species, including both common species and those classified as category C minor species, to enhance the ecological diversity and resilience of the stand.
721 Betula pubescens & Pinus sylvestris	Betula pubescens.: 60-90% Pinus sylvestris: 10-40% Minor species C: <20%	Gravelly/sandy/loamy podzols/ironpan soils, podzolic gleys/peaty ironpan Moist-dry Very poor-poor	Mosaic pattern of single-layered stands of white birch intermingled with individual trees or small areas in varying age and category C minor species, with a particular emphasis on oak. This FDT is suitable for productive silver birch or white birch stands that grow on low fertility sites, where the promotion of structural and species diversity is desired. Both white birch and oak have shown good potential for natural regeneration in such conditions.
722 Betula pubescens & Quercus petraea	Betula pubescens.: Minor species	Gravelly/sandy, loamy brown Moist-dry Poor-moderate	Single to multiple-layered stand dominated by white birch with a significant proportion of oak in individual tree to small area mixture. This FDT is similar to FDT 5.2.1 but with inverse species proportions. Compatibility of white birch and sessile oak to grow in mixture is only moderate, white birch and sessile oak are grouped in separate areas or small patches rather than being intimately mixed.

811 Castanea sativa coppice	Castanea sativa: 80-100% Minor species C: <20%	Gravelly/sandy, loamy brown with or without high base status/calcareous Slightly moist-slightly dry Moderate-very rich	Two to multiple layered stands of sweet chestnut. The management approach for the majority of trees in this FDT involves either a simple coppice system or a coppice-with-standards system. In addition to the dominant sweet chestnut trees, there are complementary species incorporated into the stand as single tree mixtures.
812 Castanea sativa & long-lived broadleaves	Castanea sativa: 50-80% broadleaves: 20-50% Minor species B: <20%	Gravelly/sandy, loamy brown with or without high base status/calcareous Slightly moist- dry Poor-very rich	Single to multiple layered stand dominated by sweet chestnut along with a mixture of other broadleaf species such as oak, beech, sycamore maple, and various others. The mixing of these species can range from individual trees to large areas. This FDT is primarily designed for the management of sweet chestnut as a high forest, although it may also incorporate some coppicing practices.
821 Fraxinus excelsior & Alnus glutinosa	Fraxinus excelsior: 50-70% Alnus glutinosa: 30-50% Minor species C: <10%	Loamy brown/ browngleys/ surface-water gleys of high base status or highly calcareous Very moist- damp Rich-very rich	Mosaic pattern comprising small groups to patches of ash and common alder of varying ages. The distribution of species in the mixture follows the moisture levels in the soil, with ash dominating in moist areas and common alder in wetter areas. Additionally, there is often a distinct shrub layer present in these stands. Due to their different growth rates and light requirements, ash and common alder are generally not suitable for intimate mixtures. It is recommended to separate them based on microsite conditions, allowing each species to thrive according to their specific needs.
822 Fraxinus excelsior & long-lived broadleaves	Fraxinus excelsior: 50-70% broadleaves: 30-50% Minor species C:	Loeamy brown/ brown gleys of high base status or highly calcareous Moist-slightly dry Rich-calcareous	Multi-layered stand dominated by ash with significant proportions of hornbeam, beech, and sycamore maple in a mixture of individual trees and small groups.
831 Platanus occidentalis	Platanus occidentalis:80-100% Minor species B: <20%	Gravelly-sandy/loamy brown/brown gleys of high base status or highly calcareous Moist-slightly dry Moderate – very rich	Single-layered stand with a mixture of ash, beech, hornbeam, oak, birch, and other category B species.
832 Platanus occidentalis & long-lived broadleaves	Platanus occidentalis: 50-70% broadleaves: 30-50% Minor species B: 20-40%	Gravelly-sandy/loamy brown/brown gleys of high base status or highly calcareous Moist-slightly dry Moderate-very rich	A multi-layered mixed stand consisting of small groups to patches. The middle and understory of the stand are dominated by beech and hornbeam, while other category B minor species are primarily present in gaps based on site conditions.

8 4-9 placeholder for other long-lived broadleaved species			
911 Alnus glutinosa	Alnus glutinosa:80-100% Minor species B: <20%	Brown gleys/surface-water gleys with or without high base status/highly calcareous, flushed peaty gles/deep peats, humic gleys of high base status/fen peats Very wet-moist Moderate-very rich	A single-layered alder stands with a mixture of category B minor species, ranging from single trees to large groups. This Forest Development Type (FDT) is specifically designed for even-aged stands of alder, aiming to enhance species and structural diversity over time.
9 2-3 placeholder for other short-lived broadleaved species			
941 Salix	Salix: 50-100% Minor species C: <50%	Flushed peaty gleys/deep peats, humic gleys of high base status/fen peats Very wet-wet Poor-very rich	Stands with diverse structures predominantly dominated by willow and accompanied by category C minor species. This FDT typically arises from neglected wet pasture areas and local areas with increased water flow. Management practices for this FDT generally involve minimal intervention and focus primarily on monitoring the health condition and addressing any disturbances that may arise.
981 Other long-lived broadleaves			
991 Other short-lived broadleaves			
10 1-9 placeholder for any special FDTs			

USING NATURAL PROCESSES, CONDITIONS AND NATURAL REGENERATION

Preferably, natural processes should be allowed to develop spontaneously and then be guided towards the desired direction. However, in reality, this process can take decades to propagate, which is why it is often not employed (Kendle and Forbes 1997; see Gustavsson et al. 2005). Planting species as seed sources can be a more feasible and less intensive management option in urban parks. However, some studies suggest that this approach may not promote biodiversity, as these sites may only have a few species establishing themselves. A better approach is to establish planted seed banks in nearby areas, increasing the chances of desired species establishment and enhancing biodiversity (Alvey 2006). Millard (2000) argues that natural regeneration is a superior option to planting, as natural selection will eliminate species that are not adapted to specific conditions. Moreover, natural regeneration can result in higher biodiversity among species, as the seed sources come from different species. Another advantage of natural regeneration is its potential to improve soil conditions on poor sites, such as old industrial areas, and pave the way for secondary species that could not have been planted without expensive soil improvements (Bell et al. 2005).

There is a risk associated with natural regeneration of woody species, as the environments may appear neglected or messy and be perceived as insecure, similar to edge zones. Therefore, it can be challenging to justify natural regeneration from a social perspective (Millard 2000). To mitigate this, it may be possible to allocate only specific portions of sites for natural regeneration, rather than leaving large open fields, making people more inclined to accept that some areas may appear less visually appealing than the rest of the site.

DEAD WOOD

Dead wood plays a crucial role in supporting diverse ecological communities by providing habitat for various organisms. Insects, fungi, lichens, and small mammals are among the many organisms that depend on dead wood for their survival. These organisms contribute to important ecological processes such as nutrient cycling and decomposition, which are essential for overall ecosystem functioning. Furthermore, the presence of dead wood can significantly enhance species diversity, particularly for specialized and rare species that rely on it for shelter, nesting, feeding, and reproduction (Harmon et al. 2004).

Figure 12. From a human perspective, dead wood is usually perceived as unsafe or unattractive by adults. However, it is important to recognize that dead wood can serve as valuable building materials for children. Incorporating dead wood into designated areas within the forest can contribute to a more organized and visually appealing landscape.

A tree with a trunk diameter of 50cm at the base and a height of 15cm can produce 1 cubic meter of dead wood and the amount of dead wood is commonly described in cubic meters per hectare (m3/ha), its significance can be interpreted as follows:

- 0-10 m3/ha: the amount of dead wood typically found in managed forests.
- 10-30 m3/ha: is significant for maintaining biodiversity.
- >30 m3/ha: sufficient amount of dead wood to support demanding species and corresponds to forests in their natural state (Natur och Miljö 2007).

VEGETATION STRUCTURES

Vegetation structure refers to the composition of vegetation that creates the unique habitat within a forest stand (Larsen & Nielsen 2012). It is crucial to distinguish between different vegetation structures as their variations have an impact on recreational, visual, and biological values. The structure encompasses factors such as the number of species planted together, the arrangement of vertical and horizontal layers, whether the mixture appears scattered or in groups, and even the absence of certain species (Bell et al. 2005).

While there are various models for vegetation structure, this paper primarily focuses on Larsen & Nielsen's (2012) model, specifically in relation to the FDTs. According to the DFDTs (2012), there are five main types of vegetation structures: forest interiors *under* closed canopies, the semi-open areas *between* scattered trees, glade *inside* forested parts, edges *along* the boundary among forested and open parts, and open areas *outside* forested parts. These forest types are presented in the following pages. Additionally, to facilitate understanding of different structures, illustrations have been created based on Gustavsson's (1991) work, which depicts the main structural types of vegetation within forest systems.

INVENTORY OF VEGETATION STRUCTURES

According to Gustavsson (1991), there are several characteristics to consider when identifying forest structures. These characteristics not only influence the perception of the forest stand but also determine the types of flora and fauna that can thrive, the productivity of the stand, and the required maintenance. The following characteristics are important:

Light: The amount of light determines the type of vegetation that can grow and the dynamics of the stand. It also influences maintenance requirements and the overall perception of the forest.

Heights of the layers: Differentiating between the vertical layers of vegetation affects their relationship within the stand. The height limit of 2 meters is particularly significant as it impacts visual cues and accessibility.

Groups: The arrangement of trees and shrubs in groups within the stand.

Plants and plant composition: The presence of characteristic plant species or individuals in all layers of the forest stand.

Crown density: The degree to which the canopies are closed or open, and the size of any canopy openings.

Variations within the tree layer: Differences in stem width and crown density among individual trees indicate species dominance.

Stem density: Ranging from sparse to very dense, the density of tree stems in the stand.

Considering these characteristics allows for a more comprehensive understanding of forest structures and their implications for management and ecosystem dynamics.

FOREST INTERIORS

The forest interior is distinguished from other forest structures by its ability to nurture an understory. The presence of an understory within the forest interior contributes significantly to biodiversity, nutrient cycling, soil stability, and wildlife habitat. It also enhances the visual appeal and ecological integrity of the forest. Recognizing the importance of the forest interior as the sole forest structure capable of hosting an understory underscores its unique role in forest ecosystems (Larsen & Nielsen 2012).

PILLAR HALLS

Light pillar hall
Without understory

Light pillar hall
With scattered or grouped understory

Light single-layered stands
With deep-crowned trees

Dark pillar hall
Without understory

Dark pillar hall
With scattered or grouped understory

Dark single-layered stands
With deep-crowned trees

Pillar hall
With multi-stemmed trees

STRUCTURALLY AND SPECIES-RICH INTERIORS

Two-layered stand
With understory of shrub species

Two-layered stand
With understory of tree (saplings)

Two-layered stand
With well-developed middle layer

Three-layered stands

Multi-layered stands

LOW FOREST INTERIORS AND SEMI-OPEN FOREST SYSTEMS

Semi-open stand
With grass or rich field layer

Thicket

Grove

Glades

Wilderness interior

PILLAR HALLS

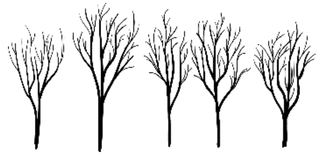
Typically associated with even-aged and single-storied monocultures that lack an understory. In Sweden, a common example of the Pillar Hall is Fagus sylvatica stands (Larsen & Nielsen 2012).

LIGHT PILLAR HALL WITHOUT UNDERSTORY

Dominated by tree species that allow high light transmission, such as Pinus sp., Larix sp., Populus sp., or Betula sp. Understory species thrives in these light conditions, making it an unstable and high-maintenance forest interior (Gustavsson 1991).

LIGHT PILLAR HALL WITH SCATTERED OR GROUPED UNDERSTORY

What the previous category usually develops into, an environment where shrubs, shrub trees, and trees thrive. To maintain a homogeneous understory within this vegetation structure, numerous interventions are necessary. Furthermore, if fully crowned trees are to be retained in the understory, the crowns of the overstory trees must be raised to facilitate the flourishing of the lower trees. (Gustavsson 1991)



LIGHT SINGLE-LAYERED STANDS WITH DEEP-CROWNED TREES

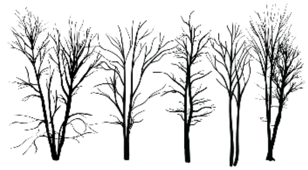
In difference to the other two categories of Pillar hall where the canopy is very high, these canopies are instead low and the tree trunks splits into several coarse branches at or just above eye level (Gustavsson 1991).

DARK PILLAR HALL WITH NO UNDERSTORY

Consist mainly of a Fagus sylvatica monoculture and are very stable, but the visual appearance can also be achieved with Aesculus hippocastanum, Tilia cordata, Carpinus betulus and old stands of Picea abies. These types of interiors usually don't have a field layer, but if so, they consist of Anemone nemorosa, ferns or mosses (Gustavsson 1991).

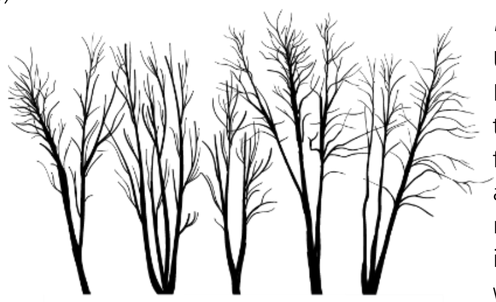
DARK PILLAR HALL WITH SCATTERED OR GROUPED UNDERSTORY

Since these Pillar halls are very dark beneath the canopies, few species can evolve in the understory. As a solution, the canopy can be thinned where understory, in form of for example Taxus baccata, is wanted (Gustavsson 1991).



DARK PILLAR HALL WITH DEEP-CROWNED TREES

The dark Pillar hall could be developed with deep-crowned trees instead, although this can be challenging to maintain when the stand gets too dense and lower branches start to fall off (Gustavsson 1991).



PILLAR HAR HALL WITH MULTI-STEMMED TREES

Usually found in loamy soils, with high water levels in river valleys or along shores. In Sweden these stands consist of Alnus sp. and Salix sp., and in other parts of the world Cercidiphyllum japonicum, Aesculus hippocastanum and Pterocarya fraxinifolia can be found. Remnants of grazing forests and coppiced forest can also develop into this type of character, with Carpinus betulus, Tilia sp., Quercus robur and Fagus sylvatica. However, when the soil is frisk, they need to be located in a wind-sheltered area otherwise the tree crowns easily bear a crooked load when maturing, making it susceptible to breaking apart (Gustavsson 1991).

STRUCTURALLY AND SPECIES-RICH INTERIORS

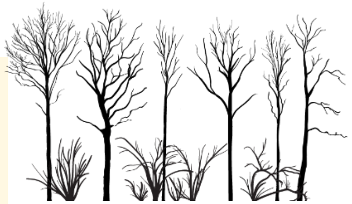
Structurally and species-rich interiors refer to even-aged stands that consist of a mixture of tree species, featuring groups of trees or individual trees with an understory. These interiors exhibit a high diversity of forms and species, showcasing a wide range of spatial patterns (Larsen & Nielsen 2012).

TWO-LAYERED STAND WITH UNDERSTORY OF SHRUB SPECIES

Can remain stable for a few decades until tree seeds become established in the understory, therefore requiring intensive maintenance (Gustavsson 1991).

TWO-LAYERED STAND WITH UNDERSTORY OF TREE SPECIES (SAPLINGS)

The understory consists mainly of seedlings and stump or root shoots. It typically appears a few years after the complete clearance of the understory and is very unstable (Gustavsson 1991).



TWO-LAYERED STAND WITH WELL-DEVELOPED MIDDLE LAYER

The dense crowns in the middle layer create a visually open and accessible environment, resulting in sparse shrub vegetation. However, allowing the middle layer trees to grow freely can eventually harm the tree layer. Therefore, thinning the understory becomes important to promote a continuous replacement of old trees. In cases where the tree layer consists of light-demanding trees like Pinus sylvestris, the middle layer tends to develop species such as Corylus avellana, Prunus padus, Amelanchier sp., Crataegus sp., Sorbus aucuparia, and Salix sp. This system is characterized by pleasing visible stems and flowering crowns in the middle layer and is considered stable. Conversely, if the middle layer comprises shade-tolerant species, the stand will have single-stemmed trees and is considered unstable (Gustavsson 1991).

THREE-LAYERED STANDS

are distinguished from two-layered stands and multi-layered stands by their distinctive visual feature of three layers. This forest structure typically occurs in between heavy thinning operations carried out at long intervals (Gustavsson 1991).

MULTI-LAYERED STANDS

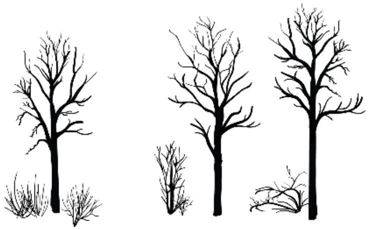
exhibit a high diversity of species arranged in different heights and compositions throughout the forest. These stands serve as effective buffers against pollution and function as windbreakers. However, this unique composition is rarely found in natural environments and requires a combination of multiple species and regular thinning to maintain a certain level of stability. The species composition ranges from light-demanding trees in the upper layer to shade-tolerant species in the understory.

The distribution of species within the stand can be evenly spread across all layers or concentrated in the understory, which offers greater accessibility and allows for intentional guidance of visitors. From a human perspective, multi-layered stands create an optical illusion, making a smaller space appear larger and enhancing the overall visual experience. (Gustavsson 1991)

LOW FOREST INTERIORS AND SEMI-OPEN FOREST SYSTEM

Low forest interiors and semi-open forest systems are characterized by various coppiced interiors and are integral to cultural forest management regimes. These areas have been shaped by human intervention over time, forming unique ecosystems. However, many of these sites have suffered from neglect and require restoration (Larsen & Nielsen 2012). According to Gustavsson (1991) in these forest systems, the tree layer is either completely absent or spaced widely enough that the tree crowns do not touch. In moist and nutrient-rich soils, shrubs and ground flora can flourish abundantly. On moist or wet soils, tall trees are more susceptible to wind damage, making the low forest interior a more suitable option.

From a human perspective, semi-open forests are often perceived as safer due to the increased visibility provided by the middle layer. The presence of visible space and access points through vistas into open environments adds to this perception. Additionally, the cultural landscapes often associated with these areas create a sense of human interaction and connection to the environment (Gundersen & Frivold 2008). The prospect-refuge theory proposed by Appleton(1984) suggests that the preference for semi-open or open landscapes over closed forests is rooted in the evolutionary benefits of refuge and visibility from potential threats. A study using visual stimuli indicated that scenic value reaches its peak when visibility exceeds 40-50 meters (Kellomäki & Savolainen 1984).



SEMI-OPEN STAND WITH GRASS OR RICH FIELD LAYER

Grazed forests, forest pastures and wooded meadows where the visitor get the feeling of walking between trees rather than under a closed canopy. Suitable species for a low stand are Salix sp., Malus sylvestris, Prunus domestica, Sorbus intermedia, and Sorbus aucuparia. High stands can include Pinus sylvestris, Betula pendula, Salix sp., Pyrus communis and Quercus robur (Gustavsson 1991). This structure is usually home to endangered species (Larsen & Nielsen 2012).

GROVE

A small group or collection of trees growing closely together, often trees that of the same or similar species. Light-demanding shrubs such as Corylus avellana, Crataegus sp., Amelanchier spicata, and Taxus baccata, as well as trees that can be maintained as shrubs or form the sparse top layer like Tilia sp. and Carpinus betulus. Other trees within the top layer can include Pinus sylvestris, Quercus robur, Betula sp., and Prunus avium (Gustavsson 1991).

THICKET

All the mentioned species above, can be utilized in this context. The forest is periodically cut back to ground level which creates a dense thicket that serves multiple purposes. It provides excellent play areas for children, acts as a sanctuary for animals and birds, and also functions as an effective landscape screen, offering privacy and visual separation (Gustavsson 1991).

GLADES

An open room within the forest interiors serves as a habitat for unique flora that cannot thrive under closed canopies. The glade provides an intimate space within the forest and offers various edges that attract people (Larsen & Nielsen 2012).

WILDERNESS INTERIORS

Unmanaged forests are characterized by old trees and abundant dead wood. Preserving these forests is crucial. These forests act as sanctuaries for specialized species that depend on the unique microhabitats found in old trees and decaying wood. While also enhancing landscape connectivity by acting as reservoirs of genetic diversity (Larsen & Nielsen 2012).

CASE EXAMPLE

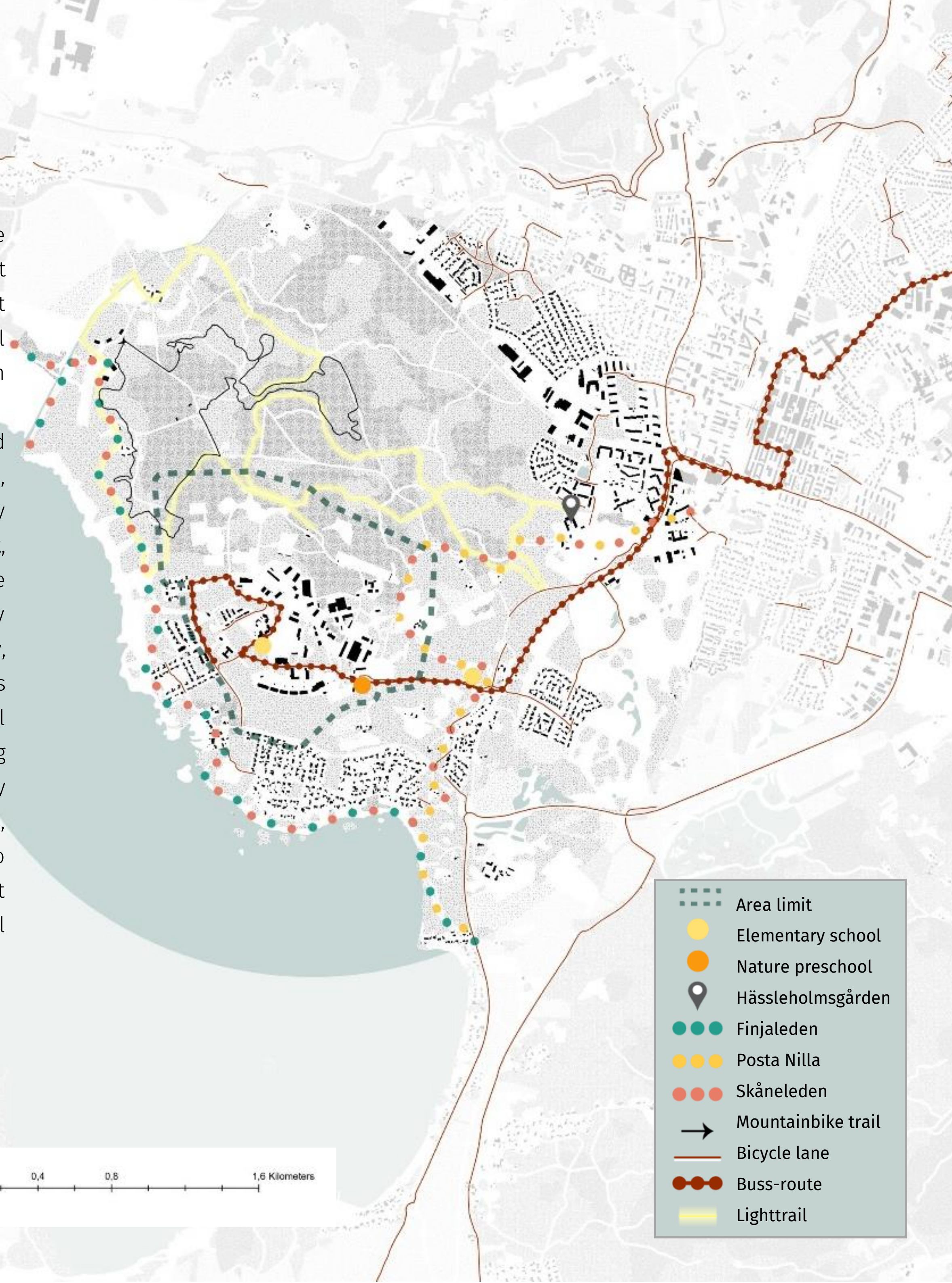
Applying the Forest Development Types
within the peri-urban forest of the
Garnisonen development area,
located in Hässleholm, Scania, Sweden.

ANALYSIS

GARNISONEN – BACKGROUND

Garnisonen is part of a larger development area located outside Hässleholm's central area. The plan for the area includes the establishment of up to 1000 new homes, with Garnisonen being prioritized as the first phase of development. This decision is based on the existing recreational qualities, natural values, and established housing areas present in Garnisonen (Hässleholms kommun 2018).

Garnisonen holds historical and natural significance as it is considered a relic of an ancient cultural landscape. It features ancient stone walls, cairns, peat bogs, oak forests, and oak fields. The area is crisscrossed by hiking trails, and a mountain bike trail runs through its northern part, connecting Hässleholms-gården in the north to Hovdala Castle in the south. It also has a significant military influence, having been occupied by the armored unit P2 for military training until the year 2000. Subsequently, the entire area was fenced off during this period of time (Hässleholms kommun 2018), and the fence inadvertently functioned as an animal barrier, leading to the establishment of a population of red deer roaming the forested areas of Garnisonen. Many of the buildings from the military activities remain today and have been repurposed for schools, preschools, municipal activities, and industry. Some new housing buildings have also been added to the area, along with pedestrian and bicycle paths that connect the northern and southern parts of Garnisonen, reducing travel time to central Hässleholm by 1 km (Hässleholms kommun 2014).



The municipality values the area's proximity to nature as a valuable asset, making it unique and attractive for future development. Residents are drawn to the area because of its natural surroundings and convenient access to central Hässleholm. The green areas not only provide stormwater control and habitats for plants and animals but also help preserve the landscape's historical significance. The detailed plans for neighboring areas, such as Artilleristen and Northern Sjörröd (figure 13), emphasize the importance of preserving the character of the area. These plans include protecting buildings surrounded by vegetation (see figure 14), maintaining the slightly hilly topography, and the preservation of the shooting passage (figure 17, on the following page) to ensure that views of the lake are maintained and at the

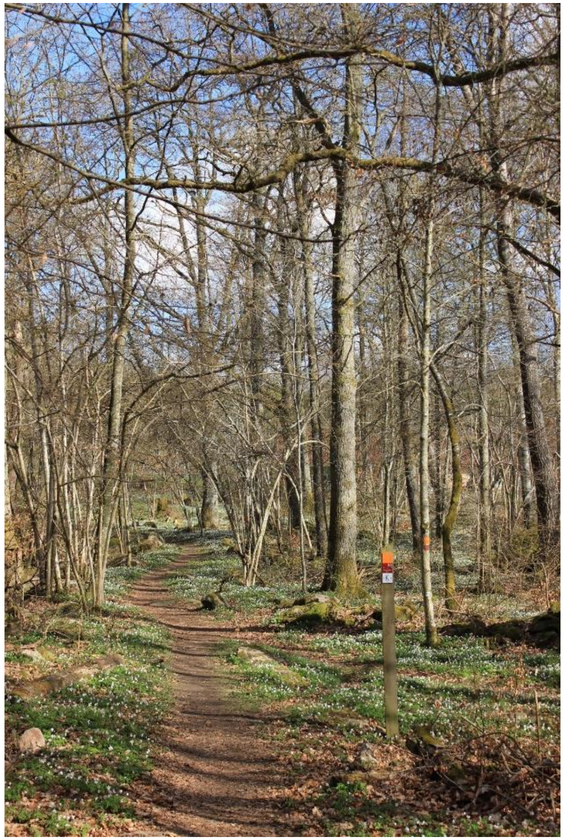


Figure 15. The project area and its surroundings are enriched with numerous hiking trails and forested areas, which is one of the reasons why many inhabitants are drawn to live here.

Figure 13. Limit area of Garnisonen and its neighbouring areas northern Sjörröd and Artilleristen.

Figure 14. Homogeneous single-story houses within the forested area of the neighboring residential zone called Artilleristen (in English translated to The Artillery Barracks).

same time honoring the historical significance of the area as a former military training facility. Furthermore, beach protection laws have safeguarded a significant portion of the vegetation in the southern section of Garnisonen (Hässleholms kommun 2007).

However, unlike Artilleristen and northern Sjörröd, Garnisonen lacks the same size, cohesion, and level of protection. Many areas consist of large paved concrete spaces and clearcuts, currently dominated by Betula species (see figure 16). The author is therefore concerned that these sites may be targeted for development rather than being preserved as green spaces. Nevertheless, the municipality of Hässleholm has expressed its intentions to reshape the street spaces within Garnisonen, aiming to create a more human-scale environment that highlights the interaction between buildings and green qualities (Hässleholms kommun 2014).

The houses bordering the nature areas in Garnisonen will be dense, low, and small-scale multi-family houses and terraced houses, without large private gardens. Houses located further into the area will have 3-4 stories and avoid extensive ground parking. The goal is to incorporate cultivation plots and larger public spaces, such as squares, parks, and playgrounds, between the residences, in line with the concept of a garden city. The municipality of Hässleholm also plans to include offices, training facilities, and craft workshops within the area (Hässleholms kommun 2018).

Figure 16. Large paved areas, clear-cuts, and young Betula stands make up a significant portion of Garnisonen.

Figure 17. An old shooting passage, dating back to the time when the area was occupied by the military, has been preserved. It not only maintains the views of Lake Finjasjön but also honors the history of the area.

THE CLIMATIC CONDITIONS OF SCANIA AND HÄSSLEHOLM

The majority of Hässleholm county consists of a dynamic landscape with alternating forests, agricultural fields, and pastures. While Fagus sylvatica is naturally forest-forming and prominent in the landscape, old stands of Fagus sylvatica are rare (Williams & Olsson 2005).

Scania, Sweden's most species-rich county, owes its abundant biodiversity to its unique geographical location where the northern coniferous forest zone meets the southern deciduous forest zone. This creates diverse habitats, with a particular abundance of deciduous forests. These deciduous forests in Scania are crucial habitats, hosting approximately half of the red-listed species found in forests (Länsstyrelsen Scania 2015). Scania is also home to an impressive 89% of all Swedish red-listed species, underscoring its importance for biodiversity conservation (de Jong 2002).

However, the overlap of these forest zones has led to the displacement and ongoing decline of deciduous trees in Scania. Extensive silviculture practices during the twentieth century, mainly focusing on cultivating Picea abies, have resulted in a significant decrease in deciduous forests throughout Scania (Hall et al. 2015). An emerging concern for the reestablishment of deciduous forests in Scania is the increasing population of fallow deer (Dama dama) in Sweden. While they are not yet abundant in Hässleholm, their expanding presence throughout the country suggests that they will likely inhabit all of Scania in the near future. The negative impacts of wild grazing have been cited as a reason for replacing Pinus sylvestris stands with Picea abies, even in areas such as bogs and edge zones where forests were historically preserved (Berlin & Niss 2019).

According to Påhlsson (1998) assessing the forest types of southern Sweden in terms of successional and stability perspectives is challenging due to significant influences from cultural heritage. These forest types can be either overgrown meadows consisting of Pinus sylvestris, Betula sp., Fraxinus excelsior, Quercus robur, and Alnus glutinosa, or part of the forestry landscape dominated by Picea abies (Williams & Olsson 2005). Reduced grazing in forest systems has resulted in the disadvantage of many light-demanding species in the field layer (Jörg 2015). Since these cultural landscapes have not had sufficient time to mature, distinct end stages for these stands are not yet apparent. However, Carpinus betulus, Betula sp., and Fagus sylvatica have benefited from the regeneration of old forest pastures, heaths, and meadows. Both Picea abies and Pinus sylvestris can compete with deciduous forests, with Picea abies being more prevalent on fertile soils (Agestam 2015), and Pinus sylvestris spreading particularly on drier soils. This variation has resulted in a greater mix of deciduous and evergreen trees within mixed forests (Påhlsson 1998).

According to Blomberg et al. (2012) Scania county has the least amount of access to land available under the Swedish public law Allemansrätten. In Hässleholm, the Scanian action plan for green infrastructure emphasizes the importance of urban forests for recreation and people's health. Therefore, despite high exploitation pressure in the expansive region, green infrastructure must be developed in these areas. Deciduous forests, deciduous trees, and the open landscape, where species such as Ulmus glabra, Fraxinus excelsior, Carpinus betulus, Fagus sylvatica, Quercus robur, Prunus avium, Tilia cordata, and Acer platanoides, should be prioritized (Berlin & Niss 2019).

FOREST STAND INVENTORY

The forest stands in Garnisonen primarily consist of Fagus sylvatica, Alnus glutinosa, and Quercus robur, with small areas covered by Betula pendula, Betula pubescens, and Pinus sylvestris, indicating a more advanced successional stage. The presence of cultivated Picea abies outside the area suggests that the forest stands serve as a seed bank for neighboring areas. Other tree species present include Populus tremula, Carpinus betulus, Prunus cerasifera, Prunus padus, and Fraxinus excelsior can also be found scattered throughout the area. With patches of Anemone nemorosa, Ranunculus ficaria, Rubus ideaus and Vaccinium myrtillus in the fieldlayer.

The scrub layer of the stands has undergone clearing, with common species such as Corylus avellana, Rosa sp., Rubus ideaus, Sambucus nigra, and Salix sp. present. In the denser areas with less maintenance, tree species and Corylus avellana dominate the middle layer. However, the thinning within the stands that have received more care does not appear to have been carried out with consideration for different stages of growth and age, as the retained individuals exhibit similar heights.

SOIL CONDITIONS

Overall sandy moraine, with some patches of Ice river sediment or marsh peat (SGU 2022). Many parts with rich field layer of Anemone nemorosa, indicates humus rich soils.

AVERAGE TEMPERATURE

6.5 degrees (Williams & Olsson 2005)

GROWING SEASON

200 days (Williams & Olsson 2005)

WIND

In winter warm and humid westerly winds and cold and dry easterly winds (Williams & Olsson 2005)

WIND SPEED

Can reach storm strength (higher than 24.5m / s) in September-March, although forest and ridges dampen the winds (Williams & Olsson 2005)

MULTI-CRITERIA-ANALYSIS
- NARROWING DOWN THE EXAMPLE AREA

An analysis of the preservation values within Garnisonen area was conducted using a multi-criteria evaluation in ArcGIS. Although there is limited data available on mixed forest systems, the analysis focused on mapping general forest systems suitable for preservation. However, during the author's site analysis, it was discovered that the majority of the area consists of mixed forests. It is important to note that excluded areas should not be considered lacking in value for protection or inclusion in the development area, as they may be significant for different landscape ecological zones. This analysis aims to identify areas where the Forest Development Types (FDTs) are applicable for larger forest stands, making them the main focus of the analysis.

ArcGIS's multi-criteria evaluation analysis provides a tool for mapping desired attributes for a specific area, based on criteria that determine true or false statements related to the intended question (Eastman 2005). In this analysis, the question is whether a forest area holds high preservation value, and the goal is to match attributes that indicate a high biological or social value within the forest system. The criteria used in this analysis include municipal land, limited area, green areas, depressions, hiking trails, tree canopy height, and cultural heritage. These criteria were mapped manually using public records, online maps, and data from sources such as Lantmäteriet and Scalgo. The weighted criteria were calculated (Height*30 + Paths*30 + Trails*15 + Cultural heritage*15 + Depression*10) and extracted using a mask that intersected green areas with municipal land.

LIMITATIONS

Previous land usage analysis was omitted from the project because, from a tree perspective, there were minimal differences in maps dating back 100 years, rendering them irrelevant to the project. An online inventory of different biotopes was available, but it did not provide sufficient information on mixed forest systems, age stands, and social values, so it was excluded from the project.

UNWEIGHTED VALUES

Since the analysis aimed to map areas with high preservation values for the development of a maintenance plan, other values that could not be assigned weights were presented to provide a comprehensive background for further investigation. These additional values included social values identified through field inventory and interviews, the differentiation between deciduous and evergreen areas, and trees deemed worthy of protection. At this stage, socially highlighted areas within monocultural stands or in close proximity to monocultures were excluded to avoid their inclusion in the final weighting process between the two maps. The unweighted values, along with figure 18 illustrating the mapped areas, are presented on the following page.

PROTECTED TREES

In the years 2008-2009, an inventory of trees worthy of protection was conducted around Finjasjön. These trees were identified as having great biological value due to their age and hollowness, which attract unusual animals and flora (Hässleholms Kommun 2022). Protecting these trees increases their chances of avoiding vandalism or unnecessary stress from machinery during the construction process. Furthermore, considering the value pyramid mentioned earlier, if a tree is protected due to its high age, it is likely that other nearby trees in the vicinity are also of significant age and value.

EVERGREEN VERSUS DECIDUOUS FOREST

Considering the impact of climate change, it is possible that the future viability of the deciduous forest, primarily Picea abies, which is abundant in the project area, might be at risk (Ekelund 2007).

SOCIAL VALUES

While the main focus of this study centers around the biological values within a mixed forest stand, it is crucial to acknowledge the significance of social values in an urban forest setting. Through interviews and field inventory, several areas of social importance were identified, such as frequently used unofficial entrances, locations favored for mushroom picking, remnants of a plant nursery, prominent sightlines, and areas appreciated for their sensory qualities. These social values play an important role in understanding the overall significance and potential uses of the forested areas.

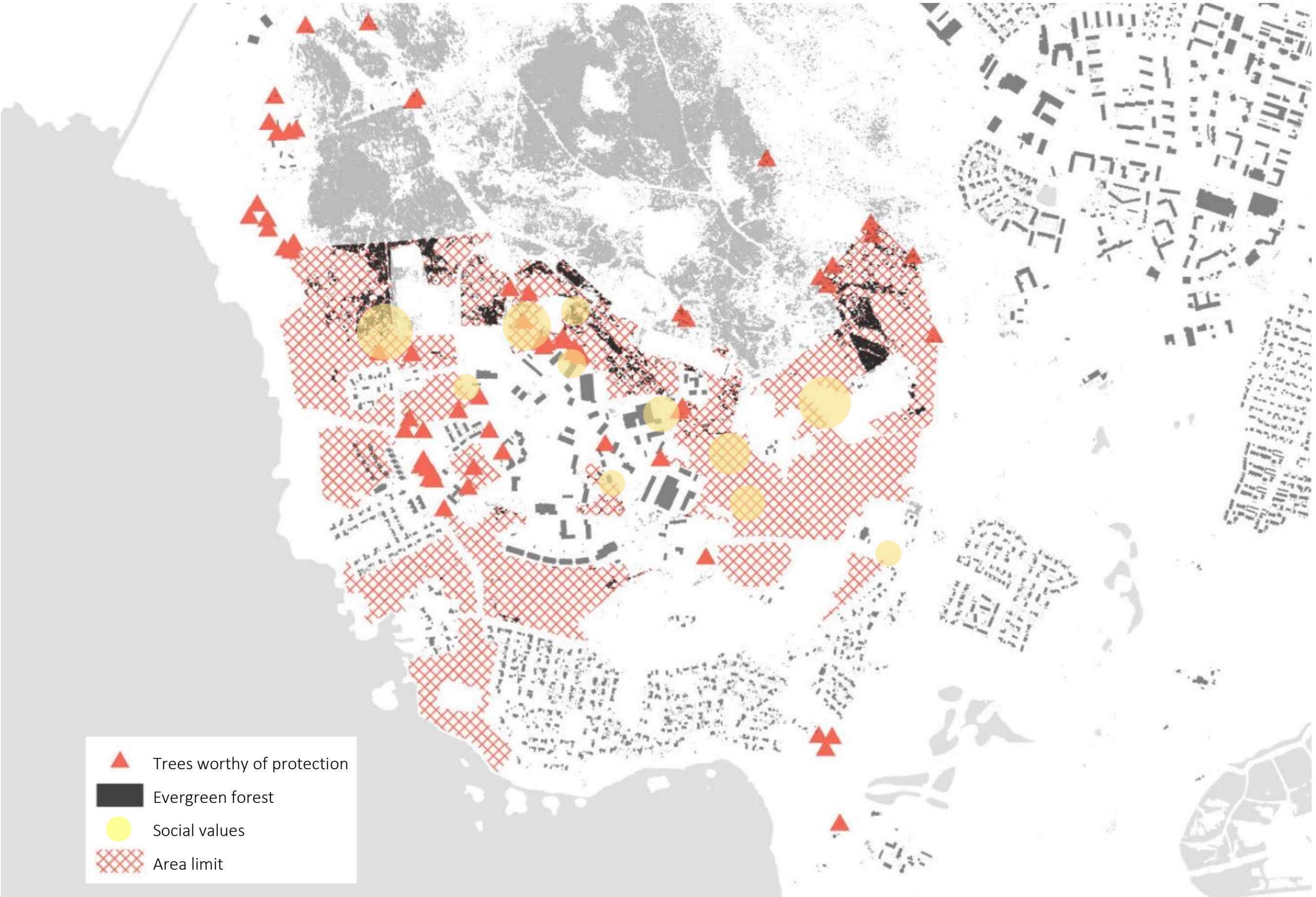


Figure 18. Map over the unweighted values featuring protected trees, evergreen forest, and social values.

CRITERIAS

MUNICIPAL LAND & AREA LIMIT

The municipal land and area limit define and restrict the projection area, as well as determine the outer area that could be relevant for a maintenance plan. However, if the land is not owned by the municipality, it is considered irrelevant since they are not responsible for its maintenance.

In terms of visual interpretation, Rydberg(2004) provides a definition for mixed forests, stating that they should have a minimum size of 0.35 hectares. Additionally, Rydberg categorizes urban forests into neighborhood forests, residential block forests, and recreational forests. District forests should be at least 1 hectare in size and are used for daily activities by nearby residents and people within the same district. They often serve as spatial dividers between city districts and are commonly used for commuting to work and school. Block forests, on the other hand, are smaller than 1 hectare and consist of strips or groves within housing blocks, primarily catering to nearby residents. Recreational forests, typically larger than district forests, are usually part of larger outdoor facilities and attract visitors who are willing to travel longer distances to engage in outdoor activities. The area surrounding Garnisonen is defined as a recreational forest, and the buffer zone automatically encompasses the recreational forest.

However, the projected area primarily focuses on being used by the future residents of Garnisonen. Assuming that new houses will be constructed on the edge of the project area limit, the buffer should be determined based on the distance residents are willing to walk to access a recreational area. According to studies conducted by the Norwegian Institute of Public Health (See Koppen et al. 2014). the limit is set at 10 minutes, which corresponds to approximately 400 meters for elderly and children. Furthermore, if a recreational area is located more than 500 meters away from residents, the number of visitors decreases by 56%. Therefore, the larger buffer zone is set to 500 meters.

GREEN AREAS

According to Boverket (Boverket 2022), an area needs to be at least 1 hectare to accommodate several important ecosystem services. However, if the area is intended for physical activities, it needs to be larger than 1 hectare. In Malmö's green model, the goal is to have green areas of at least 1 hectare and 50 meters wide located within 500 meters of residential homes. This corresponds to Rydberg's (2004) concept of neighborhood forest and the area limit buffer.

Furthermore, to be considered as green areas, they should not be interrupted by obstacles such as roads. The areas were then examined using canopy density data gathered from laser data to identify any potential forest areas that had been cut down. However, the canopy density data was excluded from the multi-criteria analysis and, therefore, cannot be seen in the flowchart.

TREE CANOPY HEIGHT

Naturvårdsverket (Webber et al. 2022) has conducted a report on the future potential of deciduous forests, which includes raster files. While not all parameters used in the report are relevant to this project, one of the main criteria considered was tree canopy height, as it can provide an indication of the presence of older trees. In this analysis, the tree height value was set to 15-21 meters, as tree heights above 22-25 meters had very low values within the area, while heights below 21 meters had higher values.

HIKING TRAILS AND PATHS

The hiking trails and paths were categorized into two separate groups, with the first category assigned a higher value and the latter a lower value. Based on the interviews, the green areas within and around Garnisonen are frequently used by nearby residents as well as people from all over Hässleholm. The hiking trails within the area are of significant interest, as they should maintain their natural character. The mountain bike trail in the area is also at risk of disappearing if it is exploited or extended into another area. It is therefore preferable to preserve it as it is, without interfering with other potential habitats that may be sensitive to excessive disturbances. The illuminated walking trail may hold greater value for nearby residents as it provides a safer environment for walking during darker periods of the year. The unofficial paths within the area were included based on interviews and field trips, as they connect the main walking paths and roads with the green areas. Other paths were assigned a lower value.

According to Duinker et al. (2017) in order for visitors to experience a Pillar hall, the size requirement is 1 hectare or 400 meters in width. For a mixed forest stand, the requirement is 0.35 hectares or 60 meters in width. Therefore, the latter width measurement will be used as a buffer zone surrounding the hiking trails. The buffer surrounding the trails was set to half of this width, specifically 30 meters. Paths and trails overlap in their values from both inputs, as they score higher in the analysis.

DEPRESSIONS

The criterion of depressions is used because these areas are not considered valuable for building purposes. Instead, they are more suitable for functions such as stormwater management or as potentially flooded areas.

CULTURAL HERITAGE

Areas with cultural heritage, similar to protected trees, have a higher likelihood of preservation if they are accompanied by a buffer zone that prohibits construction. The buffer zone helps to safeguard these areas from potential development and ensures their long-term survival. By establishing such buffer zones, the cultural heritage sites can be protected and their historical, architectural, or archaeological significance can be preserved for future generations.

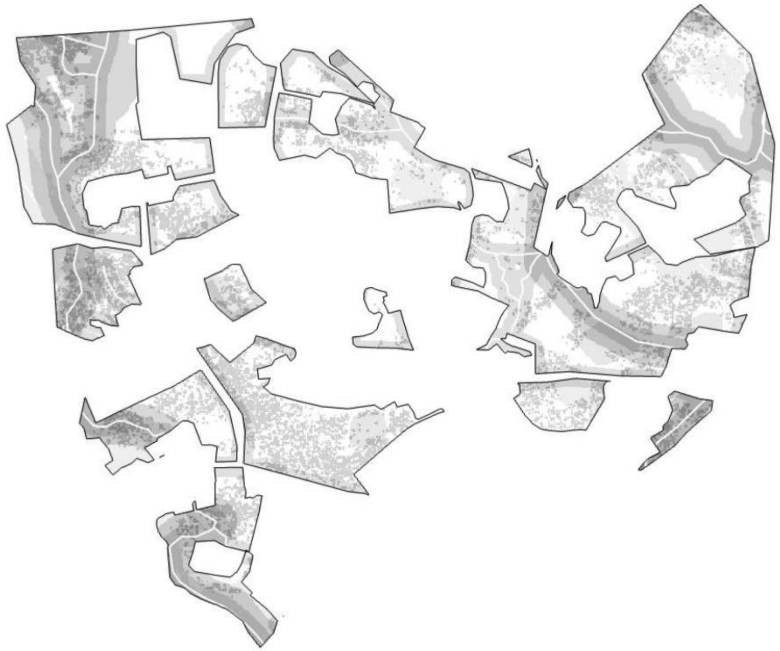


Figure 19. The weighted values of the multi-criteria-analysis (Height*30 + Paths*30 + Trails*15 + Cultural heritage*15 + Depression*10), The lowest score is represented by lightest shade, while the highest score is represented by the darkest shade.

THE PROPOSAL

THE CHOSEN AREA

The selected area holds significant values in terms of biodiversity, recreation, and culture. It is evident that the area is extensively utilized and appreciated by current residents. In order to mitigate existing conflicts (as described in the paragraph on opposing forces) the area should be kept and strengthen to prevent further fragmentation. Parts of it scored fairly high in the multi-criteria analysis, since there are both paths and trails inside the area, trees worthy of protection, and there is also a larger area with depression here. Furthermore, it falls within the scope of Hässleholm county's efforts to preserve green structures and corridors in within the project area which is visualised in figure 20 (Hässleholms kommun 2022). Illustrated in figure 21 on the following page, it is evident that the area contains diverse stand structures within a smaller area and serves as a node or meeting point with evidence of a fireplace, furthermore it acts as a main entrance into the eastern green infrastructure. Multiple paths traverse the area, including the main entrance path, the Skåneleden trail connecting to the larger landscape, a smaller well-used path, and smaller informal paths crisscrossing the entire area. There are many informal paths throughout the whole forest, which indicates that people are using the entire area, even though it is often difficult to access due to it being very dense from time to time.

There are three open areas that affect the site's orientation. The northern area shows signs of vehicular activity, with no vegetation and compacted soil. The second area is a glade, a wide pathway situated between the entrance stand of Fagus sylvatica and the second mixture-stand of Fagus sylvatica. Lastly, there is an open fold within the second Fagus sylvatica stand, surrounded by slopes and contains abandoned hay bales. Adjacent to the site is a nature preschool that frequently utilizes the open fold. All three areas possess the potential to be developed as open spaces or glades, serving as meeting points, or as restored forest areas.

When walking through the entrance of Fagus sylvatica and Pinus sylvestris, one is immediately met by a landmark consisting of a tall group of crooked Pinus sylvestris. There are various edges acting as boundaries and barriers, creating seams and lines within the area. One notable

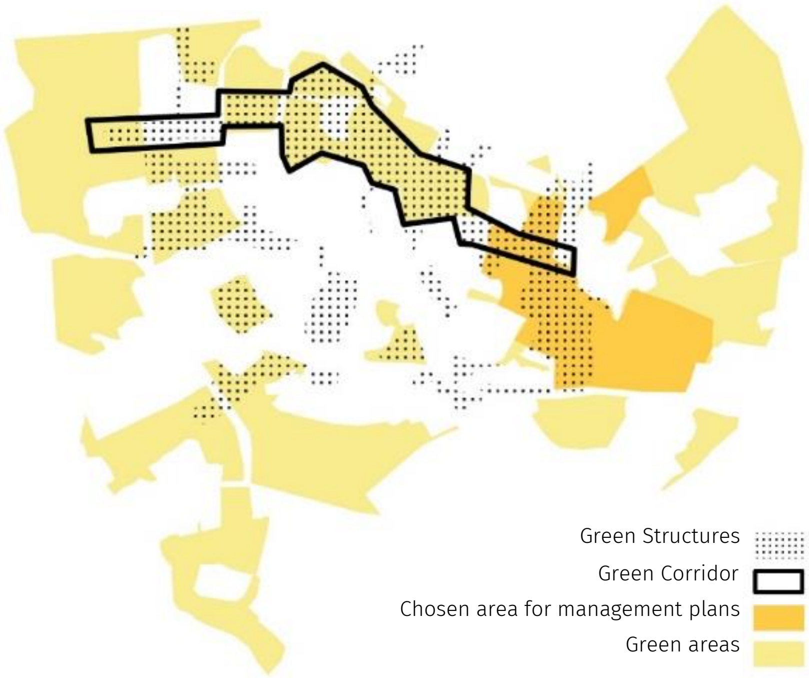


Figure 20. Illustration of the green areas surrounding Garnisonen in relation to Hässleholm county's reasoning on which green structures should be preserved and function as corridors. Furthermore, it reveals the specific area that has been selected for the management plans within this paper.

example is a row of Pinus sylvestris on one side of the entrance path, facing an open field of Rubus ideaus with scattered patches of mature Betula sp. and Fagus sylvatica shoots on the other side. Another important edge is an open field in the east, which enhances the enclosed feeling while walking along the Skåneleden trail.

Lantmäteriet have not identified any specific cultural heritage in the area. However, greater parts of the area have been utilized for agricultural purposes (light blue in figure 21) (Lantmäteriet 2023), which is evident from the presence of stone walls and remnants of coppiced Corylus avellana. Currently, there are young trees and sprouts of Alnus glutinosa scattered throughout, along with abundant growth of Rubus ideaus , Betula sp., and Salix sp.

The area has been divided into nine different stands in accordance with what species are present, what species are desired and how they are supposed to be maintained. The connecting stands where chosen, foremost for their connectivity to the meeting point, while the disconnected stand in the north is serving as a reference point in free development.

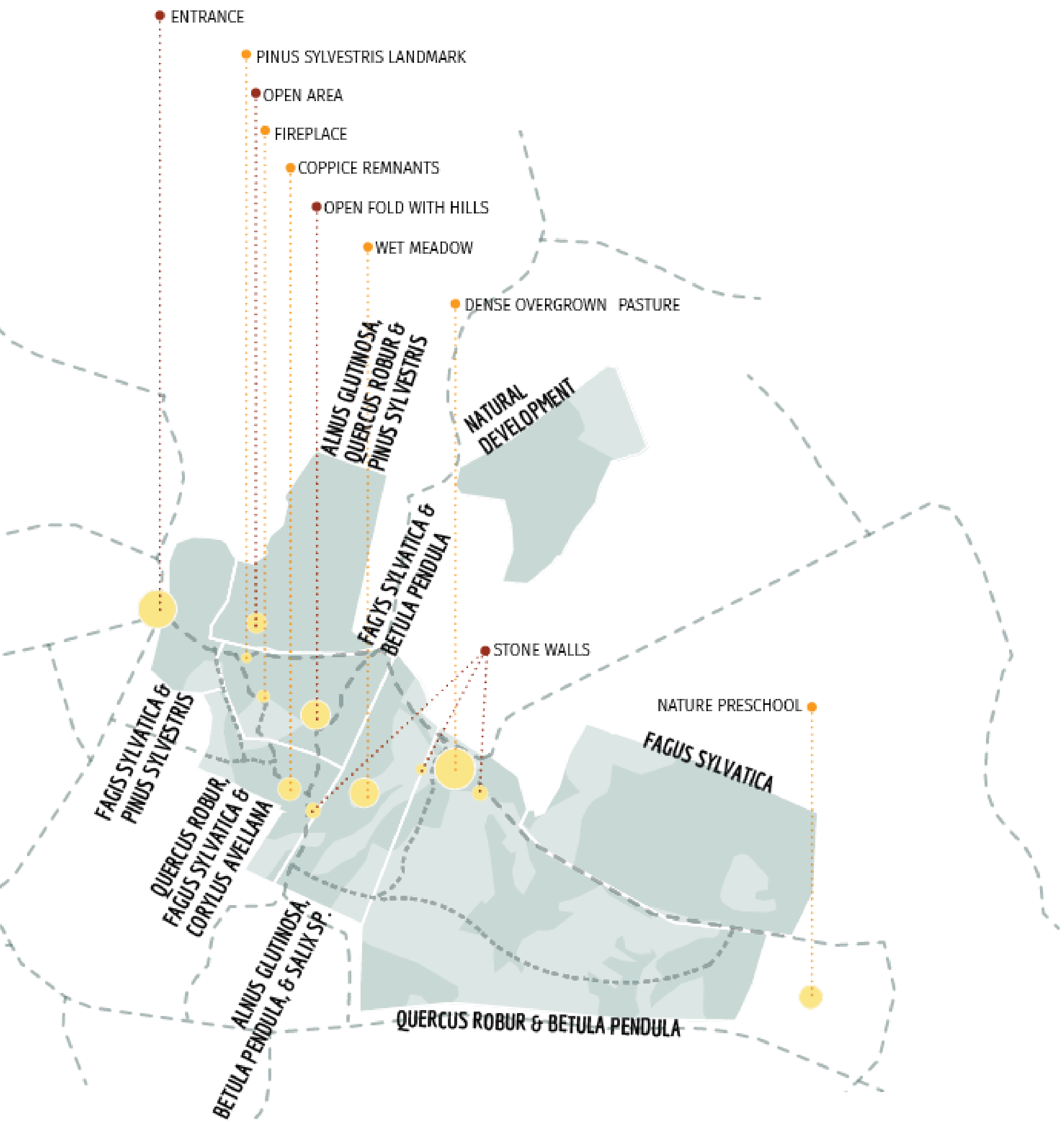


Figure 21. An overview map of the chosen area showing the divided stands, pathways running through them, as well as major landmarks and geographical features.

1. Entrance with Fagus sylvatica, Pinus sylvestris and Betula sp. saplings.

2. Taking a few more steps into the forest with the landmarking group of Pinus sylvestris and Betula sp. in the backdrop, on the left (north) Pinus sylvestris edge of Alnus glutinosa stand.

3 & 4. At the end of the path, looking into the larger patch of Betula sp. with Fagus sylvatica saplings.

5. Following the path into the Fagus, Betula and Quercus stand, and looking back.

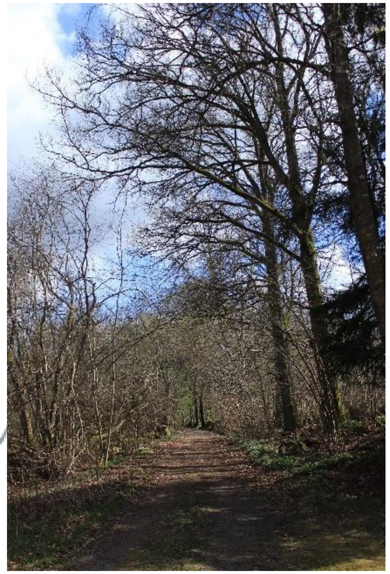
IN PHOTOS

6. Standing above the open fold.

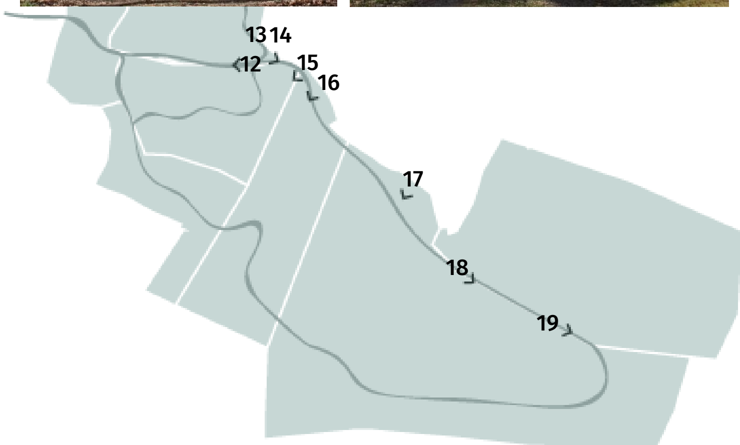
7, 8 & 9. Standing below the fold, from left to right. Pinus sylvestris landmark with wide open path in front of it. The open fold. Quercus robur stand.

10 & 11. Looking into Alnus, Betula and Salix. With tree line of mixed decidious trees to the left (east) open field of Rubus ideaus in the middle and either Salix sp. or Betula sp. with Alnus glutinosa along the water streams.

12, 13 & 14.
Starting at the end of the path with the tree line of Pinus sylvestris again, this time moving at the outer edges of the area.

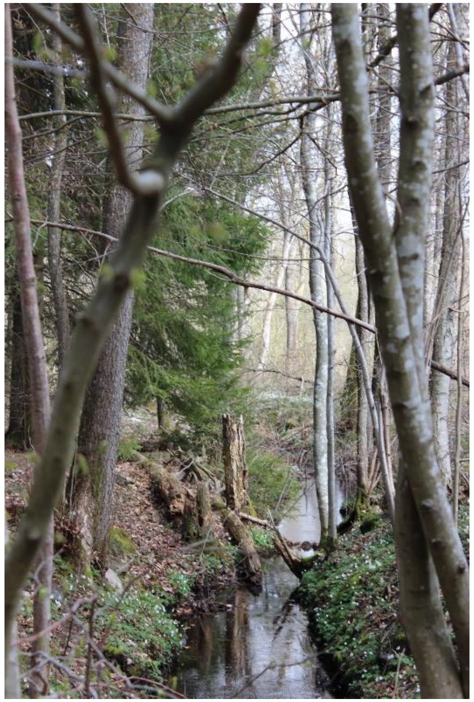


15 & 16. On the left, looking into the north-east corner of Fagus, Betula and Quercus, consisting of Populus tremula, Quercus robur, Fraxinus excelsior, Corylus avellana and Betula sp.. On the right, looking into the stand of Alnus glutinosa, Salix sp. and Betula sp..



17, 18 & 19. Moving along Skåneleden, where the path divides the two stands Fagus sylvatica and Quercus robur with Betula sp..

20 & 21. Standing inside the Alnus glutinosa and Pinus sylvestris stand.



22 & 23. Natural development f Quercus robur, Alnus glutinosa, Pinus sylvestris and Corylus avellana.

THE CURRENT PROBLEMS

- There are certain areas within the forest where blocks of stands with geometric formations coexist with open areas, resulting in a fragmented landscape. The transitional gradient between these blocks and open areas can be confusing or unclear.
- The entrance should be greater highlighted and inviting.
- Stands are predominantly even-aged, with many of them having undergone thinning using either a pillar hall or a two-layered stand with an understory of saplings. In most cases, these stands exhibit an unstable species composition.
- Parts of the stands are very dense and many of the tree crowns are closely spaced and require thinning to promote healthy growth. This is particularly true for Quercus robur in all stands where they are present.
- Many of the Corylus avellana shrubs are aging and require rejuvenation to ensure their survival. This rejuvenation process involves reducing the density of the tree crown layer.
- Based on old maps and inventory data, there is evidence suggesting the presence of agricultural land or overgrown wet meadows and pastures that require restoration or repurposing towards a different direction of development.
- The planned development of new housing and paved roads in the nearby area has the potential to result in wetter and more polluted soils.

POTENTIAL ADVANTAGES OF THE SITE

- Stands containing many different species adapted to the site are present including native broadleaved species, ensuring that there are different species who will survive the potential climate threats discussed in paragraph Future prospects.
- While the majority of stands exhibit a two-layered structure with saplings or pillar hall, there is also a range of stand structures present, including open and closed areas. As mentioned earlier in the paragraph on human preferences, this variability accommodates diverse individual preferences and holds potential for further development.
- There are young stands that have the potential to develop into forests with diverse structural types.
- Due to a relatively low population of residents in the area, there have been few instances of garden escapes. However, this may pose a potential problem in the future.
- Viscosity is a concept that refers to the tendency of people to stay or linger at a particular site. It can be observed through winding paths where people slow down or places where they naturally prefer to spend time (Cullen 1961). The area already exhibits a high level of viscosity, but it can be further enhanced by creating attractive nodes or focal points where people would be inclined to gather or spend more time.
- There is a potential to enhance species biodiversity by planting Tilia cordata and promoting its presence within the understory layer of the forest.

MANAGEMENT DESCRIPRITON

OVERALL PRINCIPAL MANAGEMENT

The mixed forest system offers a range of interconnected areas that contribute to a cohesive and harmonious landscape experience. These areas include dense, partially open, and open spaces, each playing a vital role in orientation and overall visual appeal. To ensure a diverse and enjoyable environment for forest users, it is important to cultivate various forest structures as outlined in the existing literature. This diversity not only enhances recreational opportunities but also supports biodiversity and serves as a protective barrier against potential climate-related challenges. While variations within individual forest stands are crucial, it is equally important to recognize the significance of variations between stands. Without a wide array of biotopes and stand structures across the landscape, a forest would lose its appeal and become monotonous. To maintain landscape cohesion, it is advisable to concentrate recreational activities closer to the less managed, more natural parts of the forest where people can freely explore and interact with the environment. This approach also helps minimize landscape fragmentation, ensuring a more integrated and interconnected natural setting.

GENERAL GOALS

The following goals serve as comprehensive principles for the entire area, drawn from the literature study. They are categorized into three main areas of focus within this paper: the mixed forest system (or biodiversity), human preferences, and climate change.

MIXED FOREST SYSTEMS

- Foster a mixed forest system that incorporates a range of tree species, promoting biodiversity and ecological balance.
- Maintain diverse forest structures to support diverse biotopes and enhance ecosystem resilience.
- Successional stages are used for stand-rejuvenation. In stand VI, rejuvenating Quercus robur will result in the emergence of saplings of both Q. robur and Betula sp., with the latter acting as nurse tree.
- Diverse species structures are always encouraged unless there is a need to suppress Fagus sylvatica.
- Clear-cuts are constrained. Thinning and rejuvenation should be carried out by negative spacing between individuals or in groups. Which encourage development of variations in age and structure.
- Promote wider species diversity by extending beyond current time-lapse illustrations. To enhance the overall diversity, promote species listed in "species structure in x years" unless they disrupt the stand's overall structure.
- Any specific species that are not allowed within a stand or exceed a certain percentage are mentioned in the description.
- Natural regeneration is employed in all stands unless specified.
- Since the FDTs are produced with silviculture as their main goal, the implementation of forest harvest is guided based on specific needs within stands. However, since this is a recreational forest, prioritizing recreational aspects should be of top priority.
- In alignment with the FDTs, species selection should not aim for a broader mixture without purpose. Consideration is given to nearby seed sources, existing species within the stand, natural habitat, as well as grazing pressure and wear and tear.

HUMAN PREFERENCE

- The forest scape should cater to the diverse preferences of forest users, ensuring a rich and enjoyable recreational experience.
- Encourage a balanced approach to forest management that balances conservation goals with the recreational needs of people.
- The enhancement of understory layers contributes to the forest's naturalness and wilderness, fostering a sense of solitude and separation that aligns with human preferences.
- To enhance the experiential value in the forest, it is essential to preserve special individual trees, as mentioned in the paragraph on human perception. These trees should be specifically retained, particularly in or near edge zones.
- The entrance stands I., II., and III. all exhibit a pillar hall character, with little to no understory. This feature enhances the sense of safety within the forest and also designates entrance node. Consequently, it is essential to maintain a higher level of cues of care, neatness, stewardship, and naturalness in these stands, ensuring that the development blends in with its surroundings.
- Larger paths can be cleared on a regular basis, removing the understory up to two meters into the stand each year. Smaller paths within the stands can naturally develop and be maintained through the natural process of wear and tear over time.
- Paths within the free development area should be highly restricted and only cleared where existing paths already exist. Otherwise, the stand should be maintained as dense and inaccessible to prevent wear and tear, ultimately preserving its close-to-natural state.

CLIMATE CHANGE

- Storm-water management is provided in II. and IV., additionally, the presence of Salix sp. is beneficial for water purification.
- The glade with slopes in section III. introduces visual landscape diversity. Fagus sylvatica and Tilia cordata are promoted for their adaptability to grow on slopes and ability to prevent soil erosion.
- Maintaining a free development area with restricted access creates habitats for red-listed and other vulnerable species.
- According to the recommendations of species priorities in Scania from the "Action Plan for Green Infrastructure" (Berlin & Niss 2019), the species that have been promoted within the area are Fagus sylvatica, Quercus robur, and Tilia cordata.
- According to the climate change table, there is uncertainty about the effects of Phytophthora outbreaks and potential drought on Fagus sylvatica. In all but one of the stands where Fagus sylvatica is present, other species that can thrive under these conditions are promoted. These species include Quercus robur, Tilia cordata, and Pinus sylvestris.

INDIVIDUAL STAND MANAGEMENT

The following management practices are described at stand level and should be implemented to achieve the specific goals of each stand. The paragraph covers the thinning techniques employed within the stands, soil habitat diagram interpretation guidance, and an example of interpreting the management plans for the different stands, as shown in Figure 24 on the following page.

THINNING METHODS

- Low or thinning form below
  Trees are removed from the lower canopy (mainly intermediate and suppressed trees but can also be used in codominant trees to change the dynamics within the stand) and mimics natural mortality from surface fires and competition in between trees. Low thinning can alter the composition of species within a stand.
- Crown, or thinning from above
  Removal of trees in the main canopy (dominant and codominant trees), to promote trees within the same category. Smaller trees that don't have a crown that interfere with the selected trees are kept and the stands are therefore usually two-layered. The method can be used to alter the composition within stands.
- Selection, or diameter-limit thinning
  Removal of dominant trees to promote smaller trees. Trees within a certain diameter is usually targeted and used for removing trees with high economic value.
- Free thinning
  Is highly flexible in thinning criterions, and often used to create a rich and various stand structure. (T. Graham et al. 1999).

THE SOIL HABITAT DIAGRAM

Each species has its own unique requirements and preferences to thrive and survive in their natural habitats. However, it is important to note that species can exhibit some degree of adaptability and may be able to grow within a broader range than their preferred conditions. Key factors that influence their survival include moisture levels, nutrient availability, and pH levels of the soil. By understanding these factors, we can better predict which species are likely to occur in a particular environment.

The soil habitat diagram in figure 23 provides information on the specific locations of different stands based on moisture, nutrient availability, and pH. The moisture gradient ranges from very dry, indicating sites with minimal accessible water, to very wet, representing areas where water is consistently present. The nutrient gradient spans from nutrient-poor conditions to nutrient-rich conditions. Nutrient poor conditions often correlate to low pH, and rich conditions to high pH. The diagram can be interpreted by considering water availability along the Y-axis and nutrient levels along the X-axis (Wahlsteen 2018)

Figure 23 The soil habitat diagram.

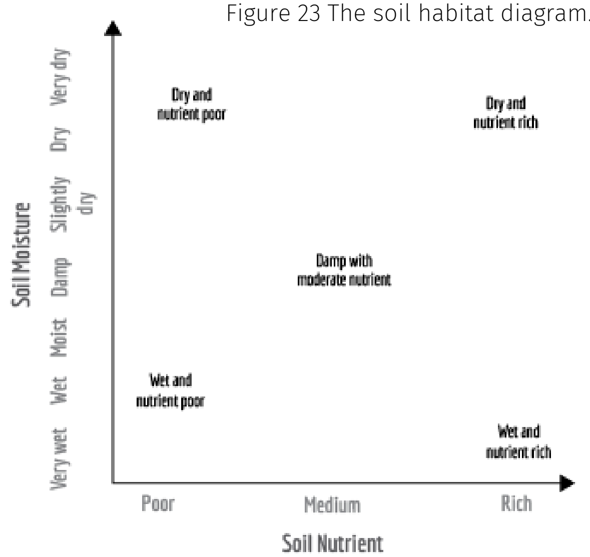


Figure 24. Guide over the management plans.

NAME OF STAND, WITH SPECIE-DOMINANCE IN ORDER

PRESENT STAND

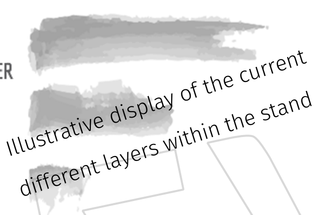
Profile is not proportional to the stand but instead mean to show the variation of the different blocks/gradients that can be found within the stand.

Stand structure

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER



DESIRED STAND

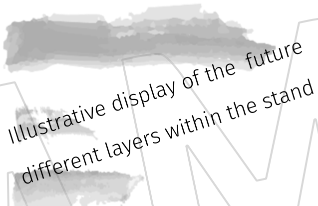
Profile is not proportional to the stand but instead mean to show the variation of the different blocks/gradients that can be found within the stand.

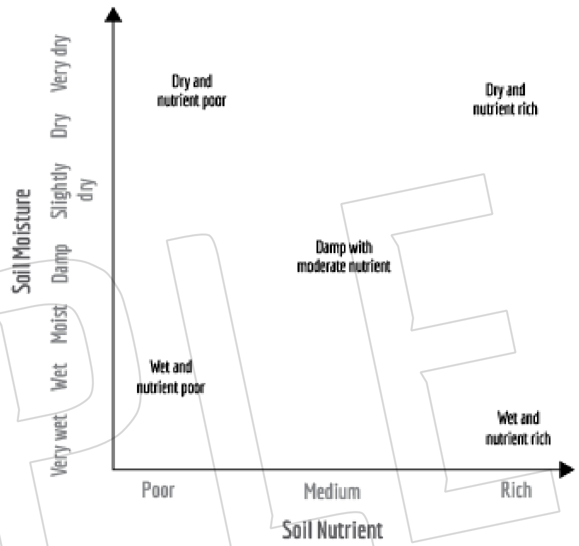
Stand structure

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER





DESCRIPTION

Description of the stand with dynamics and structure.

LONG-TERM GOAL

The long-term stand structure with species, and what recreation values it has.

BRITISH AND/OR DANISH FOREST DEVELOPMENT TYPE

Description of the FDT match including recommended species distribution, structure and dynamic.

SPECIES STRUCTURE IN X YEARS

Trees in procentage
Shrublayer: specified species and species that could potentially establish in the stand.
Fieldlayer: specified species and species that could potentially establish in the stand.

CHALLENGES AND PROSPECTS

What challenges and prospects there are in developing and managing the stand with important notes to think about.

OVERALL PRINCIPAL MANAGEMENT

The overall principal management within the stand when for example thinning and selecting trees.

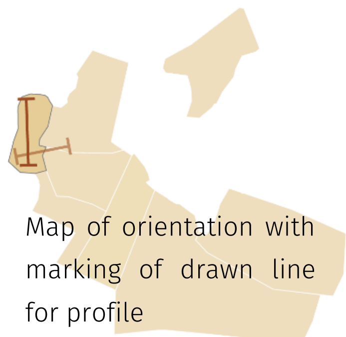
Forest type according to Wahlsteen (2018)

Tree layer

Shrub layer

Fieldlayer type
(with species if inventoried)

D = dominant specie
F = few individuals"



Map of orientation with marking of drawn line for profile

MANAGEMENT ACTIONS & YEARLY MAINTENANCE

Table on the following page along with time lapse of the vegetation structure.

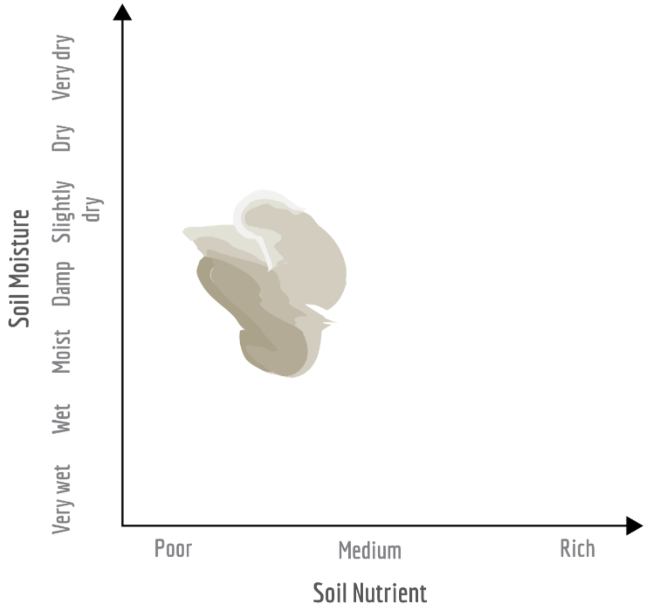
Figure 25. Goal image.

I. FAGUS SYLVATICA & PINUS SYLVESTRIS

I. FAGUS SYLVATICA & PINUS SYLVESTRIS

Pillar hall
with scattered and grouped understory

Multi-layered stand
with scattered and grouped understory



DESCRIPTION

This stand is more of an edge zone gradient with two entrances into the forest. The northern part consists of a depression filled with F. sylvatica and saplings of B. pendula and F. sylvatica. Above the depression in the east there is a row of young P. sylvestris trees, and further to the south the gradient shifts into the adjacent stand with F. sylvatica Q. robur. The edge zone towards the west here are filled with saplings of B. pendula.

LONG-TERM GOAL

Upkeeping the balance of an uneven-aged three-layered stand dominated by F. sylvatica and P. sylvestris with minor individuals of B. pendula, A. glutinosa, Q. robur, C. avellana and S. nigra (figure 20). The overall stand should be perceived as a pillar hall with grouped and scattered understory, since rejuvenation is done in groups, parts of it will be perceived as three-layered depending on the rejuvenation cycle. Since this is the entrance into the forest area, with few individuals in the understory it will highten the perceived sense of security while at the same time invite the eye when being able to see far into the forest.

HEATHLAND FOREST WITH GRASS/DWARDSHRUB

Tree layer

	Alnus glutinosa northedge	**<10%**
	Betula sp. <10%	
D	**Fagus sylvatica**	**60%**
	Pinus sylvestris	**30%**
F	**Quercus robur**	**<10%**

Shrub layer with saplings

	Betula sp.
	Corylus avellana
	Fagus sylvatica (edges)
	Pinus sylvetris
F	**Rosa sp.**
F	**Sambucus nigra**

Field layer: dwarfshrub and fern dominated

BFDT TYPE 9.8.1 OTHER LONG-LIVED BROADLEAVES

Long-lived broadleaves 30–100% secondary species: < 30% minor species: < 10% (Haufe et al. 2021b).

This FDT includes diverse long-lived broadleaved species. Stands usually start as even-aged and single-layered, potentially developing a more complex structure later. Mixture types can range from intimate to patchy. Minor species may naturally regenerate depending on site conditions.

SPECIES DISTRUBUTION IN 50 YEARS

<u>Tree layer</u>
55% Fagus sylvatica
35% Pinus sylvestris
<10% Betula sp., Carpinus betulus, possibly Acer pseudoplatanus, Malus sylvestris, Populus tremula, Prunus avium, Sorbus aucuparia, Tilia cordata
<u>Shrub and field layer:</u> Corylus avellana, Crataegus sp., Euonymus sp., Ligustrum vulgare, Lonicera sp., Ribes sanguineum, Rosa sp., Viburnum opulus

CHALLENGES AND PROSPECTS

Fagus sylvatica adds structural diversity to the stand while also controlling ground vegetation. In the rejuvenation phase, Pinus sylvestris grows faster than Fagus sylvatica and will therefore be able to establish themselves in the top tree layer before Fagus sylvatica catches up, when they do, they will press the tree crowns of Pinus sylvestris into being very small.

OVERALL PRINCIPAL MANAGEMENT

- Fagus sylvatica are rejuvenated in small groups. This will promote a variation of different ages when tinning to create a multi-layered stand.
- If wood production is the aim of Fagus sylvatica, keep and promote a few mature individuals within the stand so that there are individuals of older trees present.
- Selected trees of Pinus sylvestris and Betula sp. is promoted in the areas with juvenile individuals.
- Thinning to balance tree species, mainly cut down Fagus sylvatica since they tend to dominate and outcompete other species.
- Coppice of Corylus avellana should aim to have a rotation cycle of 50 years where 1/2 if the total stand is coppiced every 25th year.
- Leave dead wood in the north part of the stand.
- Prune trees in edges to promote a one-step edge, as a result, when selecting trees to promote towards the adjacent car road, choose trees that are located a few meters within the stand.

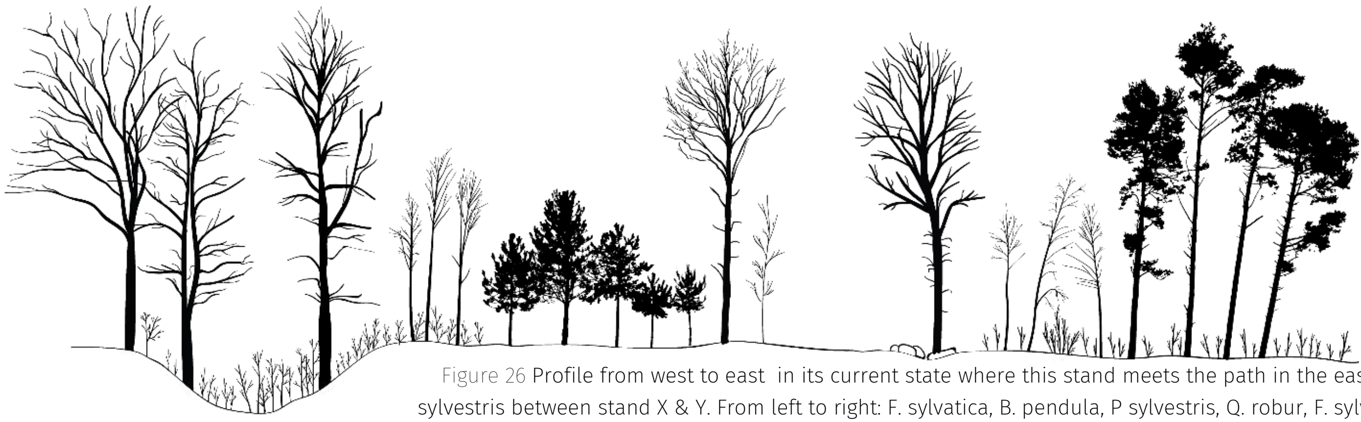


Figure 26 Profile from west to east in its current state where this stand meets the path in the east and the corridor of Pinus sylvestris between stand X & Y. From left to right: F. sylvatica, B. pendula, P sylvestris, Q. robur, F. sylvatica, Q. robur, B. pendula, F. sylvatica. With saplings of F. sylvatica and B. pendula in the hollow, and B. pendula in the east.

YEAR	MANAGEMENT ACTIONS
1	o Thinning in promotion of Pinus sylvestris o Rejuvenation by coppice of 1/2 Corylus avellana
10	o Thinning in promotion of selected trees in promotion of Fagus sylvatica and Pinus sylvestris
25-50	o Coppice of Corylus avellana with a rotation cycle of 50 years where 1/2 if the total stand is coppiced every 25th year
~50	o Thinning of groups of Fagus sylvatica and Pinus sylvestris for rejuvenation? o Potential thinning of mature Fagus sylvatica for wood production

YEARLY MAINTENANCE	MANAGEMENT ACTIONS
	o Clear branches or possibly thinning of trees that are dangerous towards the adjacent car road

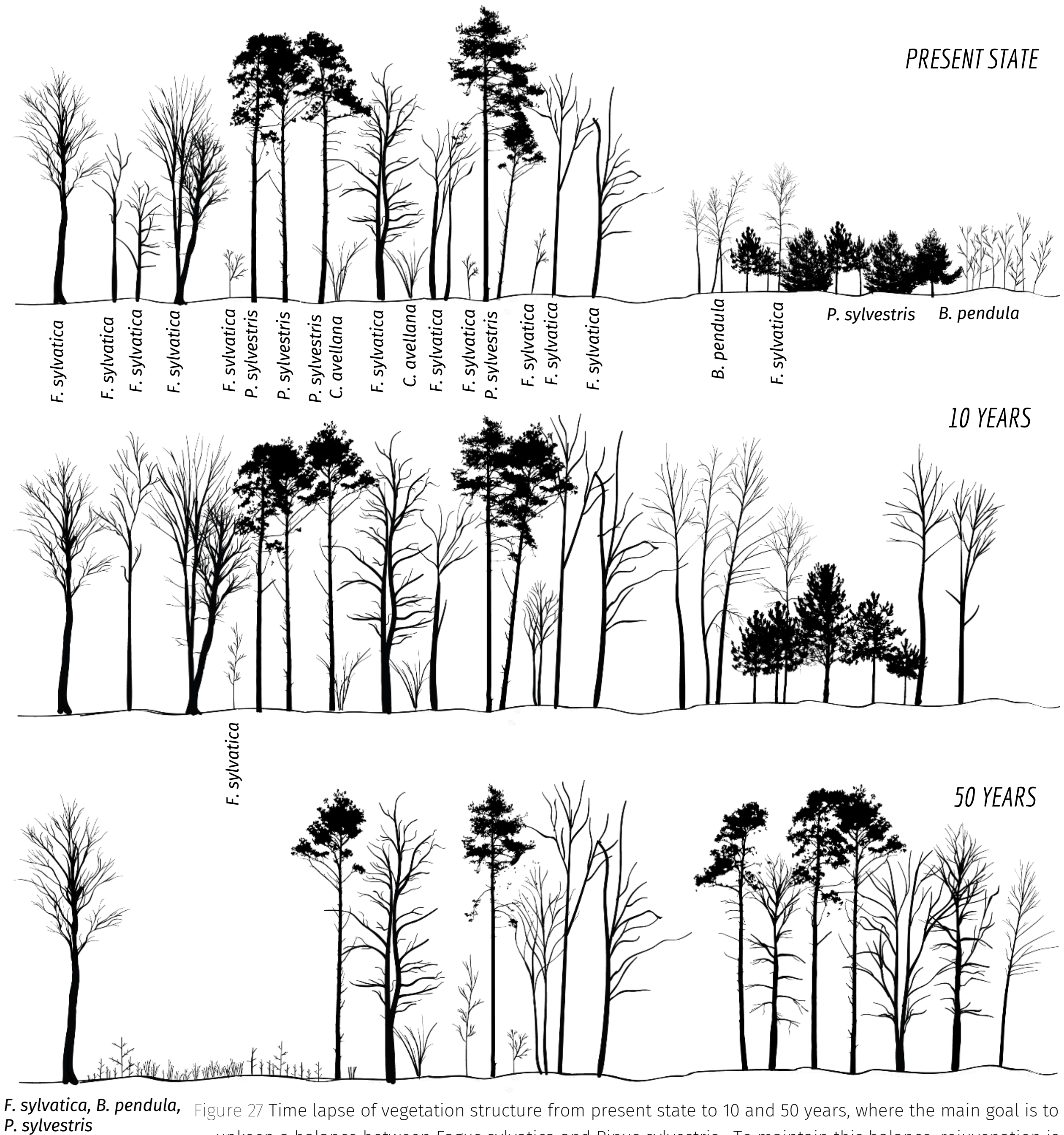


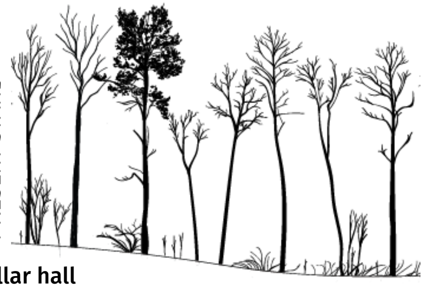
Figure 27 Time lapse of vegetation structure from present state to 10 and 50 years, where the main goal is to upkeep a balance between Fagus sylvatica and Pinus sylvestris. To maintain this balance, rejuvenation is visualized on the right side where cleared areas from the present will rejuvenate with new trees over the next 50 years. Simultaneously, on the left side, matured trees from the present are cleared in 50 years.

Figure 28. Stand in present state.

II. ALNUS GLUTINOSA, QUERCUS ROBUR & PINUS SYLVESTRIS

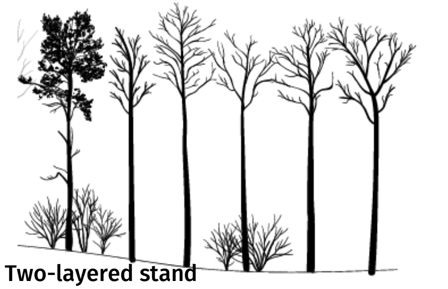
II. ALNUS GLUTINOSA, QUERCUS ROBUR & PINUS SYLVESTRIS

PRESENT STAND

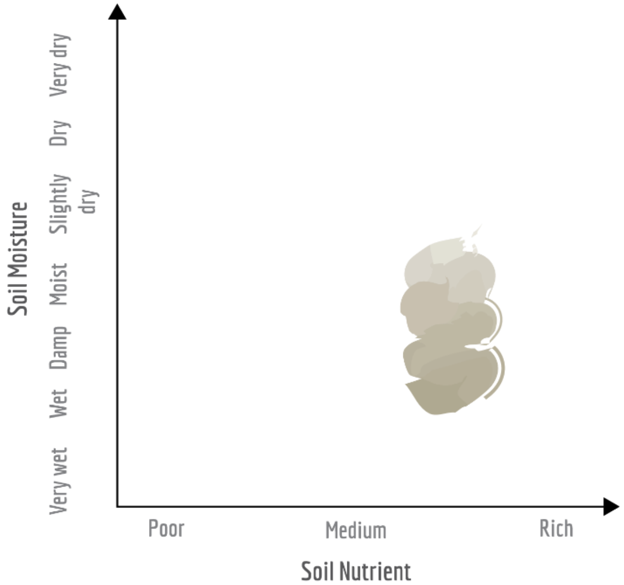


Pillar hall with scattered understory

DESIRED STAND



Two-layered stand with understory of shrub species



DESCRIPTION

Recently, the stand has undergone significant thinning in the understory, resulting in scattered shrubs and a pillar-like structure. There is no designated path leading into the stand, but upon entering, one can sense being immersed in the vegetation, despite glimpses of a building to the north, just outside the stand.

The southern part of the stand is predominantly occupied by Quercus robur, with scattered Pinus sylvestris trees. The field layer consists of Prunus padus, along with saplings of Alnus glutinosa and Picea abies. Moving towards the north, there is a transition from Quercus robur dominance to Alnus glutinosa dominance (figure 24). In the northernmost part, only Alnus glutinosa is present in the tree layer, accompanied by scattered Rubus ideaus and tree saplings.

The edge zone, although not included in the management plan due to its location outside the municipality border, exhibits a two-step edge structure. The inner edge is composed of Quercus robur and Corylus avellana, with a few individuals of Betula sp. and Alnus glutinosa. The outer edge comprises Prunus padus, Prunus avium, Corylus avellana, and Quercus robur.

ALDER FOREST OF TALL HERB TYPE

Tree layer

D	**Alnus glutinosa**	**70%**
	Pinus sylvestris	**10%**
D	**Quercus robur**	**20%**

Shrub layer with saplings

D **Alnus glutinosa**
Picea abies
D **Prunus padus**
F **Rosa multiflora**
F **Sambucus nigra**

Field & bottom layer: dwarfshrub and fern dominated

Corydalis sp.
Ferns
Ranunculus ficaria
Rubus ideaus
Mosses
F **Vaccinium myrtillus**

LONG-TERM GOAL

The current stand is characterized by even-aged vegetation, and there is a need to enhance species and structural diversity in the understory as suggested by Haufe et al.. (2021). The top tree layer should be dominated by Alnus glutinosa, with scattered individuals of other light demanding species. Since there are no Quercus robur saplings present in the field layer and Quercus robur promotion is being carried out in neighboring stands, it is advisable to promote the dominance of Alnus glutinosa in this particular stand, as there are saplings of Alnus glutinosa scattered throughout the area. However, considering that both Quercus robur and Pinus sylvestris are long-lived tree species, it is recommended to retain them within the stand for as long as possible. Although the Quercus robur individuals in this stand exhibit lower quality, indicating a shorter lifespan, they can still serve a valuable purpose as standing dead wood once they naturally die. Retaining them in this form will contribute to the ecological functioning of the forest and provide habitat for various organisms.

BFDT: 911 ALNUS GLUTINOSA EVEN-AGED

Alnus glutinosa 80 – 100%, minor species: < 20%.

One-layered Alnus glutinosa stand with category B minor species such as Betula sp. and Quercus robur, occasionally also Acer pseudoplatanus, Populus tremula, Salix sp., Sorbus aucuparia, and Picea abies in single tree to large group mixture. Designed for even-aged stands where management wishes to increase species and structural diversity over time. Small scale clearfell-and-restock or LIMA methods should be used to introduce and maintain the desired horizontal and vertical stand structure. On wet sites timber extraction may be difficult and consideration must be given to the use of appropriate harvesting methods and technology (Haufe et al. 2021b).

SPECIES DISTRUBUTION IN 50 YEARS

Tree layer
80% Alnus glutinosa
20% Other light demanding species

Understory
Accepted tree species in the understory are mainly light demanding species (such as Betula ssp., Fraxinus excelsior, Quercus robur, Populus tremula, Salix sp., Sorbus aucuparia) with occassional shade-tolerant species (such as Acer pseudoplatanus and Picea abies) that doesn't interfere with Alnus glutinous.

CHALLENGES AND PROSPECTS

In Scania, Alnus glutinosa forests are abundant and known for their species richness, including a variety of plants and mosses. The presence of old, coarse Alnus glutinosa trees is particularly important for wood-dwelling insects, contributing to their ecological significance. These forests are typically found in moist or wet soils, interspersed among larger deciduous forest landscapes, and hold high biological value (Länsstyrelsen Skåne 2019). he translucent crowns of Alnus glutinosa allow for a diverse understory and field layer, providing opportunities for a rich variety of vegetation (Andersson & Andersson 2005). According to Rytter et al. (2014) Alnus glutinosa-dominated forests in Sweden are often the least managed or thinned, resulting in overly tall tree canopies that hinder wood production. This applies to the stand in Garnisonen as well. Therefore, during the initial thinning process, the trees within the stand may not be ideal for wood production. However, if desirable, it is possible to incorporate production when selecting new saplings for regeneration.

OVERALL PRINCIPAL MANAGEMENT

- Promote understory to get a higher diversity within the stand.
- Saplings in the understory of Alnus glutinosa should be promoted for natural regeneration.
- If needed, the southern part of the stand should be selectively thinned from above to create space and promote natural regrowth of Alnus glutinosa. It is important to prioritize the retention of standing dead Quercus robur trees, as they currently pose no immediate risk in the stand, considering its infrequent use.
- Since Alnus glutinosa have a high light demand, regeneration under canopy is not recommended (Haufe et al. 2021a), thinning should therefore be carried out in groups within the areas predominantly occupied by Alnus glutinosa.
- If production is of interest, the crowns of the selected trees should be fully developed at the age of 40 years, and as Alnus glutinosa are prone to heart rot when older, rotation should be kept below 80 years, and the aim on the target DBH when thinning for production is 35-50 cm (Haufe et al. 2021a).

YEAR	*MANAGEMENT ACTIONS*
10	o Thinning in groups of Alnus glutinosa, about 15-20% of the stand. Girdle Alnus glutinosa trees that are not desired for shoot regeneration (Haufe et al. 2021a). Desired trees for production should aim to have a crown height that is 50% of the total height (Andersson & Andersson 2005). The soil should be exposed for new seedlings of Alnus glutinosa to develop (Andersson & Andersson 2005). o Shoots from thinned trees of Alnus glutinosa can be used for regeneration, however, regeneration on stump shoots should not be used for more than 2-3 generations on a single individual (Andersson & Andersson 2005). o Keeping saplings in the understory nearby thinned trees and promote as much of Prunus padus species in the understory as possible when thinning the canopy layer.
10-50	o Maintain a closed canopy for self-pruning, but consider mechanical pruning in the glades that where opened during thinning (Haufe et al. 2021a). o Thinn the bouquets on stump shoots for regeneration so that only 2-3 shoots remain per stump (Andersson & Andersson 2005). o Thinning of undesired trees in the middle layer where crowns interfere with the selected trees for promotion (Haufe et al. 2021a). The soil should be exposed for new seedlings of Alnus glutinosa to develop (Andersson & Andersson 2005). o Selected trees from saplings should be pruned to a maximum of the total tree height when they've reached 5-7 cm in DBH (Andersson & Andersson 2005). o Further thinning of selected trees from saplings.
50	o The crowns of the selected trees in year ten should be fully developed at the age of 40 years.

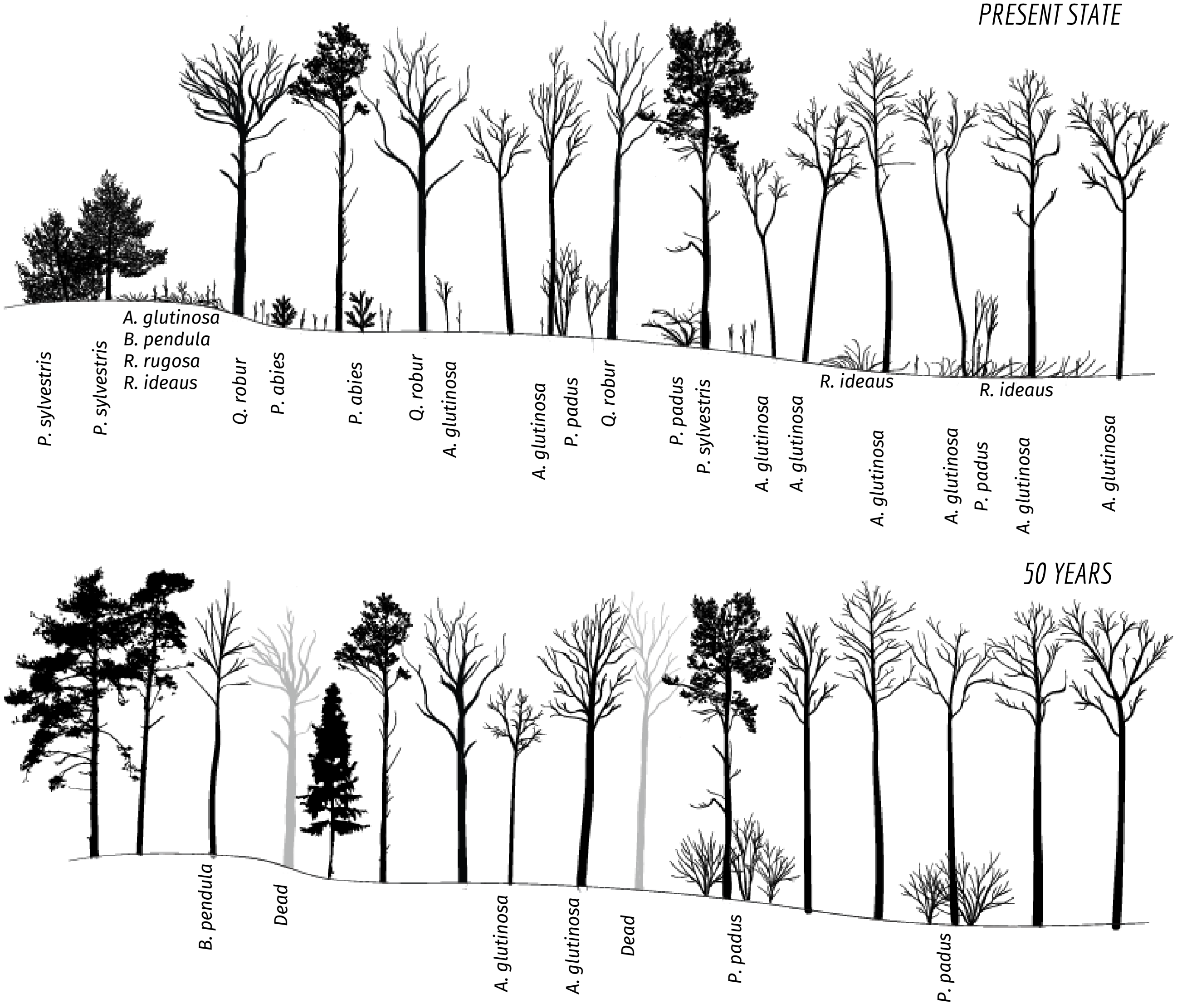


Figure 29. A timelapse of the stand, with the top illustration depicting the current appearance, while the lower illustration portrays its projected state in 50 years. In the top illustration, the edge zone located in the south (left side) exhibits a greater diversity of tree species, while the north (right side) predominantly consists of a more uniform representation of Alnus glutinosa. In the lower illustration, the southern edge zone continues to showcase a diverse composition, potentially enriched with a wider variety of tree species. In contrast, the northern section remains predominantly dominated by Alnus glutinosa, forming a more homogeneous canopy with a grouped understory of Prunus padus.

Figure 30. Stand in present state.

III. FAGUS SYLVATICA & BETULA SP.

III. FAGUS SYLVATICA & BETULA SP.

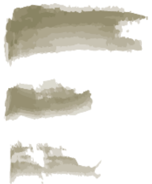
PRESENT STAND

Two-layered stand
With saplings (with glade)

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER



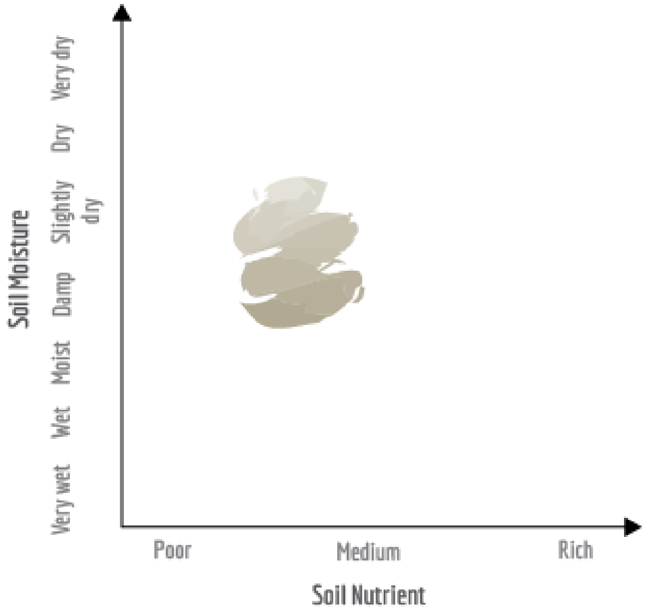
DESIRED STAND

Pillar hall
(with glade)

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER



DESCRIPTION

This stand is divided into three different blocks, the north edge, the slope with Fagus sylvatica and the open fold in the south. The northern edge has recently been heavily thinned and mainly consists of Betula sp., Rubus ideaus and Fagus sylvatica saplings. The eastern part of the edge has a few individuals of Pinus sylvestris. The slope consists mainly of Fagus sylvatica, and Betula sp. where the edge zone meets the stand. The open fold is an open glade of grass, and on top of the hill there are a few individuals of Betula sp., Fagus sylvatica, Pinus sylvestris and Quercus robur. In the slopes there are saplings of Betula sp. and Fagus sylvatica. This glade with its inviting slopes is used a lot by children in the nearby area, during inventory the author met a school class where the teachers told the author that they usually come to this place to play or two other nearby forest areas. The edge towards the meadow consists of mainly the same species as Fagus, Quercus, Corylus stand. Alnus glutinosa, Quercus robur, Corylus avellana, Pinus sylvestris, Fagus sylvatica, Betula sp.. There is however a difference in the northern part of the edge where the vegetation has been cleared previously. Here Populus tremula, Quercus robur, Fraxinus excelsior, Corylus avellana and Betula sp. are present.

BEECH FOREST OF HEATHLAND TYPE

Tree layer

D Betula sp.
D Fagus sylvatica
Pinus sylvestris
F Quercus robur

Shrub layer with saplings:
Betula

Fieldlayer: Grass dominated

LONG-TERM GOAL

Similar species to Fagus sylvatica and Pinus sylvestris stand, but they have a different vegetation structure both currently and, in the future, requiring a separate approach to their development. The glades and slopes will be kept open, mainly through wear and tear, and it is recommended to place picnic tables within the glade. Betula sp. species will continue to diminish, but they are still permitted within the stand, particularly in areas where children play and may damage vegetation, saplings are likely to emerge.

BFDT 6.1.4 FAGUS SYLVATICA AND LONG-LIVED BROADLEAVES

Fagus sylvatica 50 – 70%, Broadleaves 30 – 50%, minor species: 10 – 30% (Haufe et al. 2021b).

Multiple-layered stand dominated by Fagus sylvatica, along with mixed broadleaved species like Acer pseudoplatanus, Tilia cordata, Prunus avium, and others. Which may occur in varying proportions, ranging from large groups to smaller areas, and occasionally as dominant individual trees. Category A minor species are incorporated based upon site conditions. Prioritizing the establishment of robust groups of broadleaved species, as opposed to close mixtures, enhances their competitiveness against Fagus sylvatica. Less competitive species may require ongoing thinning interventions for continuous support (Haufe et al. 2021b).

CHALLENGES AND PROSPECTS

Rubus ideaus is in very close proximity to the walking path, however when trees and shrubs are allowed to develop here, they will hopefully be less dense. Fagus sylvatica is sometimes referred to as the tree of slopes because it thrives excellently on slopes in hilly terrain. Pinus sylvestris can grow in pretty much all habitats, and Tilia cordata is also a great tree for growing on slopes. However, there are no potential seed sources in the area now, but hopefully they will migrate from the connecting stand in the south. If so, there will be a more homogenous transition between the two stands (Löf et al. 2009).

The glade, which is located in the middle of this stand, offers a secluded area within the forest. It is characterized by its aesthetic qualities, providing a setting for social engagement. The glade serves as a backdrop for activities such as games, relaxation, and picnics, enjoyed by both children and adults.

SPECIES DISTRIBUTION IN 60 YEARS

Tree layer
60% Fagus sylvatica
25% Pinus sylvestris
<15% Betula sp., Carpinus betulus, Quercus robur

OVERALL PRINCIPAL MANAGEMENT

- Promote Fagus sylvatica and Pinus sylvestris throughout the stand, as well as Quercus robur in the north and south.
- Pinus sylvestris should be present as individual trees.
- Betula sp. will serve as nurse trees along with Pinus sylvestris for Fagus sylvatica.
- Thinning, if necessary, targets Betula sp., however, they will most likely die back from being shaded out.
- The tree canopy surrounding the slopes should have an open crown layer. However, there should always be trees present on and above the slopes. Targeted trees for rejuvenation need to be fenced off to prevent wear and tear.
- Dead wood is placed in piles in the surrounding stands.

YEAR	MANAGEMENT ACTIONS
1	○ Remove the hay bales and install picnic area within the glade.
5	○ Negative spacing, if necessary, should be implemented to promote Quercus robur, Fagus sylvatica, and Pinus sylvestris.
15	○ Inventory of potential risk-trees on and near the slopes with selective thinning and selection of trees for future tree layer, if necessary, selected trees should be fenced off.

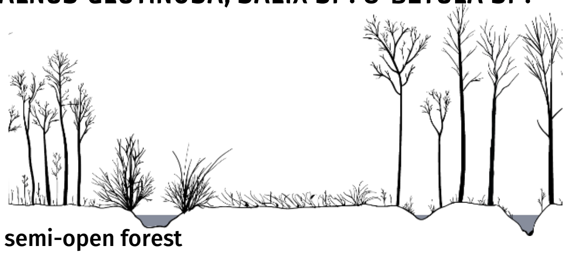
Figure 31. A timelapse of the stand shows the top illustration depicting the current appearance of Betula dominance to the left (north), a glade in the middle, and Quercus robur to the right (south). After 15 years, in the middle image, the saplings have developed in the middle layer, and a few mature trees have been thinned to promote the growth of Quercus robur and Fagus sylvatica. In the lower image, the tree canopies now form the top layer of the forest, and Fagus sylvatica dominates the species structure.

Figure 33. Stand in present state.

IV. ALNUS GLUTINOSA, SALIX SP. & BETULA SP.

IV. ALNUS GLUTINOSA, SALIX SP. & BETULA SP.

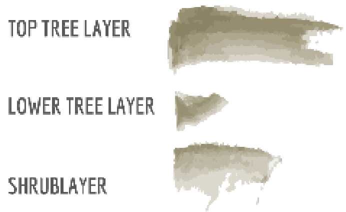
PRESENT STAND

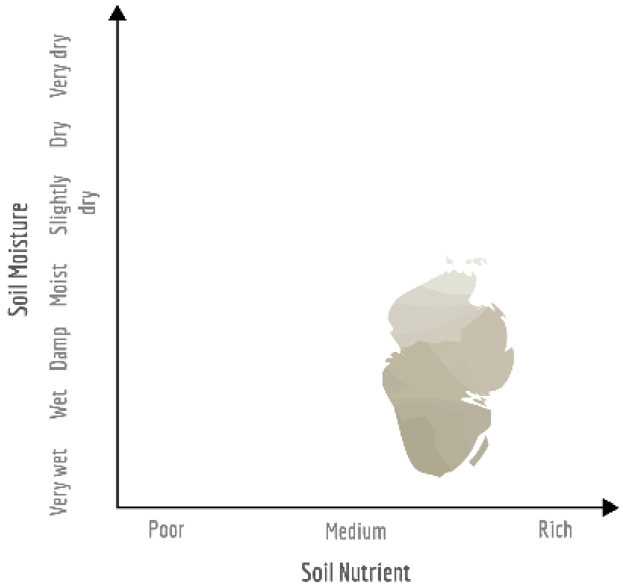


The semi-open forest

DESIRED STAND

Three-layered stand, Pillar Hall, Semi-open forest, and thicket





DESCRIPTION

Semi-open forest with groupings of Alnus glutinosa and Betula sp., as well as more open and wetter areas with Salix sp. where they grow along watercourses through the stand. In the more open areas, Rubus ideaus and tufts of grass grow, as well as Populus tremula, Fagus sylvatica, and occasional Quercus robur and Prunus avium. The northern and western part of the stand consists of denser younger Alnus glutinosa trees. There is reason to believe that the area was previously a wet meadow or marsh, as it is surrounded by stone walls, has very few stones in the terrain, and is marked as cultivated land on Häradskartan. In the edge zone towards the open area in a south-facing direction, there are Alnus glutinosa, Salix sp., Sambucus nigra, and Corylus avellana.

LONG-TERM GOAL

This stand exhibits a diverse range of vegetation structures. In the eastern part, the presence of clustered Alnus glutinosa and Betula sp. creates a closed canopy, while in the western part, groupings of Salix species and coppiced Alnus glutinosa give the impression of a thicket. At certain intervals, the stand will visually appear as a three-layered structure. Regular removal of vegetation at specific intervals will ensure the continuity of Salix species and Rubus ideaus is controlled through continuous rejuvenation.

FOREST OF HIGH HERB TYPE

Tree layer

D	**Alnus glutinosa (sly and juvenile)**		**50%**
D	**Betula sp.. (sly)**		**20%**
	Fagus sylvatica		**<10%**
F	**Prunus avium**		**<10%**
D	**Salix spp.**	**10%**	
F	**Quercus robur**		**<10%**

Shrublayer including saplings

D **Alnus glutinosa**
Corylus avellana
Fagus sylvatica
Fraxinus excelsior
Populus tremula
Prunus avium
Prunus padus
Rosa sp.
D **Rubus ideaus**
D **Salix sp.**
Quercus robur

Fieldlayer: Grass and dwarfshrub dominated

DFDT 91 COPPICED FOREST

Alder coppice (wetland forest): Alnus glutinosa, Fraxinus excelsior, Betula sp., Salix sp., Prunus padus, other.

The coppiced forest is divided into two types: low forest, where all trees are regularly cut back, and intermediate forest, where selected trees are left as the top layer. Coppicing is an old management practice to produce small-sized timber for various uses. It involves periodically clear-cutting a portion of the forest over several years. Ideally, a coppiced forest consists of equally-sized sub-areas with trees of the same age, primarily light-demanding species that regenerate from shoots. To maintain a balanced distribution of different age classes, coppicing is done in plots ranging from 0.25 to 1 hectare. The rotation period varies depending on the purpose and tree species. For instance, in Alnus glutinosa swamps in eastern Denmark, the rotation period is around 20 to 40 years, while Salix plantations and energy forests are coppiced at shorter intervals (Larsen 2005).

BFDT 911 ALNUS GLUTINOSA

Alnus glutinosa 80 – 100% minor species B: < 20%

Single layered stand of Alnus glutinosa, along with minor species Category B, such as Betula sp., Fraxinus excelsior, Quercus petraea, occasionally Acer pseudoplatanus, Populus tremula, Salix spp., Sorbus aucuparia, Picea sitchensis, and Picea abies, forming a mixture ranging from individual trees to large groups. These stands are typically managed with clear-cutting and restocking approach. However, it is advisable to explore opportunities for alternative management techniques such as CCF/LIMA, and to prioritize natural regeneration wherever feasible. Coppice management can also be considered for sites with challenging accessibility.

SPECIES DISTRIBUTION IN 40 YEARS

Top tree layer
60% Alnus glutinosa
20% Betula sp.
<10% Prunus avium, Quercus robur, Fagus sylvatica, Populus tremula

Middle and shrub layer
Salix spp., Corylus avellana, Prunus padus, Rubus ideaus, Euonymus sp., Sambucus nigra, Viburnum opulus

CHALLENGES AND PROSPECTS

This stand could benefit from restoration as a wet meadow, but since this paper focuses on forest structures, it will be developed as a forest system.

Selective coppicing in urban forestry offers aesthetic appeal, shelter provision, and support for biodiversity. The small scale of coppice areas creates a resilient environment suitable for children's play. Birds taking shelter in these areas enhance the recreational value of surrounding stands due to their delightful songs. Coppicing will be performed on Salix sp. and groups of Alnus glutinosa. (Nielsen & Møller 2008).

Salix sp., offer diverse habitats for various organisms and are commonly found along watercourses and wetland areas. They play a vital role in stabilizing riverbanks, preventing erosion, and absorbing and retaining nutrients from the soil. This nutrient cycling helps reduce runoff into water bodies, ultimately promoting healthier ecosystems (Enescu et al. 2016).

Rubus ideaus, or raspberry bushes, are often undervalued due to their thorny characteristics and the challenges they pose in terms of management. However, local residents appreciate these bushes for their opportunity to pick berries. Extensive management practices would be required to eliminate them; therefore they are not actively promoted, but managed alongside the coppiced system.

OVERALL PRINCIPAL MANAGEMENT

- The growth response of Alnus glutinosa to thinning is strong at a young age but diminishes quickly later, so silvicultural interventions should ensure fully developed crowns of FC trees by around 40 years of age.
- Alnus glutinosa has a high light demand, and regeneration under canopy is not recommended. Thinning should be carried out in groups through crown thinning, focusing on areas predominantly occupied by Alnus glutinosa.
- If production is a priority, selected trees should have fully developed crowns by the age of 40 years. To prevent heart rot in older Alnus glutinosa, rotation should be kept below 80 years, and the target DBH during thinning for production should be 35-50 cm.
- Rubus ideaus is somewhat isolated here, but to prevent further spreading, it will be managed alongside the Salix coppice, where all Rubus ideaus is cut down every 10th year, if other species (such as Salix and Alnus establish themselves here, they are promoted.
- The surrounding trees of Alnus glutinosa should be managed as a coppiced intermediate forest with sparse Alnus glutinosa trees towards the adjacent stand in the west, ensuring a half-open tree canopy surrounding Salix for their survival.
- Rejuvenation of Salix thicket, along with Rubus ideaus, should have a rotation period of 20 years, cutting down ½ every 10 years.
- Coppicing of Alnus glutinosa with a rotation cycle of 40 years where ½ of the groups should be done cut down every 20 years.
- Dead wood should be placed in piles or sections within the stand, at least 10 meters away from the main paths.
- Due to the potential flooding of the stand with the new development area nearby, the stand should be re-evaluated in the future. The species in the stand can withstand wetter conditions, but it may be beneficial to deepen the water streams to accommodate more water. However, this will impact the management of the stand. If the area is very wet, less management is appropriate, and parts of the tall tree forest should be left for free development, with only paths being cleared.

YEAR	*MANAGEMENT ACTIONS*
1	○ Rejuvenation of ½ Salix sp, along with Rubus ideaus and Alnus glutinosa.
10	○ Rejuvenation of 1/2 Salix sp. and Rubus ideaus
20	○ Thinning of Betula in the pillar hall to promote Alnus glutinosa ○ Rejuvenation of 1/2 Salix sp. and Rubus ideaus and Alnus glutinosa.
30	○ Rejuvenation of 1/2 Salix sp. and Rubus ideaus.
40	○ Rejuvenation of 1/2 Salix sp. and Rubus ideaus and Alnus glutinosa.

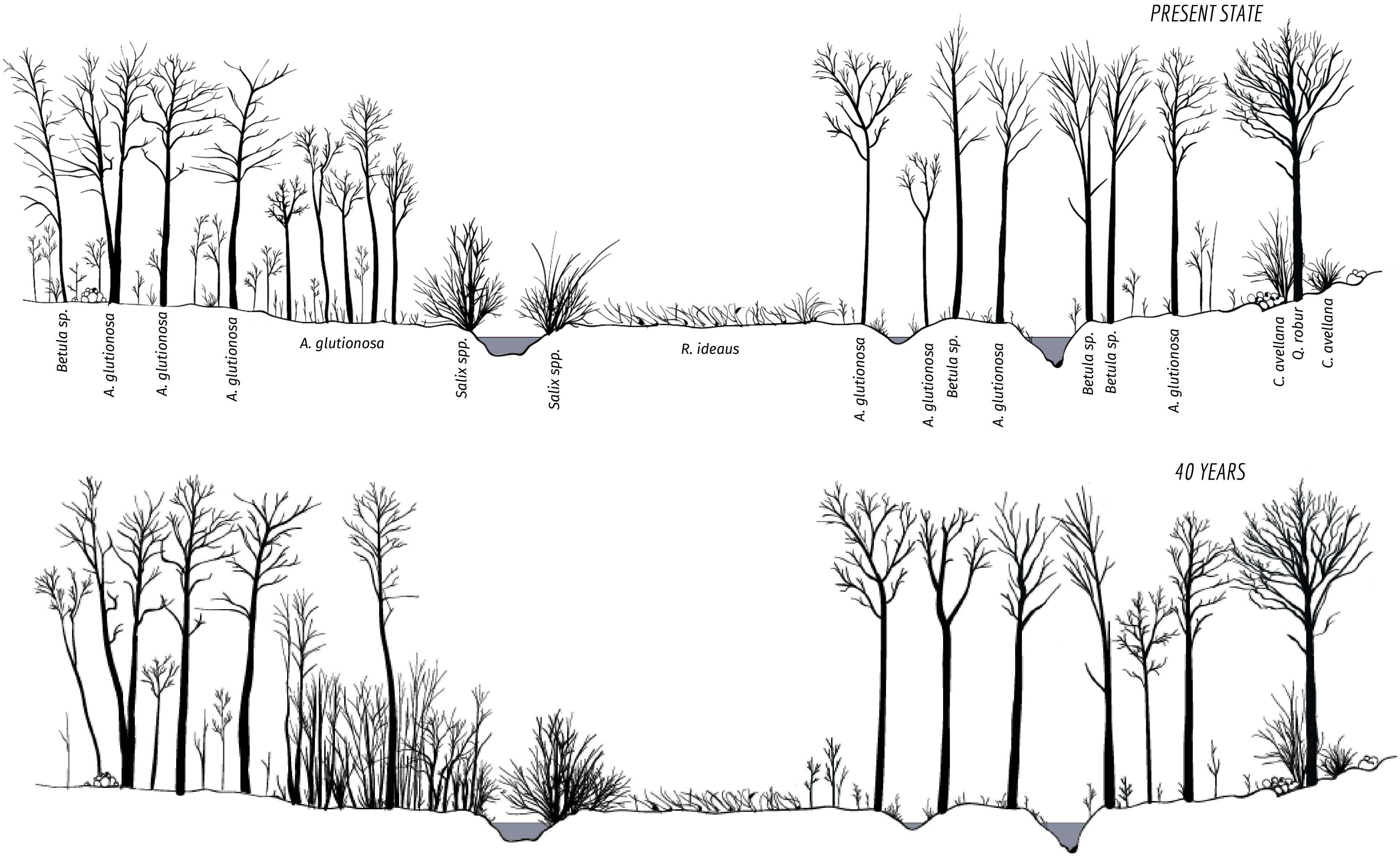


Figure 34. The first illustration showcases the current state of the stand, with young Alnus glutinosa trees near the Salix stream and an open area occupied by Rubus ideaus. Towards the west, there is a pillar hall structure consisting of Alnus glutinosa and Betula sp. The second illustration represents the stand after 50 years, where Betula sp. have either thinned out or died, and Alnus glutinosa has taken their place. The thickets of Alnus glutinosa and Salix sp. are depicted just before the thinning procedures in year 40. The area of Rubus ideaus has slightly decreased in size.

Figure 35. Inspirational image

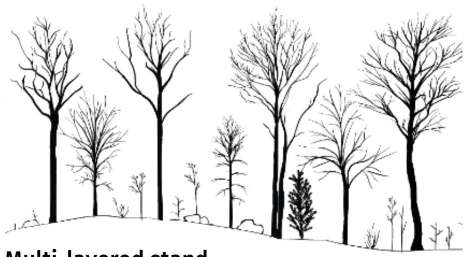
V. QUERCUS ROBUR, FAGUS SYLVATICA & CORYLUS AVELLANA

V. QUERCUS ROBUR, FAGUS SYLVATICA & CORYLUS AVELLANA

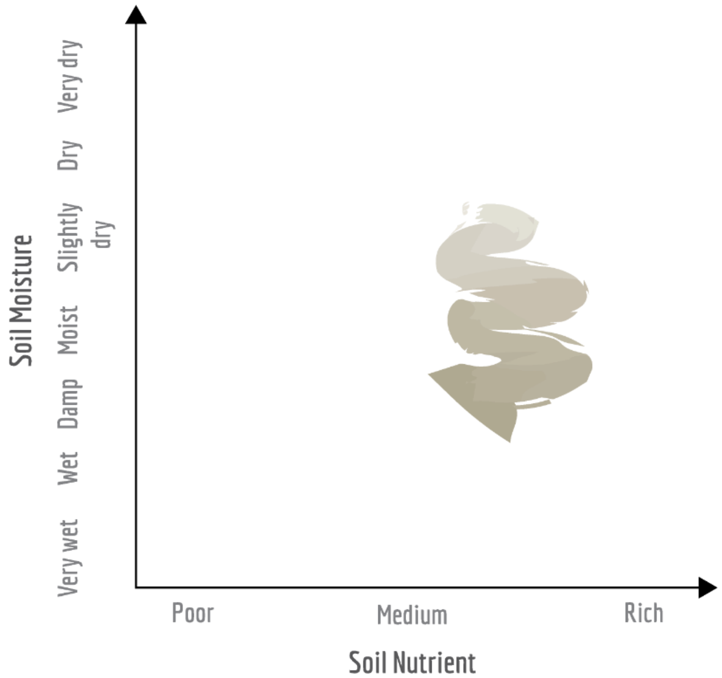
PRESENT STAND

Pillar hall
With saplings

DESIRED STAND



Multi-layered stand
With a noticeably grouped understory



DESCRIPTION

Despite its block-like size, this area is divided into a stand for separate management strategies. It contains a pillar hall and a corridor that leads into the forest. The tree layer of the pillar hall is predominantly populated by F. sylvatica and Q. robur, with Q. robur exhibiting a slight dominance. Towards the southern and western edges, there are scattered P. sylvestris and B. pendula trees. In the field layer, F. sylvatica dominate particularly in areas where previous thinning has taken place, along with C. avellana and two individuals of J. communis. Currently, the tree crowns are positioned just below the height of Q. robur, but some of them are in proximity and at risk of damaging Q. robur. The corridor showcases various species, including A. glutinosa, Q. robur, C. avellana, P. sylvestris, F. sylvatica, and B. pendula. At the end of the corridor, older coppiced C. avellana shrubs are present and in need of rejuvenation.

LONG-TERM GOAL

A Q. robur dominated stand with supporting T. cordata in the lower tree layer and a rich understory of C. avellana. Acceptance of scattered trees like F. sylvatica, P. sylvestris, P. tremula, S. aucuparia, and Betula sp.,, preferably in the lower tree layer. It's important to thin trees when their crowns interfere with Q. robur. To enhance the chance of T. cordata regeneration, group planting should be done during the initial thinning phase, gradually replacing F. sylvatica. This three-layered stand provides a play-friendly environment for children, while the understory acts as a screen, giving the larger forest area a more secluded feel, especially towards the industry building and fence in the backdrop.

BEECH FOREST OF LOW HERB TYPE

Tree layer

	Betula sp. 10%
D	**Fagus sylvatica 30%**
	Pinus sylvestris
D	**Quercus robur 40%**

Shrub layer with saplings

D	**Corylus avellana**
	Fagus sylvatica
	Juniperus communis

Field layer: Grass dominated

DFDT 22 QUERCUS ROBUR, TILIA CORDATA AND FAGUS SYLVATICA

Quercus sp. 60-80%, Tilia cordata & Fagus sylvatica >30%, Betula sp., Carpinus betulus, Populus tremula, Sorbus aucuparia >10% (Larsen 2005:200).

BFDT 5.3.2 QUERCUS ROBUR AND LONG-LIVED BROADLEAVES

Quercus robur 50 – 70%, broadleaves 30 – 50%, minor species: < 30% (Haufe et al. 2021b).

Multi-layered stand dominatated by Q. robur with A. pseudoplatanus, T. cordata, P. sylvestris, P. tremula and others in single tree to small group mixture. F. sylvatica, C. betulus and C. avellana, are present in the middle-layer and understory. Light-demanding minor species of category C, including Betula sp., P. avium, Crataegus sp., S. nigra and others, occupy gaps and edges (Larsen 2005; Haufe et al. 2021b). The forest development type aligns with the vegetation dynamics observed during the transition from Quercus sp. scrub to tall forest. Over time, there is a possibility of F. sylvatica dominance, which can be mitigated by selective harvesting of F. sylvatica trees from the upper canopy and actively conducting logging in groups or smaller areas to promote Q. robur regeneration. Additionally, the potential problem of coniferous species (such as P. abies) encroaching on the open canopy is addressed by removing them to prevent competition (Larsen 2005). To optimize natural regeneration, management should employ LIMA / CCF (Haufe et al. 2021b).

GOAL TARGET OF SPECIES DISTRIBUTION

Tree layer
45% Quercus robur
30% Tilia cordata
15% Fagus sylvatica
<10% Carpinus betulus, Pinus sylvestris, Populus tremula, Prunus avium, , Sorbus aucuparia, Juniperus communis, Alnus glutinosa
Shrub and fieldlayer
Corylus avellana, Crataegus sp., Ribes alpinum

CHALLENGES AND PROSPECTS

There are approx. 20,000 hectares of oak and mixed oak forests in Scania. Several plant and animal species depend on old coarse Quercus robur individuals, and their preservation requires active management. The Quercus robur forests within Scania display a variety of structure, from pastures to heathlands and herb-rich forests which all have high biological values. (Länsstyrelsen Skåne 2019)

According to Löf et al. (2009) natural regeneration of Q. robur poses a global challenge due to fluctuating acorn production and animal consumption of both acorns and saplings. Furthermore, F. sylvatica often outcompetes Q. robur due to its tolerance to low light conditions. To support the natural regeneration of Q. robur, it is crucial to implement soil mulching for acorns and encourage the presence of understory vegetation. While F. sylvatica is commonly used as a companion species, T. cordata is a more suitable choice as it has a lower growth height, minimizing competition with Q. robur in the tree crowns. With T. cordata being scarce in the neighboring forest areas, its establishment within the forest stand will serve as a valuable seed source for the wider forest. However, the intense grazing pressure in Garnisonen may hinder the natural rejuvenation of T. cordata and Q. robur. Without intervention, there is a significant risk of the stand transforming into a monoculture dominated by F. sylvatica.

OVERALL PRINCIPAL MANAGEMENT

- To prevent a monoculture of Fagus sylvatica and promote the rejuvenation of Quercus robur, thinning of Fagus sylvatica should be cut from above and thinning should be done in groups in smaller areas (Dansk skovforening & Larsen 2005).
- Soil preparation for planting of Tilia cordata, and fencing of sapling trees.
- Fagus sylvatica should preferably only be present in the understory since Tilia cordata should be promoted in the lower tree layer.
- Conifer trees should be removed if they threaten other light-demanding species (Dansk skovforening & Larsen 2005).
- Understory species are promoted as they help natural self-pruning of Quercus robur (Löf et al. 2009).
- If individuals of Tilia cordata self-rejuvenate, they should be promoted.
- The phasing out of Fagus sylvatica in the present tree canopy should be thinned twice over a ten-year period. Since it lowers the risk of water sprouts in crown and stem on Quercus robur (Almgren et al. 1986).
- Rejuvenation of old Corylus avellana should be executed at the same time as the phasing out of Fagus sylvatica, thereafter the rotation cycle should aim to be 45 years where 1/3 if the total stand is coppiced every 15th year.
- Quercus robur is very sensitive to crowding and shade from the sides, branches should therefore have at least 2 meter of free space to nearby tree crowns (Almgren et al. 1986).
- If wood production of Quercus robur is wanted, or grazing pressure is too high, saplings should be fenced to prevent grazing. However, Quercus robur saplings can withstand some grazing, but it will lead to them growing in weird shapes (Almgren et al. 1986). If natural regeneration is not possible, trees are planted or seeded in fenced groups during October.
- If wood production is the aim for Quercus robur, sparsely keep and promote a few mature individuals within the stand since old Quercus robur trees are great for biodiversity.
- The chosen saplings of Quercus robur for wood production should be stempruned and cleared from water sprouts when they reach about 6-8 meters of height and <20 cm in DBH to about half of the tree's height. Stempruning should continue until the tree reaches 16 meters in height. When trees reach about 40-50 years of age, thinning should be done every fifth year to ensure that the crowns have sufficient space. At age 80 ??they can be harvested. (Löf et al. 2009).
- The tree canopy should be semi-open to promote light for lower tree layer and understory, and at the same time give the upper tree level enough space to spread their crowns.
- Keep some dead wood in piles for building materials for children to play with.

YEAR	MANAGEMENT ACTION
1	o Take down 40% of Fagus sylvatica. o Ground preparation, planting and fencing of Tilia cordata in groups. o Rejuvenation by coppice of 1/3 Corylus avellana. o Thinning of trees surrounding Corylus avellana corridor to achieve a semi-open canopy to promote Corylus avellana.
6	o Take down remaining Fagus sylvatica in tree layer. o Negative selecting of Tilia cordata.
15	o Rejuvenation by coppice of 1/3 Corylus avellana o Continue with negative respacing if necessary.
15-50	o Suppress Fagus sylvatica. o Proceed with thinning to achieve a semi-open canopy to promote Corylus avellana and Tilia cordata. o Coppice of Corylus avellana with a rotation cycle of 45 years, where 1/3 of the total stand is coppiced every 15th year. o Promote saplings of Quercus robur in the new openings
~50	o Thinning of Quercus robur

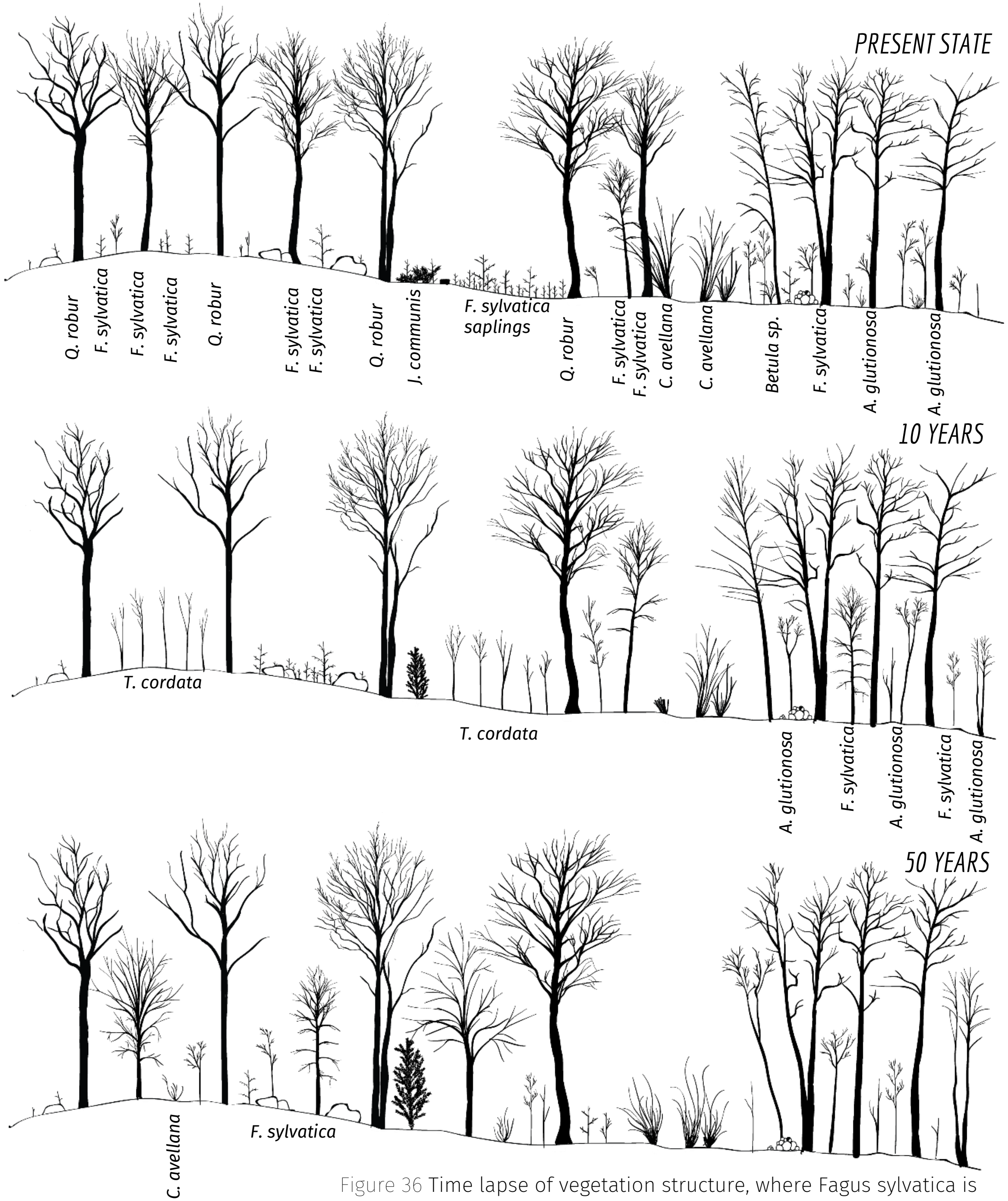
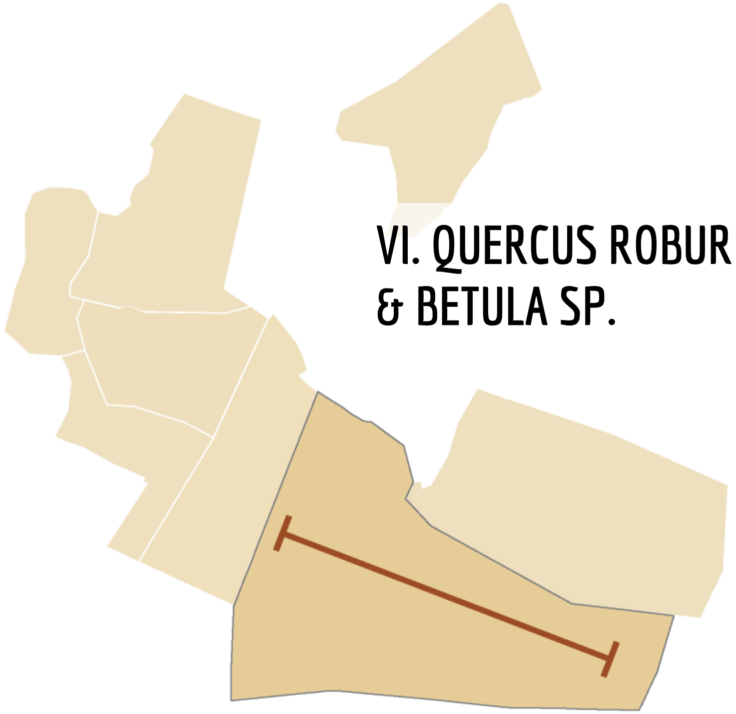


Figure 36 Time lapse of vegetation structure, where Fagus sylvatica is replaced with Tilia cordata in the lower tree layer, Corylus avellana is coppiced and the canopy is less dense surrounding it.

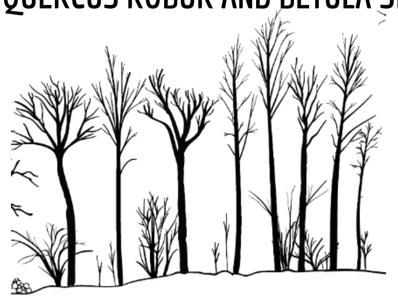
Figure 34. Smaller patch of the stand which has been cleared recently, with a more representative image of the ground vegetation throughout the stand.

VI. QUERCUS ROBUR & BETULA SP.



VI. QUERCUS ROBUR AND BETULA SP.

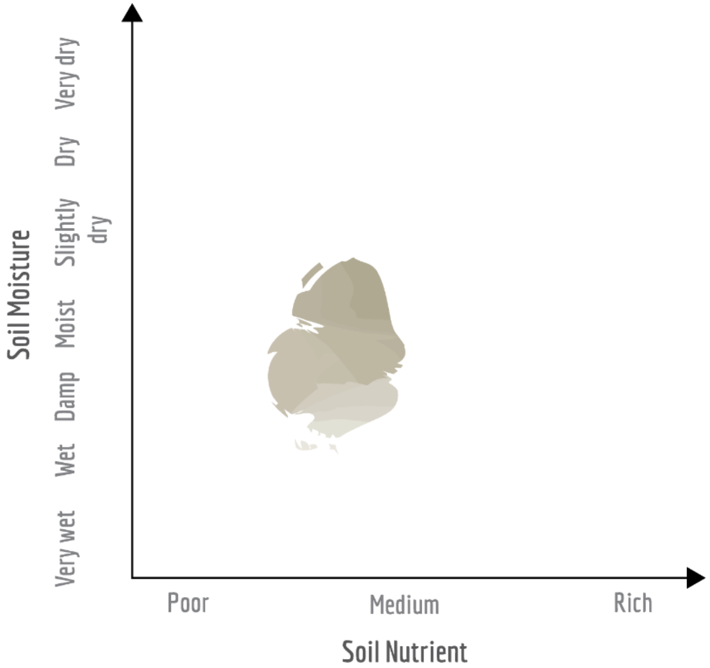
PRESENT STAND



Two-layered stand
With well-developed shrub layer

DESIRED STAND

Two layered stand
With well-developed middle layer



DESCRIPTION

In the western part of the stand, there is a denser structure with Quercus robur and Corylus avellana. As the topography changes to higher elevation, a shift can also be seen with less understory and a more evenly spaced species intervention between Quercus robur and Betula sp., with sparse Corylus avellana. In the middle of the stand, mainly Betula sp. and Corylus avellana are present. Up to this point, the ground vegetation is mainly grass and fern dominated. However, in the east, it shifts to more herb-dominated species and a more homogeneous distribution of Quercus robur, Betula sp., and Corylus avellana.

LONG-TERM GOAL

A two-layered stand with well-developed middle layer dominated by shrub species. The vegetation structure gives a visually open and accessible environment, while also being very stable.

The tree layer is dominated by Quercus robur with groups or individuals of Betula sp., and an understory of Corulus avellana. The goal of the stand is to create a diverse woodland of natural appearance including standing and lying dead wood.

QUERCUS ROBUR FOREST OF HEATHLAND TYPE

<u>Tree layer</u>
30% Betula sp.
70% Quercus robur

<u>Shrub layer with saplings</u>
D Corylus avellana
Fagus sylvatica
F Ribes alpinum
Sambucus nigra

<u>Fieldlayer</u>: Grass and fern dominated

<u>South edge</u>
Alnus glutinosa
D Prunus padus
Rubus ideaus
Sambucus nigra
F Sorbus aucuparia

BFDT: 521 QUERCUS PETRAEA AND BETULA SP.

Quercus petraea 50 – 80% Betula sp. 20 – 50% minor species: 10 – 30%.

Single to multiple-layered stand with Quercus petraea dominance and Betula sp. occurring as individual trees or in small areas. Category C minor species, such as Fagus sylvatica, Pinus sylvestris, Sorbus aucuparia, Populus tremula, Alnus glutinosa, and others, are incorporated based on local site conditions. As a pioneer species, Betula sp. will outgrow Quercus petraea in its early stages but will lose its competitive advantage as the stand matures. Thinning interventions should be adapted accordingly.

SPECIES DISTRIBUTION IN X YEARS

Tree layer
80% Quercus robur
50% Betula sp.
<30% Pinus sylvestris, Sorbus aucuparia, Populus tremula, Alnus glutinosa, Prunus avium

Shrublayer: Corylus avellana, Prunus padus, Sambucus nigra, Rubus ideaus, Ribes alpinum

CHALLENGES AND PROSPECTS

A combination of light-demanding species can create a diverse habitat. Quercus robur plays a crucial role when it comes to deadwood and aging. Betula species serve as excellent crown screens for other trees and contribute to the self-pruning of Quercus robur. However, their light shade may pose a risk of stem damage. In comparison to the stand with Quercus robur and Fagus sylvatica, thinning out Betula species carries a smaller risk of water sprouts and stress on Quercus robur (Andersson & Andersson 2005).

Figure 38. Present state of a smaller patch in the eastern part of the stand where the ground vegetation is dominated by herbs instead of heathland.

OVERALL PRINCIPAL MANAGEMENT

- Thinning is carried out to promote Quercus robur.
- Upkeep a closed canopy for self-pruning of Quercus robur.
- Quercus robur is very sensitive to crowding and shade from the sides, so branches should have at least 2 meters of free space to nearby tree crowns (Almgren et al. 1986).
- Conifer trees should be removed if they pose a threat to other light-demanding species (Dansk skovforening & Larsen 2005).
- Understory species are promoted as they aid in the natural self-pruning of Quercus robur (Löf et al. 2009).
- Young saplings of Quercus robur are somewhat shade tolerant but require a more open canopy to develop properly. During thinning in a Quercus robur stand, they will respond with water sprouts in crown and stem, which will need to be pruned every 2-3 years (Löf et al. 2009).
- If wood production of Quercus robur is desired or grazing pressure is high, saplings should be fenced to prevent grazing. While they can tolerate some grazing, it may lead to irregular growth shapes, a desirable goal for recreational forests (Almgren et al. 1986).
- Selected saplings of Quercus robur intended for wood production should undergo stem pruning and clearance of water sprouts when they reach approximately 6-8 meters in height and <20 cm in DBH, up to half of the tree's height. Stem pruning should continue until the tree reaches 16 meters in height. Thinning should be carried out every five years when the trees reach about 40-50 years of age to ensure adequate crown space. Harvesting can be done at the age of 80 (Löf et al. 2009).
- If wood production of Betula species is also a goal, crown thinning should be performed when individuals reach a height of 10-14 meters (Almgren et al. 1986).
- The present shift in species from west to east should aim to be less noticeable in both the tree and shrub layers in the future.
- Rejuvenation of old Corylus avellana with a rotation cycle of 45 years where 1/3 if the total stand is coppiced every 15th year.

YEAR	*MANAGEMENT ACTIONS*
1	o Negative spacing and the removal of undesirable trees are carried out to promote Quercus robur. The focus is on removing trees, specifically targeting Betula sp. (although some Quercus robur individuals needs to be taken down in promotion of selected trees), that interfere with the tree crowns of the selected Quercus robur trees chosen for positive selection. Approximately 15% of the total stand is designated for thinning. It is recommended to retain 2/3 of the thinned Quercus robur trees as high stubs. o Rejuvenation by coppice of 1/3 Corylus avellana.
4	o Pruning of water sprouts on Quercus robur.
7	o Continue with negative spacing and the removal of undesirable trees if needed in promotion of Quercus robur. o Pruning of water sprouts on Quercus robur o Fencing of Quercus robur saplings for positive selection
>15	o Thinning, pruning, raising crowns and rejuvenation of Corylus avellana in accordance to the overall principal management.

Figure 39. The top illustration represents the current state of the stand, showcasing a denser structure of Quercus robur and Corylus avellana towards the eastern side (left). As the elevation increases, Betula sp. becomes dominant, and as the topography lowers again towards the east, there is a more evenly spaced Quercus robur forest with a shrub layer of Corylus avellana. The lower illustration portrays the stand 45 years after thinning has been carried out to promote Quercus robur. New individuals have emerged into the canopy, particularly towards the trail, where there used to be Betula sp. dominance.

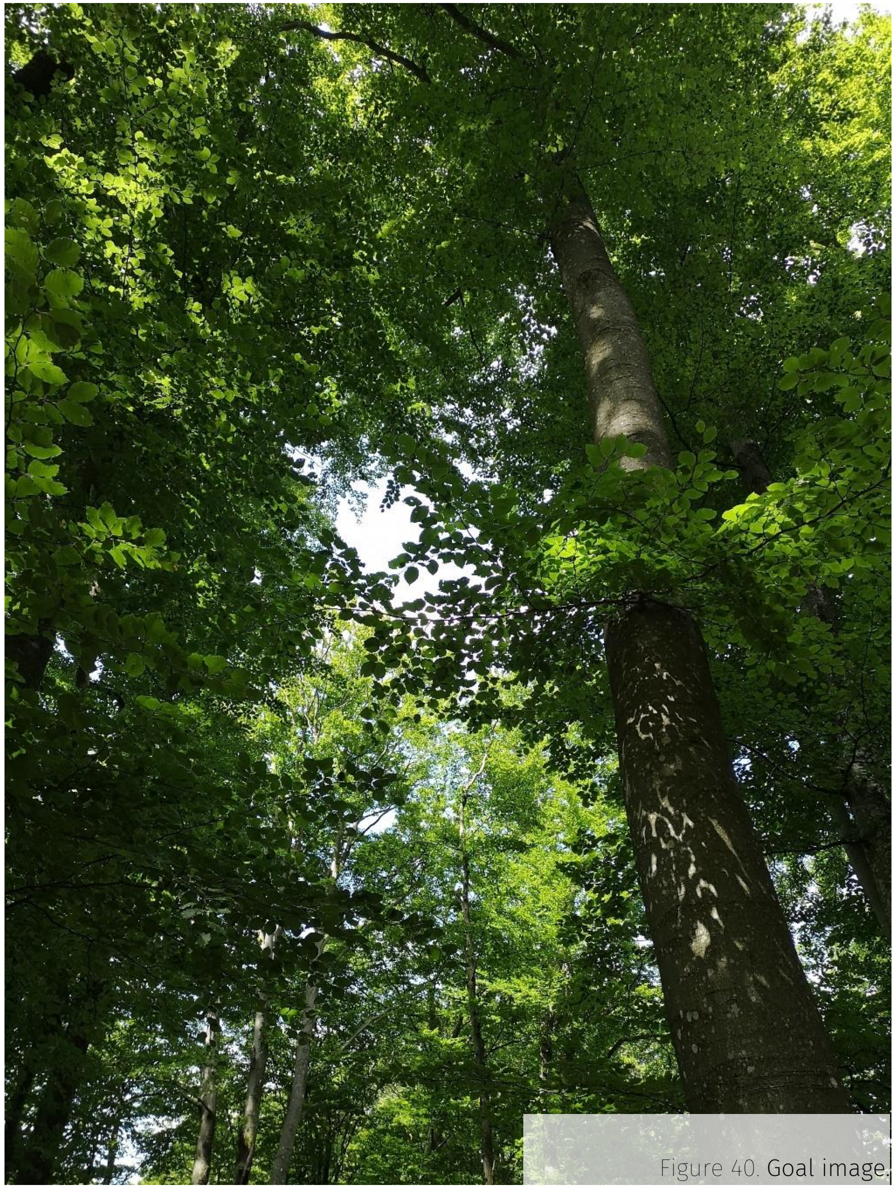
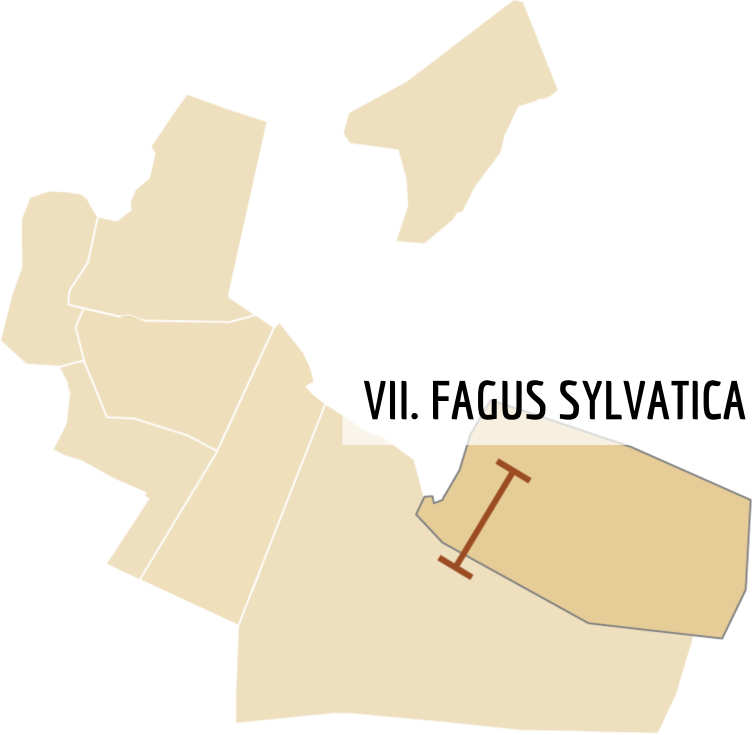


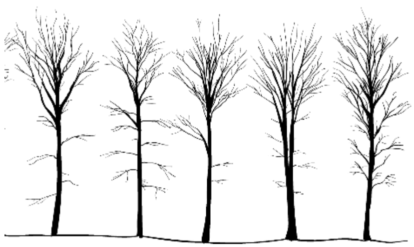
Figure 40. Goal image.



VII. FAGUS SYLVATICA

VII. FAGUS SYLVATICA

PRESENT STAND



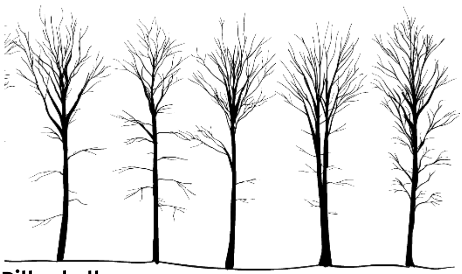
Pillar hall
Of monoculture

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER

DESIRED STAND

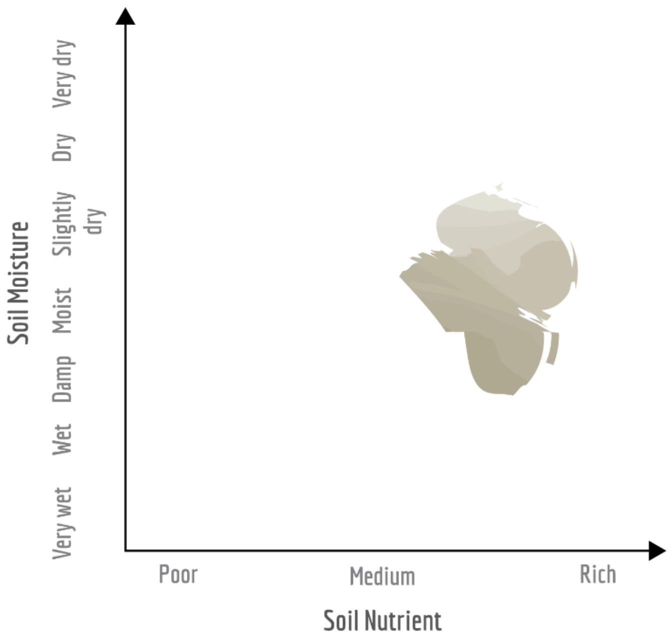


Pillar hall
With groups or individuals of other species

TOP TREE LAYER

LOWER TREE LAYER

SHRUBLAYER



DESCRIPTION

The majority of the stand consists of a monoculture of Fagus sylvatica, where a noticeable transition is visually visible along the trails Posta Nilla and Skåneleden. Within the edge zone of the stand, there are occasional Pinus sylvestris trees, while the transition towards Quercus robur, Betula sp., and Corylus avellana is composed of mentioned species.

LONG-TERM GOAL

The long-term goal of this stand is to maintain a pillar hall and a monoculture throughout most parts of the forest, with isolated groups or individuals of other species where climatic conditions, along with management promotion, will allow their growth. Periodic interventions such as group rejuvenation create openings and gaps within the forest, allowing for the establishment and growth of different tree species and understory vegetation. This helps to maintain a dynamic forest structure and facilitates the regeneration of new species. The mix of species and varying age classes contributes to a healthier forest ecosystem with improved habitat quality for a wide range of organisms.

BEECH FOREST OF HEATHLAND TYPE

<u>Tree layer</u>
Fagus sylvatica
(F) Pinus sylvestris

<u>Fieldlayer</u>: of grass and herb types
Anemone nemorosa
Deschampsia flexuosa
Majanthemum bifolium
Oxalis acetosella

DFDT: 11 FAGUS SYLVATICA

Fagus sylvatica: 70-80 %, Quercus sp., Fraxinus excelsior, Acer pseudoplatanus & Prunus avium: 20-30%, Conifer trees: >10% (Larsen 2005).

The beech forest consists of clustered formations with a mixture of Quercus robur, Fraxinus excelsior, Acer pseudoplatanus, and Prunus avium and are found in groups but can also occur individually. In the understory, various species such as Ilex aquifolium, Viburnum opulus, and Prunus panus are present. There may be sporadic occurrences of conifers (Picea abies and Larix decidua), but they should not exceed 10% of the forest composition.

Fagus sylvatica trees tend to form relatively homogeneous stands under natural conditions. In beech-dominated forests, management practices involve gradually removing dominant trees while maintaining a distinct horizontal structure. Other tree species may appear as isolated individuals or in small groups. In the most uniform areas, the forest development type can resemble traditional Fagus sylvatica cultivation methods, such as group-wise or even-aged regeneration. Coniferous trees have a maximum crown cover of 10%.

BFDT: 611 FAGUS SYLVATICA

Fagus sylvatica 90 – 100%, minor species: < 10% (Haufe et al. 2021b).

Single-layered Fagus sylvatica stand with category A minor species such as Quercus robur, Acer pseudoplatanus, Fraxinus excelsior, Prunus avium, Betula sp. and others depending on the site condition. Shade tolerant minor species may occupy the middle and understory. Stands may be managed under clearfell-and-restock regime or simple CCF / LIMA options such as large scale shelterwood methods to utilize natural regeneration of Fagus sylvatica. Minor species regenerate naturally within the stand.

CHALLENGES AND PROSPECTS

Approximately 50% of Scania's land area is covered by Fagus sylvatica forests, accounting for 70% of Sweden's Fagus sylvatica forest regions (Länsstyrelsen Skåne 2019). These Fagus sylvatica forests are Scania's most significant areas of responsibility and play a vital role in the region's landscape and ecological richness. Many of the natural environments in southern Sweden consist of Fagus sylvatica stands, creating habitats for various species of mosses, lichens, and insects. Fagus sylvatica also serves as a nesting tree for birds and is an important food source for many birds and animals. The field layer often consists of patches of Anemone nemorosa. The mature form of a Fagus sylvatica stand offers a visually appealing experience when moving through or observing the forest from the pillar hall. Due to the lack of an understory, one can see into the depths of the forest, its topography, and the flora (Larsen 2005). Although it is mentioned in the structure paragraph that Taxus baccata could be planted to increase diversity, it is not recommended for the inland areas of Scania as it is not typical there.

SPECIES DISTRIBUTION IN 50 YEARS

Tree layer
80% Fagus sylvatica
20% Quercus robur, Pinus sylvestris, Acer pseudoplatanus, Prunus avium
< 10% Picea abies

Fieldlayer of grass and herb types
Anemone nemorosa, Deschampsia flexuosa, Majanthemum bifolium, Oxalis acetosella

OVERALL PRINCIPAL MANAGEMENT

- Encourage varied age structure of Fagus sylvatica in the stand to counter the uniform age composition. Use caution when thinning in areas where a homogeneous pillar hall is desired. Apply thinning to individual trees throughout the stand to promote growth of new Fagus sylvatica saplings (Haufe et al. 2021b).
- More rigorous and selective thinning implemented to create clearings or glades where other potential species can establish themselves, promoting a more diverse stand structure (Haufe et al. 2021b). Additionally, promote diversity in the forest edges and transition zone towards the path in the southern direction, which leads to the stand of Quercus robur and Betula sp..
- Fagus sylvatica demonstrates a strong positive response to thinning at all stages of its lifespan. This implies that even late thinning interventions can significantly enhance its growth (Haufe et al. 2021b)..
- Thinning of Fagus sylvatica should be carried out with crown thinning (Haufe et al. 2021b).
- Dead wood should be kept in piles in the east part of the stand.
- Rejuvenation of Fagus sylvatica is best carried out during a favorable acorn year, which usually happens every 4-8 years. It is crucial to conduct site preparation during summer or early autumn in a way that exposes the mineral soil adequately. This is important to prevent the rapid growth of grass from the surrounding areas, which could potentially outcompete Fagus sylvatica (Almgren et al. 1986).

YEAR	MANAGEMENT ACTIONS
~1 (During a good acorn year)	o To promote rejuvenation and enhance age variation within the stand, selective thinning of Fagus sylvatica is conducted by removing approximately 10% of the tree-layer of Fagus sylvatica. o Soil preparation should be done during the summer, ideally before September.
10-15	o Maintain a closed canopy in areas where Fagus sylvatica is desired to encourage self-pruning. o Negative spacing by promoting potential species that aren’t Fagus sylvatica in the clearings established during year one, otherwise, negative spacing in promotion of Fagus sylvatica.
~40 (During a good acorn year)	o Clearings or glades should be created to facilitate the establishment of other potential species by removing approximately 15% of the stand. o Soil preparation should be done during the summer, preferably before September.
46-50	o Negative selective respacing is recommended.
50-54	o If needed, continue negative respacing. Otherwise, focus should shift to positive selection.

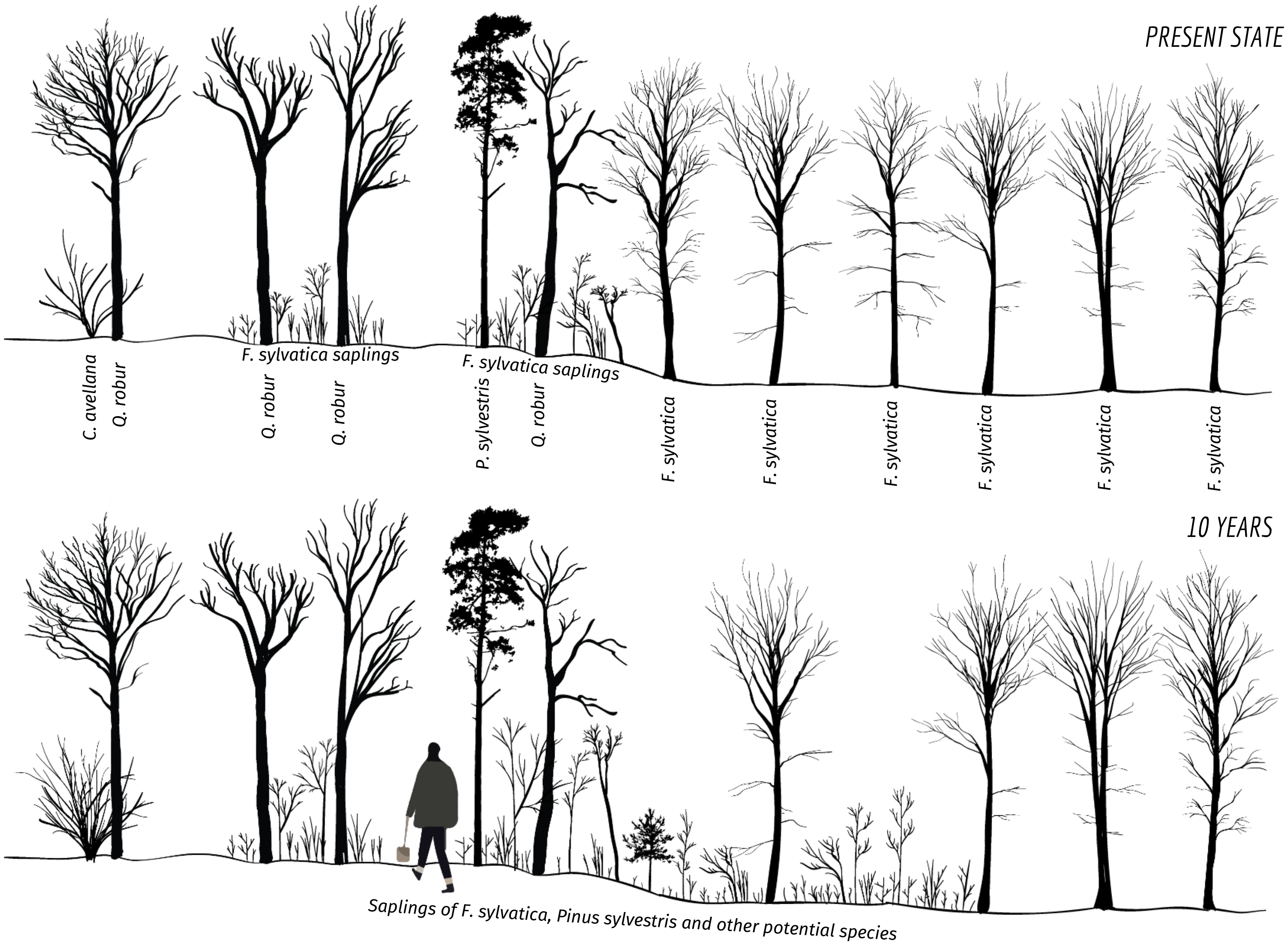
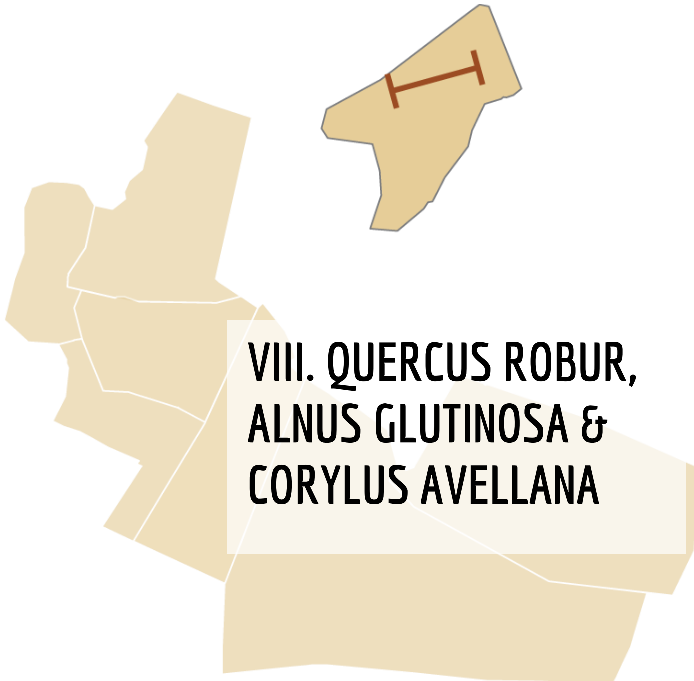


Figure 41. Top illustration of the current stand today and the edge zone towards adjacent stand with Quercus robur and Betula sp.. Bottom illustration where selective thinning have been carried out on Fagus sylvatica to create a richer diversity in species and age-structure. An illustration showing the stand further in to the future is not provided since it is unclear what speceis will develop in the glades and rejuvination of Fagus sylvatica, however the stand should more or less resemblance a monoculture of Fagus sylvatica through most parts of the stand.

Figure 42. Stand in present state.



VIII. QUERCUS ROBUR, ALNUS GLUTINOSA & CORYLUS AVELLANA

VIII. QUERCUS ROBUR, ALNUS GLUTINOSA & CORYLUS AVELLANA

DESCRIPTION

The main part of this stand is very dense with a rich variation of species in the field layer understory and tree layer. The stand is considered to be close to naturalistic and most parts of it has most likely been under free development. The dense tree crowns in the stand are neglecting Quercus robur and there is a lot of dead standing and lying wood. In some of the glades that have naturally occurred individuals of Salix species can be found, as well as an overall species richness in the shrub layer, however dominated by Corylus avellana, throughout the stand. In the south that is dominated by Quercus robur, from the edge and moving approximately 10 meters into the stand some thinning seems to have been carried out since there is no dead wood and a lot of Quercus robur saplings together with Rubus ideaus. Water is running here during parts of the year and there are free sightlines into the open fields outside the stand, it is a place that is hard to reach but when arriving it is a place of solitude.

DFDT: 94 UNTOUCHED FOREST

Untouched forests are characterized by being free from human involvement from a specific point in time. They contain a significant amount of deadwood, both standing and lying, and have a diverse structure of different ages and various types of vegetation and species. The species present in the forest depend on the species that were already there when humans stopped managing it, and the regeneration will reflect the habitat conditions suitable for species survival. The development of untouched forests can be random and unpredictable due to large-scale disturbances. It is challenging to predict exactly how the forest will look. However, it is likely to remain relatively similar to its current state, perhaps with the addition of more indigenous species and garden escapees (Larsen 2005).

CHALLENGES AND PROSPECTS

In areas where Quercus robur trees are densely packed together with Alnus glutinosa, many of the Quercus robur trees may die because their crowns are too crowded. This demonstrates the importance of maintaining appropriate spacing between tree crowns within maintained stands. When trees naturally die and fall, there is a possibility that Pinus sylvestris may regrow sporadically in some areas. However, in general, the trees within the stand will likely remain standing for a considerable period of time.

In the southern part of the forest, adjacent to the open field where thinning has recently occurred, there are many Quercus robur saplings. It is likely that this area will develop into a small Quercus robur forest. The understory throughout the entire forest mainly consists of Corylus avellana, Salix sp., and Sambucus nigra. The diverse habitats within this forest can potentially support a wide range of species. However, the predictions are further complicated by potential habitat disturbances caused by climate change.

BEECH FOREST OF HEATHLAND TYPE

<u>Tree layer</u>

D	**Alnus glutinosa**	**40%**
F	**Carpinus betulus**	**<5%**
	Fagus sylvatica	**<5%**
	Pinus sylvestris	**10%**
D	**Quercus robur**	**40%**

<u>Shrub layer with saplings</u>

Corylus avellana
Fagus sylvatica
Prunus padus
Rubus ideaus
Salix sp
Quercus robur

<u>Fieldlayer of herb and grass types</u>

Anemone nemorosa
Ranunculus ficaria

GOALS AND MANAGEMENT

Since this particular stand represents a natural environment within its surrounding area, it should be preserved for free development and considered a reference area for natural dynamics. The only suggested management action within this stand would be to create a pathway into the southern Quercus robur section, where there is running water and a view of the open fields. This pathway would allow for human access and enhance the overall experience within the larger forested area. However, this suggestion may seem contradictory as it increases the likelihood of human use, thus compromising its "untouched" status.

Nevertheless, as mentioned earlier in the "cues to care" paragraph, creating a pathway would make certain parts of the forest accessible to humans. Meanwhile, the denser and more untouched areas would remain harder to reach, limiting their accessibility.

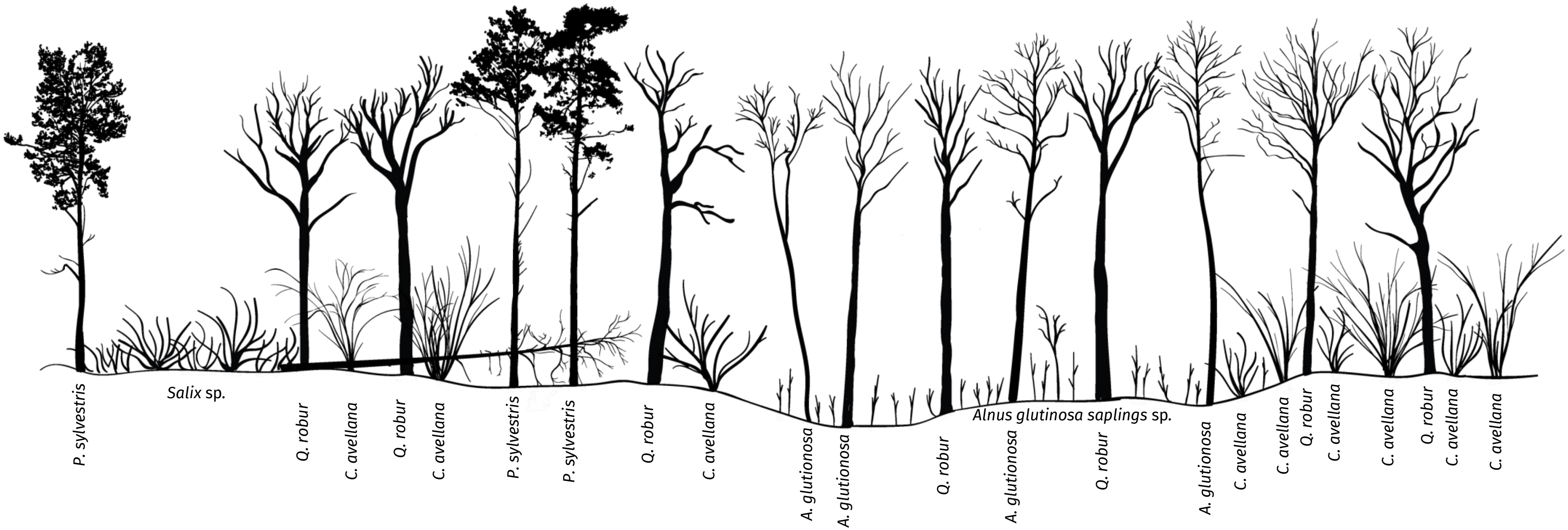


Figure 43. Illustration of the stand in its current state, from the left (west) where a tree has fallen, leaving new open spaces for Salix sp., then leading up to a mixture of Quercus robur and Pinus sylvestris with a sparser understory of Corylus avellana than on the far-right side (east), where the understory is very dense. In the middle, the wetter parts are dominated by Alnus glutinosa, moving towards the right (east), there is a transition zone of Alnus glutinosa and Quercus robur, where the crowns are very close to each other.

RESULTS

This paper aimed to explore the applicability and relevance of the Forest Development Types (FDTs) in designing resilient and diverse forest systems in urban areas, while also assessing their potential in enhancing ecological values. The findings reveal a mixed response, encompassing both positive and negative aspects.

KEY FINDINGS

The exploration of the applicability of Forest Development Types in designing resilient and diverse urban forest systems revealed several key findings:

Challenges in Applying the FDTs to Urban Forests: Despite being primarily designed for silvicultural purposes, the application of FDTs to recreational forests demonstrated nuanced outcomes. Limitations were identified in terms of adapting the FDTs to align with desired outcomes for both recreational and ecological values.

The FDTs lacked detailed descriptions of forest structures, neglected complex interactions between urban residents and forests, and faced challenges in small-scale urban applications. However, they provided a valuable conceptual starting point for inspiring adaptable urban forest stand structures.

Need for Adaptation to Climate Change: the FDTs do not explicitly consider the impacts of climate change. As a result, modifications are required to address this crucial factor. The study emphasizes the necessity of additional resources and modifications to align forest management plans with changing climate conditions.

Economic Prospects in Urban Forests: FDTs shed light on the potential economic prospects within urban forests, a dimension often overlooked. Although this study prioritizes other aspects in recreational forests, it sheds lights on valuable insights into the economic aspects of forest management that can be incorporated alongside considerations of recreational and ecological values.

The Crucial Role of Knowledge in Forest Management: Close-to-nature management requires high ecological knowledge and forestry skills, presenting a challenge. Balancing short-term economic and political considerations with long-term ecological goals is crucial in achieving effective forest management.

QUESTION OF ISSUE

To what extent can the model Forest Development Types be applied when developing and managing an urban woodland with both rich ecological diversity and recreational values?

The results indicate a mixed response to the applicability and relevance of the Forest Development Types (FDTs) in urban woodlands. While the FDTs offer insights into designing resilient and diverse forest systems, their limitations become apparent when applied to recreational forests. The FDTs are primarily designed for silvicultural purposes, presenting challenges when seeking alignment with both recreational and ecological values. However, the FDTs can serve as an initial framework, inspiring modifications to meet the desired outcomes for both aspects.

In the context of exploring Close-to-Nature management in a peri-urban forest, is the Forest Development Types model relevant and applicable?

The findings suggest that the Forest Development Types (FDTs) may have limitations when applied to Close-to-Nature management in a peri-urban forest. The focus on silviculture in the FDTs may not fully align with the complexities and diverse goals of peri-urban forests. While the FDTs offer valuable insights, additional modifications and resources are needed to ensure successful management and development in the peri-urban context.

What implementations and limitations are there when using the model Forest Development Types in the case example?

This study highlights both positive and negative aspects of implementing the Forest Development Types (FDTs) in the case example of Garnisonen. The limitations arise when attempting to categorize diverse forest stands, especially those evolving through natural regeneration, into predefined FDTs. The challenges include the absence of representation for certain species, structural details, transitional forest structures along with forest management methods suitable for recreational forests.

What considerations must be done in an urban woodland in relation to the expected climate change?

The discussion acknowledges the ongoing factor of expected climate change in urban woodlands. It emphasizes that the Forest Development Types do not explicitly consider climate change impacts. Instead, modifications and alternative resources must be considered. The study focuses on converting monoculture stands into deciduous mixed stands to enhance resilience against climate change. The importance of managing for diversity, preserving habitat diversity, and adapting to climate change is underscored, and the FDTs lack explicit guidance on climate change impacts and adaptation strategies.

DISCUSSION

This paper commenced with the author's aspiration to expand their knowledge about Swedish forest systems and the native species within them. The author aimed to gain a deeper understanding of the methods employed in creating sustainable management plans that can be implemented in both urban and nearby areas. The primary focus was on the FDTs. Within this study, valuable insights were gained from applying the Forest Development types (p.33-49) in a recreational forest, while also recognizing their implementations and limitations.

URBAN APPLICABILITY OF THE FOREST DEVELOPMENT TYPES

According to Dunnett and Hitchmough (2004), many stakeholders, designers, and managers involved in creating landscapes, especially in urban areas, often lack sufficient mental images of reference landscapes for different types of woodlands. This scarcity is primarily due to the limited number of well-established woodland examples. This paper has found that the FDTs are partially applicable as reference landscapes when developing positive and attractive woodlands through management.

SPECIES COMPOSITION

While the main objective within this paper was to apply only the Danish FDTs within an urban context, it soon became clear when writing the management descriptions for the individual stands, that they were insufficient since they are mainly focused on production of conifer trees. Therefore, the British Forest Development Types had to be incorporated into the work. However, pinpointing a suitable FDT continued to prove challenging since many of the species present in the forest were not represented in the available forest types, and vice versa. This may be attributed to the fact that the FDTs are based on silviculture and may not be applicable to all forest stands, especially those that have evolved through natural regeneration. Although natural regeneration is favored as a management method within the FDTs, the species listed in them do not automatically align with the inventoried stand. According to Millard (2000), spontaneously established individuals are well-adapted to the specific site, resulting in higher biodiversity. Confidently, favored within this study.

Furthermore, certain species compositions may not be mentioned in the FDTs due to their low economic value or lack of stability in Denmark or Britain. The British FDTs categorize complementary tree species as long-lived or short-lived broadleaves or shade-tolerant conifers, which excludes Pinus sylvestris by default. However, Pinus sylvestris could serve as a complementary species on many sites in Sweden. Another point to note about species composition within the FDTs is the prevalence of Picea abies and Fraxinus excelsior. Relying heavily on these species is peculiar considering the uncertain survival of Picea abies in Scania and Denmark (p. 26), and the near absence of Fraxinus excelsior in forest systems globally due to the devastating impact of Ash Dieback Disease (p.29).

FOREST STRUCTURES

Forest structures refer to the spatial arrangement, composition, and distribution of different components within a forest ecosystem, including trees, understory vegetation, and other elements (Gustavsson 1991). These structures influence ecological processes, biodiversity, and the overall functionality of the forest. The forest structures provided by the FDTs were insufficient when describing or pinpointing a suitable FDT, necessitating the utilization of Gustavsson's (p. 52-56) forest structures for further descriptions. In the literature, the distinction between different types of forest structures has generally been made in mature forest types, which holds true within the FDTs. However, transitional forest structures also need consideration. These transitional forest types were found in the case example and became apparent during the analysis conducted in this study. The small size of the stands and recent maintenance activities made it challenging to capture the overall character and vegetation structure within a stand. Additionally, many of these small stands resemble edge gradients, and the FDTs rarely mention anything about edge zones. This is why the edge zones are seldom mentioned in the management descriptions.

AN IMPORTANT NOTE ABOUT EDGE ZONES

The FDTs state that they can be applied from small patches to large hectares; however, it became evident that this was very challenging when applying the FDTs on a small scale. Urban areas have limited space, and traditional forestry models may not adequately consider spatial challenges, leading to difficulties in implementing certain forestry practices, such as clear-cutting or extensive thinning (p. 31-32). This is also due to the fact that small patches should more often than not be considered as edge gradients if we wish to work with their natural succession patterns. This consideration also extends to the management of paths and clearings in the recreational forest, which would be fully excluded from the management descriptions if only the FDTs had been utilized. This exclusion applies not only to the actual clearance of paths and open areas but also to the closest forested areas next to them, as these will behave more like edge zones rather than larger forested areas.

MANAGING FOR DIVERSITY

Promoting diversity in management is a comprehensive strategy that acknowledges the interdependence of ecological, social, and economic factors. Its goal is to establish and sustain resilient and well-balanced ecosystems capable of thriving in ever-changing environmental and societal contexts. Yet, achieving harmony among these three aspects has proven to be a formidable challenge (p. 21).

CLOSE-TO-NATURE MANAGEMENT

Close-to-nature management emphasizes adapting practices to site-specific conditions (p. 33). However, certain sites may present unique challenges, making it difficult to apply a one-size-fits-all approach. In mixed forest systems, certain tree species may compete for resources, leading to dominance by a few species. Close-to-nature management may struggle to maintain a balanced mix, potentially resulting in the dominance of fast-growing or aggressive species (p. 25).

The FDTs were created with the goal of promoting biodiversity in silviculture. While they provide information on the habitat characteristics of the forest, such as soil composition, water availability, and nutrient levels, they offer limited guidance on management after the juvenile phase, particularly in the context of recreational forests. This becomes even more challenging when transforming existing forest stands into desired conditions or maintaining their current vegetation structure, as demonstrated in this paper. It requires a combination of creative thinking, interpretation, and knowledge. Additional sources of information are necessary to effectively identify a forest type and ensure its successful management and development. This is especially important if one lacks knowledge of the characteristics of natural native forest systems. Furthermore, available literature on specific management actions is often unsuitable for public environments as they originate from a silvicultural context (p. 31-34). As a result, certain management actions outlined in this paper may be considered excessively extreme for a recreational forest.

Another important note here is that conventional forestry practices of clear-cuttings (p. 31), which were not incorporated into this paper, may pose challenges to existing trails, recreational infrastructure, and amenities within the forest. Clear-cutting or large-scale interventions can disrupt recreational activities and user experience. Therefore, developing flexible and adaptive management plans that can be adjusted to accommodate spatial constraints and respond to changing urban dynamics are just as important, which allows for more effective and sustainable forest management. This is where the Cues to Care practice (p. 22) comes into play. It emphasizes the importance of incorporating elements such as dead wood, management directed towards paths and understory, and diversity within the forest structure. These considerations cater to various desires and preferences, ensuring a more comprehensive and harmonious approach to urban forest management.

CLIMATE CHANGE

The FDTs are man-made artificial systems primarily designed for maximizing forest production. When the goal is to closely align with natural processes for sustainable maintenance, alternative systems are desirable. This situation poses an inherent paradox since most of today's forests have evolved through human interventions, making them essentially man-made (p.17). The projected changes in future climate conditions further complicate the situation. The uncertainties surrounding potential pests, diseases, temperature fluctuations, altered precipitation patterns, and increased wildfire occurrences make it challenging to anticipate their impacts on both native and non-native flora (p.25-27).

Climate change poses a significant threat to natural biotopes and vulnerable species, requiring conservation efforts for their preservation. The same principle applies to essential ecosystem services, which are crucial for human well-being (p. 16, 23). By preserving habitat diversity, species richness, and genetic resources, nature is assisted in adapting to climate change and minimizing potential consequences for society. The projected transformations in various habitats will also bring changes to nature's contributions to recreation and overall health.

Although the FDTs emphasize that mixed forest systems are more resilient to climate change, they do not explicitly explain the impacts of climate change and how native and exotic species might be impacted by it. As mentioned in species composition (p.120), some species may be highly vulnerable and face the risk of extinction. The importance lies in promoting mixed forest systems, where higher species diversity serves as a buffer against diseases. In such systems, if one tree dies, another can take its place. Given Scania's historical dominance by deciduous trees and the potential shift of the coniferous zone (p. 62), the focus of this paper has thereby been on converting monoculture stands into deciduous mixed stands and maintaining or increasing species diversity within mixed stands. However, the intentional maintenance of one monoculture stand, dominated by Fagus sylvatica (p.110), contrasts with the broader approach of maintaining mixed stands. This strategic choice, coupled with proactive and informed forest management practices, is essential to mitigate the impacts of climate change, ensuring the resilience and sustainability of our diverse woodland ecosystems for generations to come.

ECONOMY

The FDTs were initially developed with a focus on the economic values associated with forestry, as they were designed for silvicultural purposes. This study aimed to apply the FDTs in the context of recreational forests, the emphasis was not placed on delving into the economic values of each stand. Consequently, the management actions prioritized other aspects over economic considerations. However, the management actions did include suggestions for potential production, recognizing that urban forests possess inherent economic value that can benefit both management approaches and municipal income. However, this conflict can lead to tensions between management goals and the preferences of recreational users (p. 21).

RECREATION

While the FDTs highlight that a larger diversity of different types of forest stands will ultimately please more people due to varying perceptions of beauty in nature, forestry models may not adequately account for the complex interactions between urban residents and the forest. Human activities, recreational needs, and cultural values may conflict with conventional forestry practices. The FDTs focus primarily on topics revolving around ecological aspects and forest dynamics, posing challenges in addressing human desires and requirements in a recreational forest. Therefore, the focus was directed towards finding management strategies that would satisfy the aesthetic preferences of a forest, consistently pointing towards a variation of forest stands (p. 23). Moreover, urban woodlands possess a considerable "social capacity" and offer a distinct sense of detachment from the urban environment. Improving their natural and wild characteristics fosters feelings of solitude and separation, concurrently boosting forest activity, elevating aesthetic values, and enhancing the well-being of residents (p. 19).

BALANCING KNOWLEDGE, TIME, AND RESOURCES IN FORESTRY MANAGEMENT

Implementing close-to-nature management effectively demands a high level of ecological knowledge and forestry skills, and in regions where such expertise is lacking, the successful application of this approach may be impeded. The challenges of managing mixed forests are heightened by the need for intricate planning and decision-making due to the diversity of species and ecological interactions. This complexity poses challenges for foresters in determining optimal interventions without causing unintended consequences. Furthermore, close-to-nature management often requires a long-term perspective, which may not align with short-term economic and political considerations. Balancing the immediate needs of stakeholders with the long-term ecological goals can be a persistent challenge, emphasizing the importance of sustainable practices and informed decision-making in forestry management.

IN CONCLUSION

The application of FDTs showcases the urban forest's economic potential while also offering recreational values and sustainability. However, while the FDTs can serve as inspirational prototypes that embody complexity and diversity, they prove inefficient when developing a recreational or peri-urban forest. Delivering the full-depth management descriptions found within this paper would not have been possible without additional resources of information and reference landscapes. Moreover, creative thinking is necessary for effective management and development, as our forest systems face further threats of fragmentation. Creating forest communities and protecting vital habitats requires a significant amount of time. By developing urban forests and parks as natural systems that prioritize biodiversity and mimic nature, we can achieve conservation goals and reduce maintenance requirements, thus making the urban forest a pioneer in silviculture.

METHOD DISCUSSION

The discussion of the methodology sheds light on the various approaches used to address the questions of issue and at the same time uncover important findings. This pursuit resulted in the creation of a literature review that laid the groundwork for the subsequent case example, illustrating the practical application of FDTs.

LITERATURE STUDY

The literature study played a pivotal role in shaping the methodological framework of this research. It provided a comprehensive understanding of the historical development of urban forests and their ecological dynamics. Additionally, the literature review informed the selection of management methods, including typical silviculture actions, and addressed challenges in meeting human desires and requirements in recreational forests. By focusing on ecological aspects and forest dynamics, the literature study laid the groundwork for the subsequent case example, illustrating the practical application of Forest Development Types (FDTs). The insights gained from the literature study not only guided the research questions but also influenced the overall methodological approach, ensuring a robust foundation for subsequent analyses and discussions.

MANAGEMENT PLANS

In this study, the development of management plans was essential to provide a systematic framework for guiding the sustainable enhancement and future direction of the urban forest. These plans served as strategic tools to address ecological dynamics, species compositions, and stand structures, ensuring a comprehensive approach to managing the forest within the unique context of urban and peri-urban environments. However, succession, species dynamics, and natural systems are inherently complex. Likewise, simplifying and effectively conveying the goals of a forest system in a clear and understandable manner is also a complex task. It involves providing adequate information for readers to grasp the present state and future aspirations of individual stand structures, while ensuring a comprehensive alignment with the applicable model. In this regard, additional sources of vegetation structure and an alternative Forest Development Type model were incorporated as valuable background information for the management plans, supported by the use of illustrative profile diagrams.

INVENTORY METHODS AND PROFILE DIAGRAMS

The inventory methods employed in the study were effective in providing a comprehensive understanding of the Garnisonen area. They successfully identified the dominant tree species, documented various plant and animal species, and assessed the successional stage of the forest stands. However, limitations arose in considering different stages of growth and age within the stands, as the retained individuals exhibited similar heights. This limitation, most likely, stemmed from the absence of profile diagrams conducted in the field. Instead, profile diagrams were produced through pictures, sampling-based estimation, and sketches with a species inventory. Despite these challenges, the inventory methods yielded valuable insights into the site's characteristics and formed the basis for developing management plans. However, to further enhance the inventory methods, a more detailed approach could be adopted. This could involve using profile diagrams to measure crown size, distance between species, heights, and width, aligning with the approach suggested by Gustavsson (1986, 1991). By incorporating these detailed measurements and visual representations, a more comprehensive and visually appealing presentation of the development within different stands can be achieved. This would greatly enhance the understanding of stand dynamics, species interactions, and structural characteristics. Furthermore, by assessing the successional patterns, growth rates, and overall health of the forest stands through such detailed inventory data, more informed management decisions and strategies could be made. Additionally, it would effectively illustrate the future goals of the stands, enabling a more proactive approach towards their management.

ANALYZING METHODS

A range of different analysis methods were employed to gather information about the site while also narrowing down the selected area. However, using numerous analysis methods can sometimes lead to a somewhat ambiguous assessment of an area. Nonetheless, it proved valuable for the author in gaining a comprehensive understanding of Garnisonen. While there were numerous sub-areas to choose from, the selected area demonstrated a strong foundation of residential usage and diverse stand structures, offering valuable insights for future development. However, the author acknowledges that there is room for improvement in the execution of the interviews conducted with the residents. These aspects are further discussed in the "Further Research" section.

FURTHER RESEARCH

In addition to the findings discussed earlier, there are several areas that hold potential for further research and development.

ECOSYSTEM SERVICES, EDGE ZONES, AND SHRUB DIVERSITY

Incorporating ecosystem services as an analytical framework would offer a more comprehensive understanding of the value of the studied forest areas. This approach would involve assessing their contributions to pollination, water purification, climate regulation, cultural values, and other ecosystem services that benefit humans and society. By quantifying and evaluating these ecosystem services, we can demonstrate the tangible benefits that urban woodlands provide and highlight their significance in supporting human well-being and environmental sustainability. However, implementing this approach would require additional data and specific methodologies for assessing and quantifying ecosystem services. This aspect should be considered in the planning of future research in the field.

One area of research is the exploration of the optimal design of edge zones in relation to FDTs. This investigation would focus on creating transitional areas that seamlessly integrate with the surrounding forest while enhancing biodiversity and providing recreational opportunities. By understanding how to design these edge zones effectively, we can promote smoother ecological transitions and create ecologically diverse habitats that complement the adjacent forest areas.

Another avenue for research is testing the applicability of FDTs within a Swedish context, where there is a greater abundance of shrubs and understory species. This analysis would provide valuable insights into how FDTs can be adapted and optimized to account for the unique ecological characteristics of Swedish woodlands. Investigating the ecological dynamics of understory development and assessing the factors that influence the establishment and growth of understory vegetation would contribute to a more comprehensive understanding of forest development within the FDTs.

THE CONNOISSEUR METHOD

There is a development model known as the connoisseur method, as described by Mellqvist (2017). It involves harnessing the knowledge of well-informed visitors to the local landscape in collaboration with practitioners in landscape development and management. This approach offers the potential to achieve a more contextually sensitive, sustainable, and community-driven approach to landscape development. Local knowledge and engagement with a deep personal connection to the landscape ensure that the planning process incorporates a rich understanding of the local context, thereby increasing awareness and appreciation of the local landscape. Furthermore, it promotes learning and knowledge exchange among different actors involved in the planning process, fostering a collective understanding and shared learning that can lead to more informed and effective planning. Therefore, in this study, engaging with maintenance personnel and conducting in-depth interviews with a broader focus group of residents living in the surrounding area after the stand inventory would provide valuable insights. By involving key stakeholders, such as maintenance personnel responsible for the woodland area, we can gather practical knowledge and perspectives on the challenges and opportunities associated with managing the forests according to the principles of the FDTs. Additionally, engaging with a wider focus group of residents would allow us to understand their perceptions, expectations, and experiences related to the woodland area, providing valuable input for future management and development plans.

Considering the restoration and realignment of the landscape based on historical land practices in alignment with the Forest Development Types would contribute to a more holistic and meaningful restoration process. Examining the historical context and previous land usage would provide a comprehensive understanding for informed restoration efforts. This approach would contribute to a more holistic and meaningful restoration process, where the historical context and past land practices are taken.

CLIMATE CHANGE

The need for continuous new studies of forest systems arises from the dynamic nature of ecosystems and the ongoing challenges posed by climate change. Climate change has the potential to significantly impact the balance of species within forest systems, alter competition dynamics among species, and lead to changes in species composition. To effectively manage and guide forest systems in the face of these changes, it is essential to have a comprehensive understanding of how climate change influences the interactions between species and their environment. This understanding can be gained through continuous studies that monitor and analyze the effects of climate change on forest ecosystems. By understanding how climate change affects species dynamics, forest managers can propose and implement suitable strategies to maintain or restore the desired balance of species, promote biodiversity, and enhance the resilience of the ecosystem.

IN SUMMARIZE

Exploring these areas further would deepen our understanding and application of the FDTs in a peri-urban context, contributing to the creation of more resilient and sustainable cities, fostering healthier and more livable environments for both humans and nature.

REFERENCES

Agestam, E. (2015). Gallring, kapitel 7. In: *Skogsskötselserien*. Skogsstyrelsen. https://www.skogsstyrelsen.se/mer-om-skog/skogsskotselserien/skotsel-av-adellovskog/ [2023-04-12]

Almgren, G., Ekeland, K., Widén, M., & Sverige Skogsstyrelsen (1986). *Ädellövskog: ekologi och skötsel*. [Ny uppl.]. Jönköping: Skogsstyr.

Alvey, A.A. (2006). Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening*, 5 (4), 195–201. https://doi.org/10.1016/j.ufug.2006.09.003

Andersson, R. & Andersson, M. (2005). *Björk, asp och al: föryngring, skötsel och naturvård*. Jönköping: Skogsstyrelsens förlag.

Bell, S., Blom, D., Rautamäki, M., Castel-Branco, C., Simson, A. & Olsen, I.A. (2005). Design of Urban Forests. In: *Urban Forests and Trees A Reference Book*. 1st ed. 2005. Berlin: Springer Berlin Heidelberg. 149–185. https://doi.org/10.1007/3-540-27684-X

Bellard, C., Bertelsmeier, C., Leadley, P., Thuiller, W. & Courchamp, F. (2012). Impacts of climate change on the future of biodiversity. *Ecology letters*, 15 (4), 365–377. https://doi.org/10.1111/j.1461-0248.2011.01736.x

Berlin, G. & Niss, J. (2019). *Handlingsplan för grön infrastruktur - insatsområden för grön infrastruktur 2019-2030*. (2019:3). Malmö: Länsstyrelsen Skåne. https://www.lansstyrelsen.se/download/18.26f506e0167c605d5693eec7/1617691080105/Handlingsplan%20Gr%C3%B6n%20infrastruktur%20Sk%C3%A5ne.pdf [2022-02-21]

Blomberg, P., Åhnberg, M., Sellers, I., Andersson, T., Hellsten, J., Sörvik, V. & Utzon-Frank, T. (2012). *Grönstruktur i Skåne*. Region Skåne. https://utveckling.skane.se/publikationer/rapporter-analyser-och-prognoser/temapm---gronstruktur-i-skane/ [2022-02-21]

Bolte, A., Hilbrig, L., Grundmann, B., Kampf, F., Brunet, J. & Roloff, A. (2010). Climate change impacts on stand structure and competitive interactions in a southern Swedish spruce–beech forest. *European Journal of Forest Research*, 129 (3), 261–276. https://doi.org/10.1007/s10342-009-0323-1

Boverket (2022). Att arbeta med riktlinjer i grönplaneringen. *Boverket*. https://www.boverket.se/sv/PBL-kunskapsbanken/teman/gronplan/att-arbeta/riktlinjer/ [2023-03-02]

Bradshaw, R.H., Holmqvist, B.H., Cowling, S.A. & Sykes, M.T. (2000). The effects of climate change on the distribution and management of Picea abies in southern Scandinavia. *Canadian journal of forest research*, 30 (12), 1992–1998. https://doi.org/10.1139/x00-130

Bravo-Oviedo, A., Pretzsch, H., Ammer, C., Andenmatten, E., Barbati, A., Barreiro, S., Brang, P., Bravo, F., Coll, L., Corona, P. & Ouden, den (2014). European Mixed Forests: Definition and research perspectives. *Forest systems*, 23 (3), 518–533. https://doi.org/10.5424/fs/2014233-06256

Bryman, A. (2018). Samhällsvetenskapliga metoder. Stockholm: Liber.

Colding, J. (2013). Local Assessment of Stockholm: Revisiting the Stockholm Urban Assessment. In: Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P.J., McDonald, R.I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C., & Wilkinson, C. (eds) *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment*. Dordrecht: Springer Netherlands. 313–335. https://doi.org/10.1007/978-94-007-7088-1_17

Coles, R.W. & Bussey, S.C. (2000). Urban forest landscapes in the UK — progressing the social agenda. *Landscape and urban planning*, 52 (2), 181–188. https://doi.org/10.1016/S0169-2046(00)00132-8

Crow, T.R. (2012). What Can Landscape Ecology Contribute to Forest Landscape Restoration? In: Stanturf, J., Lamb, D., & Madsen, P. (eds) *Forest Landscape Restoration: Integrating Natural and Social Sciences*. Dordrecht: Springer Netherlands. 25–37. https://doi.org/10.1007/978-94-007-5326-6_2

Dansk skovforening & Larsen, J.B. (2005). *Naturnær skovdrift*. København: Dansk skovforening.

Duinker, P.N., Lehvävirta, S., Nielsen, A.B. & Toni, S.A. (2017). Urban woodlands and their management. In: *Routledge Handbook of Urban Forestry*. London; New york: Routledge. 515–528.

Dukes, J.S., Pontius, J., Orwig, D., Garnas, J.R., Rodgers, V.L., Brazee, N., Cooke, B., Theoharides, K.A., Stange, E.E., Harrington, R., Ehrenfeld, J., Gurevitch, J., Lerdau, M., Stinson, K., Wick, R. & Ayres, M. (2009). Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: What can we predict?This article is one of a selection of papers from NE Forests 2100: A Synthesis of Climate Change Impacts on Forests of the Northeastern US and Eastern Canada. *Canadian Journal of Forest Research*, 39 (2), 231–248. https://doi.org/10.1139/X08-171

Dunnett, N. & Hitchmough, J. (2004). Exploring Woodland Design: Designing with Complexity and Dynamics—Woodland Types, Their Dynamic Architecture and Establishment. In: *The Dynamic Landscape*. United Kingdom: Taylor & Francis. 252–299. https://doi.org/10.4324/9780203402870-12

Eastman, J. (2005). Multi-criteria evaluation and GIS. https://www.semanticscholar.org/paper/Multi-criteria-evaluation-and-GIS-Eastman/7ee362272327b1da29f8e41b4efc7388606a5836 [2023-03-11]

Ekelund, N. (2007). *Effekter på den biologiska mångfalden av ett förändrat klimat*. Miljöförvaltningen Stockholm stad. https://miljobarometern.stockholm.se/content/docs/tema/natur/Klimat-Biologisk_mangfald.pdf [2022-02-09]

Enescu, C.M., Houston Durrant, T., de Rigo, D. & Caudullo, G. (2016). Salix caprea in Europe: distribution, habitat, usage and threats. In: *The European Atlas of Forest Tree Species: modelling, data and information on forest tree species*. 2. ed. European Comission.

Fieldhouse, K. & Hitchmough, J. (2004). *Plant user handbook: a guide to effective specifying / edited by James Hitchmough and Ken Fieldhouse*. Oxford: Blackwell Pub.

Filyushkina, A., Agimass, F., Lundhede, T., Strange, N. & Jacobsen, J.B. (2017). Preferences for variation in forest characteristics: Does diversity between stands matter? *Ecological economics*, 140, 22–29. https://doi.org/10.1016/j.ecolecon.2017.04.010

Florgård, C. (2000). Long-term changes in indigenous vegetation preserved in urban areas. *Landscape and Urban Planning*, 52 (2), 101–116. https://doi.org/10.1016/S0169-2046(00)00126-2

Forrest, M. & Konijnendijk, C.C. (2005). A History of Urban Forests and Trees in Europe. In: *Urban Forests and Trees A Reference Book*. 1st ed. 2005. Berlin: Springer Berlin Heidelberg. 23–47. https://doi.org/10.1007/3-540-27684-X

Forzieri, G., Girardello, M., Ceccherini, G., Spinoni, J., Feyen, L., Hartmann, H., Beck, P.S.A., Camps-Valls, G., Chirici, G., Mauri, A. & Cescatti, A. (2021). Emergent vulnerability to climate-driven disturbances in European forests. *Nature communications*, 12 (1), 1081–12. https://doi.org/10.1038/s41467-021-21399-7

Gundersen, V.S. & Frivold, L.H. (2008). Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden. *Urban forestry & urban greening*, 7 (4), 241–258. https://doi.org/10.1016/j.ufug.2008.05.001

Gustavsson, R. (1991). *Furulunds fure: en skog i samhällets centrum : vegetationsstudier, historia, fågelinventering samt modeller och förslag till framtida skötsel = Furulunds fure : a forest in the centre of town : studies of vegetation, history, inventory of birds along with models and suggestions for the future management*. Alnarp: Sveriges lantbruksuniv. (Stad & land (Alnarp. 1982), 96)

Gustavsson, R. (1994). *Det nya landskapet: kunskaper och idéer om naturvård, skogsodling och planering i kulturbygd*. 1. uppl. Jönköping: Skogsstyr.

Gustavsson, R. (2009). The touch of the world: dynamic vegetation studies and embodied knowledge. *Journal of landscape architecture (Wageningen, Netherlands)*, 4 (1), 42–55. https://doi.org/10.1080/18626033.2009.9723412

Gustavsson, R., Hermy, M., Konijnendijk van den Bosch, C. & Steidle, A. (2005). Management of urban woodland and parks - searching for creative and sustainable concepts. In: *Urban Forests and Trees A*

Reference Book. 1st ed. 2005. Berlin: Springer Berlin Heidelberg. 369-. https://doi.org/10.1007/3-540-27684-X

H. Gobster, P. (2012). Alternative Approaches to Urban Natural Areas Restoration: Integrating Social and Ecological Goals. In: *Forest Landscape Restoration*. (World Forests). Dordrecht: Springer Netherlands. 155–176. https://doi.org/10.1007/978-94-007-5326-6_9

Hall, M., Lund, E. & Rummukainen, M. (2015). *Klimatsäkrat Skåne*. (CEC Rapport Nr 02., ISBN 978-91-981577-4-1). Center for Environmental and Climate Research. Lund University. https://utveckling.skane.se/publikationer/rapporter-analyser-och-prognoser/klimatsakrat-skane/ [2022-02-20]

Halling, E. (2017). *Skogsutvecklingstyper i urban skog: en fallstudie av skogsutvecklingstyper i Sverige*. Sveriges lantbruksuniversitet.

Hannerz, M., Lindhagen, L., Forsberg, O., Fries, C. & Rydberg, D. (2016). Skogsskötsel för friluftsliv rekreation, kapitel 15. In: *Skogsskötselserien*. Skogsstyrelsen. https://www.skogsstyrelsen.se/mer-om-skog/skogsskotselserien/skogsskotsel-for-friluftsliv-rekreation/ [2023-04-14]

Harmon, M., Franklin, J., Swanson, F., Sollins, P., Gregory, S., Lattin, J., Andersson, N., Cline, S., Aumen, N., Sedell, J., Lienkaemper, G., Cromack, K. & Cummins, K. (2004). Ecology of Coarse Woody Debris in Temperate Ecosystems. In: *Advances in Ecological Research*. United Kingdom: Elsevier Science & Technology. 59–234. https://doi.org/10.1016/S0065-2504(03)34002-4

Hässleholms kommun (2007). *Detaljplan för Norra Sjörröd, del av Finjasjö Park*. Hässleholm: Hässleholms stad och kommun.

Hässleholms kommun (2014). *Detaljplan för Artilleristen 2 m.fl.* Hässleholm: Hässleholms stad och kommun.

Hässleholms kommun (2018). *PM (Program) för Garnisonen, Torshem, Sjörröds gård m fl*. (BN 2016-286). Hässleholm: Hässleholms stad och kommun. https://www.hassleholm.se/download/18.2ade2ad41679a91c31541bee/1544612250267/Pm%20Program%20Garnisonen%20godk%C3%A4nd%20BN%2020121211.pdf [2022-02-22]

Hässleholms kommun (2022). *Planprogram för Garnisonen*. (BN 2016-286). Hässleholm: Miljö- och stadsbyggnadsförvaltningen.

Hässleholms Kommun (2022). *Skyddsvärda träd runt Finjasjön 2008/09. Närmare 900 identifierade träd.* Hässleholm. https://www.hassleholm.se/download/18.6b23b86515a55f27be7f0257/1487754399266/Skyddsv%C3%A4rda+tr%C3%A4d+runt+Finjasj%C3%B6n+2008-09.pdf [2022-03-09]

Haufe, J., Kerr, G., Stokes, V. & Bathgate, S. (2021a). *Forest Development Types: A guide to the design and management of diverse forests in Britain*. Version 1.0. The Research Agency of the Forest commission.

Haufe, J., Kerr, G., Stokes, V. & Bathgate, S. (2021b). *Forest Development Types: Flashcards*. Version 1.0. The Research Agency of the Forest commission.

Jansson, M., Fors, H., Lindgren, T. & Wiström, B. (2013). Perceived personal safety in relation to urban woodland vegetation – A review. *Urban forestry & urban greening*, 12 (2), 127–133. https://doi.org/10.1016/j.ufug.2013.01.005

de Jong, J. (2002). *Populationsförändringar hos skogslevande arter i relation till landskapets utveckling*. (CBM: s skriftserie 7). Uppsala: Centrum för biologisk mångfald.

Jörg, B. (2015). *Långsiktiga vegetationsförändringar i Sveriges skogar – orsaker och konsekvenser för skogsskötseln*. Alnarp: Department of Southern Swedish Forest Science.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of environmental psychology*, 15 (3), 169–182. https://doi.org/10.1016/0272-4944(95)90001-2

Konijnendijk, C.C., Ricard, R.M., Kenney, A. & Randrup, T.B. (2006). Defining urban forestry – A comparative perspective of North America and Europe. *Urban forestry & urban greening*, 4 (3), 93–103. https://doi.org/10.1016/j.ufug.2005.11.003

Koppen, G., Ode Sang, Å. & Sundli Tveit, M. (2014). Managing the potential for outdoor recreation: Adequate mapping and measuring of accessibility to urban recreational landscapes - ScienceDirect. *Urban Forestry & Urban Greening*, Volume 13, Issue 1, Pages 71-83

Kuuluvainen, T. (2009). Forest Management and Biodiversity Conservation Based on Natural Ecosystem Dynamics in Northern Europe: The Complexity Challenge. *AMBIO: A Journal of the Human Environment*, 38 (6), 309–315. https://doi.org/10.1579/08-A-490.1

Länsstyrelsen Skåne (2015). *Naturvårdsstrategi för Skåne*. (2015:23). https://www.lansstyrelsen.se/skane/tjanster/publikationer/naturvardsstrategi-for-skane.html [2022-02-21]

Länsstyrelsen Skåne (2019). *Strategi för formellt skydd av skog i Skåne län*. (2019:21). Länsstyrelsen Skåne.

Lantmäteriet (2023). Hässleholm, 3-50; Häradsekonomiska kartan 1926-1928 . https://historiskakartor.lantmateriet.se/hk/positionsearch?e=420718&n=6222961 [2023-06-21]

Larsen, J.B. (2005). *Katalog over skovudviklingstyper i Danmark*. Skov- og Naturstyrelsen.

Larsen, J.B. & Nielsen, A.B. (2007). Nature-based forest management: Where are we going? Elaborating forest development types in and with practice. *Forest ecology and management*, 238 (1–3), 107–117

Larsen, J.B. & Nielsen, A.B. (2012a). Urban Forest Landscape Restoration – Applying Forest Development Types in Design and Planning. In: *Forest Landscape Restoration*. (World Forests). Dordrecht: Springer Netherlands. 177–199. https://doi.org/10.1007/978-94-007-5326-6_9

Larsen, J.B. & Nielsen, A.B. (2012b). Urban Forest Landscape Restoration – Applying Forest Development Types in Design and Planning. In: Stanturf, J., Lamb, D., & Madsen, P. (eds) *Forest Landscape Restoration: Integrating Natural and Social Sciences*. Dordrecht: Springer Netherlands. 177–199. https://doi.org/10.1007/978-94-007-5326-6_9

Löf, M., Møller-Madsen, E. & Rytter, L. (2009). Skötsel av ädellövskog, chapter 10. In: *Skogsskötselserien*. Skogsstyrelsen. https://www.skogsstyrelsen.se/mer-om-skog/skogsskotselserien/skotsel-av-adellovskog/ [2023-04-12]

Löfvenhaft, K., Björn, C. & Ihse, M. (2002). Biotope patterns in urban areas: a conceptual model integrating biodiversity issues in spatial planning. *Landscape and Urban Planning*, 58 (2), 223–240. https://doi.org/10.1016/S0169-2046(01)00223-7

Lynch, K. (1960). *The image of the city*. Cambridge [Mass: M.I.T. Press & Harvard Univ. Press. (Publications of the Joint Center for Urban Studies)

McHarg, I.L. (1992). *Design with nature*. 25th anniversary edition. New York: Wiley.

McKinney, M.L. (2002). Urbanization, Biodiversity, and Conservation. *BioScience*, 52 (10), 883–890. https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

McPherson, G.E., Nowak, D.J. & Rowntree, R.A. (1994). Chicago's urban forest ecosystem: results of the Chicago Urban Forest Climate Project. *Gen. Tech. Rep. NE-186. Radnor, PA: U. S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 201 p.*, 186. https://doi.org/10.2737/NE-GTR-186

Mellqvist, H. (2017). *The connoisseur method a study on long-term participation in landscape planning*. Department of Landscape Architecture, Planning and Management, Swedish University of Agricultural Sciences.

Millard, A. (2000). The potential role of natural colonisation as a design tool for urban forestry — a pilot study. *Landscape and Urban Planning*, 52 (2), 173–179. https://doi.org/10.1016/S0169-2046(00)00131-6

Nassauer, J.I. (1995). Messy Ecosystems, Orderly Frames. *Landscape journal*, 14 (2), 161–170. https://doi.org/10.3368/lj.14.2.161

Nationalencyklopedin (2022). *restaurera*. https://www.ne.se/uppslagsverk/ordbok/svensk/restaurera [2022-02-16]

Natur och Miljö (2007). *Stig in i skogen. Inventeringshandbok för skogsintresserade.*

Newton, R.J. & Goodin, J.R. (1989). 16 - Moisture Stress Adaptation in Shrubs. In: *The Biology and Utilization of Shrubs*. Elsevier Inc. 365–383. https://doi.org/10.1016/B978-0-12-484810-8.50024-5

Nielsen, A.B. & Møller, F. (2008). Is coppice a potential for urban forestry? The social perspective. *Urban forestry & urban greening*, 7 (2), 129–138. https://doi.org/10.1016/j.ufug.2008.02.005

Nylander, O. (2018). *Svensk bostadsarkitektur : utveckling från 1800-tal till 2000-tal*. Lund: Studentlitteratur AB.

Ode Sang, Å., Knez, I., Gunnarsson, B. & Hedblom, M. (2016). The effects of naturalness, gender, and age on how urban green space is perceived and used. *Urban forestry & urban greening*, 18, 268–276. https://doi.org/10.1016/j.ufug.2016.06.008

Önell, B. (2022). Gav startbesked till Hässlehem utan att vänta på domstolen. *Frilagt Hässleholm*,.

https://www.frilagt.se/2022/01/14/gav-startbesked-till-hasslehem-utan-att-vanta-pa-dom/ [2022-03-09]
Påhlsson, L. (1998). *Vegetationstyper i Norden*. [3. uppl.]. København: Nordisk Ministerråd. (Miljø)
Pauleit, S., Jones, N., Nyhuus, S., Pirnat, J. & Salbitano, F. (2005). Urban Forest Resources in European Cities. In: *Urban Forests and Trees A Reference Book*. 1st ed. 2005. Berlin: Springer Berlin Heidelberg. 49–78. https://doi.org/10.1007/3-540-27684-X
Phillips, R. (1989). *Shrubs*. London: Pan.
Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem, A. & Rama, B. (2022). *Summary for Policymakers. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. (IPCC). Cambridge University Press. In Press.
Pöyry, J., Luoto, M., Heikkinen, R., Kuussaari, M. & Saarinen, K. (2009). Species traits explain recent range shifts of Finnish butterflies. *Global Change Biology*, 15, 732–743. https://doi.org/10.1111/j.1365-2486.2008.01789.x
Ritchie, H. & Roser, M. (2018). Urbanization. *Our World in Data*,. https://ourworldindata.org/urbanization [2023-03-31]
Robinson, N. & Wu, J.-H. (2016). *The planting design handbook*. Third edition. London ; Routledge. https://doi.org/10.4324/9781315554648
Rydberg, D. (2004). *Vår tätortsnära natur: en bok om förvaltning och skötsel*. Jönköping: Skogsstyr:s förl.
Rytter, L., Karlsson, A., Karlsson, M. & Stener, L.-G. (2014). Skötsel av björk, al och asp. In: *Skogsskötselserien*. Andra upplagan 2014. Skogsstyrelsen. https://www.skogsstyrelsen.se/mer-om-skog/skogsskotselserien/skotsel-av-bjork-al-och-asp/ [2023-04-14]
Sæbø, A., Benedikz, T. & Randrup, T.B. (2003). Selection of trees for urban forestry in the Nordic countries. *Urban Forestry & Urban Greening*, 2 (2), 101–114. https://doi.org/10.1078/1618-8667-00027
Schibbye, B. (2001). *Landskap i fokus: utvärdering av metoder för landskapsanalys*. Stockholm: Riksantikvarieämbetets förlag.
Schipperijn, J., Ekholm, O., Stigsdotter, U.K., Toftager, M., Bentsen, P., Kamper-Jørgensen, F. & Randrup, T.B. (2010). Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and urban planning*, 95 (3), 130–137. https://doi.org/10.1016/j.landurbplan.2009.12.010
Schütz, J.-P., Pukkala, T., Donoso, P.J. & von Gadow, K. (2011). Historical Emergence and Current Application of CCF. In: *Continuous Cover Forestry*. (Managing Forest Ecosystems). Dordrecht: Springer Netherlands. 1–28. https://doi.org/10.1007/978-94-007-2202-6_1
Sheppard, S.R.J. (2001). Beyond visual resource management: emerging theories of an ecological aesthetic and visible stewardship. In: *Forests and landscapes: linking ecology, sustainability and aesthetics*. Wallingford, UK: CABI Publishing. 149–172. https://doi.org/10.1079/9780851995007.0149
Sidoroff, K., Kuuluvainen, T., Tanskanen, H. & Vanha-Majamaa, I. (2007). Tree mortality after low-intensity prescribed fires in managed Pinus sylvestris stands in southern Finland. *Scandinavian journal of forest research*, 22 (1), 2–12. https://doi.org/10.1080/02827580500365935
Sjöman, H. (2018). *Solitärbuskar: mångfald och användning*. Alnarp: Movium. (Movium Fakta, 2018:5)
Sjöman, H., Morgenroth, J., Sjöman, J.D., Sæbø, A. & Kowarik, I. (2016). Diversification of the urban forest—Can we afford to exclude exotic tree species? *Urban Forestry & Urban Greening*, 18, 237–241. https://doi.org/10.1016/j.ufug.2016.06.011
Sjöman, H. & Slagstedt, J. (2015). *Träd i urbana landskap*. 1. uppl. Lund: Studentlitteratur.
SMHI (2021). *Klimat i förändring 2021. Den vetenskapliga grunden*. (ISSN: 1624-2258). https://www.smhi.se/polopoly_fs/1.179269!/Klimatologi_65%20Klimat%20i%20f%C3%B6r%C3%A4ndring%202021%20Den%20naturvetenskapliga%20grunden.pdf [2022-02-21]
SMHI (2022). *Vinter*. https://www.smhi.se/kunskapsbanken/meteorologi/arstider/vinter/vinter-1.22843 [2022-03-05]
Society for Ecological Restoration International Science & Policy Working Group (2004). Restoration Resource Center The SER International

Primer on Ecological Restoration. Society for Ecological Restoration. https://www.ser-rrc.org/resource/the-ser-international-primer-on/ [2022-03-05]

Spiecker, H. (2003). Silvicultural management in maintaining biodiversity and resistance of forests in Europe—temperate zone. *Journal of environmental management*, 67 (1), 55–65. https://doi.org/10.1016/S0301-4797(02)00188-3

Staudt, A., Leidner, A.K., Howard, J., Brauman, K.A., Dukes, J.S., Hansen, L.J., Paukert, C., Sabo, J. & Solórzano, L.A. (2013). The added complications of climate change: understanding and managing biodiversity and ecosystems. *Frontiers in Ecology and the Environment*, 11 (9), 494–501

Sykes, M. (2007). Kommande vegetationsförändringar - sydsvenska skogar 1960-2100. In: *Floran i Skåne: arterna och deras utbredning*. Lund: Lunds botaniska förening.

Tyrväinen, L., Pauleit, S., Seeland, K. & Vries, S. de (2005). Benefits and Uses of Urban Forests and Trees. In: *Urban Forests and Trees A Reference Book*. 1st ed. 2005. Berlin: Springer Berlin Heidelberg. 81–110. https://doi.org/10.1007/3-540-27684-X

Vollbrecht, T. & Karlsson, M. (1999). *Forntida skogar och framtida skogsbruk i södra Sverige: historiska fakta och idéer om skogsskötsel*. Alnarp: Sveriges lantbruksuniv. (SLU kontakt, 5)

Wahlsteen, E. (2018). *Växt- och ståndortskännedom*. Lund: Media-Tryck.

Webber, L., Ingvander, S. & Ahlkrona, E. (2022). *Framtida potentiella lövskogar*. (Metria AB). Naturvårdsverket.

Weeks, B.C., Naeem, S., Lasky, J.R., Tobias, J.A. & Davies, J. (2022). Diversity and extinction risk are inversely related at a global scale. *Ecology letters*, 25 (3), 697–707. https://doi.org/10.1111/ele.13860

Williams, L.-E. & Olsson, P. (2005). *Naturvårdsprogram för Hässleholms kommun*. Hässleholm. https://utveckling.skane.se/siteassets/publikationer_dokument/gronstruktur_i_skane.pdf [2022-02-21]

Willis, C.G., Ruhfel, B.R., Primack, R.B., Miller-Rushing, A.J., Losos, J.B. & Davis, C.C. (2010). Favorable Climate Change Response Explains Non-Native Species' Success in Thoreau's Woods. *PLOS ONE*, 5 (1), e8878. https://doi.org/10.1371/journal.pone.0008878

Wimberly, M.C., Boyte, S.P. & Gustafson, E.J. (2012). Understanding Landscapes Through Spatial Modeling. In: Stanturf, J., Lamb, D., & Madsen, P. (eds) *Forest Landscape Restoration: Integrating Natural and Social Sciences*. Dordrecht: Springer Netherlands. 111–128. https://doi.org/10.1007/978-94-007-5326-6_6

Wolf, A., Møller, P.F., Bradshaw, R.H.W. & Bigler, J. (2004). Storm damage and long-term mortality in a semi-natural, temperate deciduous forest. *Forest Ecology and Management*, 188 (1), 197–210. https://doi.org/10.1016/j.foreco.2003.07.009

AUTHOR'S NOTE

Apart from the cover figure and the illustrations in the results and discussion sections, which was created using the Artificial Intelligence Midjourney with some personal modifications, all the photographs and illustrations featured in this paper were captured or created by the author.

APPENDIX

GARNISONEN INTERVIEW WALK

The following text was sent out to the interviewees before the interview walk.

BACKGROUND

I will write a management proposal for the urban forest in the housing development area in Garnisonen. The forest will be a case example to apply a method for management plans. Interview walks are used to bring out existing values in the forest by today's visitors, with the goal of preserving and developing these places.

AREA MAP

The limited area within the planning area that is available for maintenance plan, marked in colors.

QUESTIONS OF ISSUE

- How close do you live to the area?
- How long have you lived there?
- How often are you out in nature?
- For example, 5 times / week, 1 time / week, 1 time / month.
- How often do you usually be out in Garnisonen Forest and what do you do there?
- For example, walk / run / rest the dog.
- Have you seen any other activities in the area?
- What is your favorite place / favorite part of the area?
- Are there any landmarks visible from the forest area that you appreciate?
- For example, views / ancient monument / buildings.
- Which areas could be improved?
- Do you perceive any part of the area as unsafe?