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Baseline Analysis, Frame Conditions, and Management Plan for Sjælegård:

A Rewilding Ecotourism Initiative on Bornholm, Denmark

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1. Preface

Before reading the contents of this thesis, two disclaimers must be made. Firstly, the owners of Sjælegård are my mother - Helle Bay Eriksen, and stepfather - Claus Bay Eriksen. Secondly, I will have continued involvement with the project following the release of this thesis and likely will implement parts of its management plan myself. Therefore, on top of a purely academic motive, I have a vested interest in seeing the project succeed. Additionally, there is emphasis on aspects of the plan that – although pertinent – are in line with the family vision of the project. That is not to say that the analyses are created to fit a pre-conceived plan. Rather that the plan is built with the limitations of a small privately owned project in mind, these limitations are transparently discussed. Furthermore, some interventions were conducted prior to the completion of the management plan. These interventions were informed by reading and data-gathering but out of necessity were carried out prior to some analyses and before the synthesis of the management plan. Interventions taken prior to completion are still discussed in the exploration. Many topics relevant to the management of Sjælegård were either excluded or very briefly addressed due to time considerations; these include: stakeholder interests, tourism, science communication, dispersal strategies, etc.

2. Acknowledgements

I would like to thank the people who have contributed to this thesis through their expertise, time, and labour. Karsten Raulund-Rasmussen for acting as a supervisor and guiding hand. Helle Eriksen & Claus Eriksen, the owners of Sjælegård for their hospitality and accommodation at Sjælegård. Agnes Nielsen, Anna Zimmerman, Sarah Kisbye and Yannick Hendriks for help with gathering botanical samples. Rasmus Thomsen for his help with driving soil cores into the ground. Tristan Rapp for assistance in biotope mapping. Michael Stoltze, Ole Lyshede, Morten-Ole Top, Linda Thomsen, and Lars Thomas for their contribution as experts during the bioblitz, as well as the many amateurs who partook in the activity. Anders Pihl and James Dodd for information on the history of Sjælegård, and the assistance of Bornholm's Museum generally. Ole Holm Pedersen and his team for investigation of hydrology on behalf of Bornholm Municipality. Thanks to Martin Sandager for inspiration provided by his private tour of Kragelund – a wetland rewilding project in central Jutland. Advice offered by Ole Pedersen (Not the same person as Ole Holm Pedersen) regarding forestry practices. Consultancy for agricultural subsidies and planning was provided by Simon Munk. Thanks to DOF Bornholm and especially Sune Sørensen for reshaping the DOF boundaries to allow ornithological monitoring at the site.

3. Abstract

The biodiversity crisis has become a global issue. In response to this there has been a growing number of private 'rewilding' initiatives to offset declines elsewhere. One such initiative is 'Sjælegård', a 26 ha agro-rewilding project on the island of Bornholm in Denmark. The baseline conditions of this site are investigated through: ecotope mapping, botanical surveys, vegetation structure analysis, bioblitz, photo sampling, bracken surveys, forest structure analysis, hydrology, and soil sampling. This is supplemented by a review of management tools for bracken control, options for grazing regimes and the legal and subsidy regimes in Denmark, all of which inform frame conditions at Sjælegård. The baseline study and frame condition review are synthesized into a management plan to transform agricultural fields and spruce plantations into biodiverse open landscapes and deciduous forest, respectively. With further improvements to a pre-existing oak forest, dominated by bracken. Herein, Galloway cattle and Shetland ponies are introduced and are - along with tree plantings, fencing, and selective clearings – used to create a wood-pasture. Spruce plantations are harvested and left to free succession. Bracken is managed primarily using biannual cutting. Many of these interventions are adaptive and subject to ongoing monitoring. The projects rely on subsidy schemes for funding.

4. Introduction

The world is facing a biodiversity crisis. There have been 322 species of vertebrates recorded lost since 1500, a decline in 67% of monitored insect populations and many more metrics of biodiversity loss globally (Dirzo et al 2014). In response to these declines as well as a general loss of nature areas, the field of restoration ecology arose. Of note in restoration is the concept of 'Rewilding' (box 1) which has become increasing popular in both the public and private sphere.

What is 'Rewilding'?

The word 'rewilding' has taken on a plethora of meanings, in its most broad sense it is the process of restoring a landscape to a 'wilder' state. Where rewilding usually differs from conventional 'Ecological restoration' is that rather than trying to emulate a baseline it is focused on restoring 'natural processes' even if it results in a novel state, and without the need for large-scale ongoing human management. In some cases, 'rewilding' specifically refers to the re-establishment of natural processes generated by fauna – typically in the form of vegetation disturbance via grazing or other activities (Jørgensen 2015). In this plan we will adopt the definition brought forward with Navarro & Pereira 2015 "Passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing human control of landscapes".

Box 1. The difficulties of defining rewilding and the definition used in this exploration.

One area where rewilding has become increasingly prolific is Europe, where urbanization has increasingly led to rural land abandonment, with 7.6 million hectares of agricultural land left uncultivated between 2001 and 2012 (Estel et al 2015). This is expected to create new opportunities for establishing nature areas on agricultural estates (Ceausu et al 2015). Some landowners have actively encouraged this trend of rewilding and set up nature-based initiatives and businesses. This often takes on a distinctly domestic character, where food-producing livestock are used as analogues for wild megafauna (Gordon et al 2021; Corson et al 2022). Such a system theoretically offers both biodiversity and financial opportunities through livestock rearing and ecotourism (Corson et al 2022). This may be referred to as 'agricultural rewilding' (Corson et al 2022) or 'rewilding lite' (Gordon et al 2021) and can be thought of as an intermediary of extensive agriculture and 'true' rewilding (Gordon et al 2021; Corson et al 2022).

A great example of this is Knepp Wildland in the UK – a 1400 ha rewilding initiative, which replaced its former business model of intensive agricultural with agricultural rewilding with revenue generated from meat sales, biodiversity schemes and eco-tourism (Tree 2017). Along with this shift was a change in the health of the local ecosystems with measured improvements in soil fertility, biodiversity, carbon sequestration, and other ecosystem services (Tree 2017)

Sjælegård is a new private ‘agricultural rewilding’ initiative, on the island of Bornholm in Denmark and seeks to emulate the successes of Knepp Wildland. Though Knepp can provide inspiration to the project, the management regime of Sjælegård is likely to differ from Knepp, due to three key differences: Firstly, it operates at a much smaller scale – encompassing 26 hectares; secondly Sjælegård is based in Denmark, rather than the UK and therefore most conform to different legal and subsidy requirements; and lastly the underlying ecological conditions are likely to differ.

The vision at Sjælegård is to convert an intensive agricultural landscape into a woodland-pasture or ’Vera landscape’ (Box 2) which supports high levels of biodiversity and habitat heterogeneity (Plieninger et al 2021). To this end, a few challenges need to be addressed. Firstly, the vegetation structure of Sjælegård’s open areas is exceedingly homogenous, and the establishment of a mosaic is needed to attain a woodland-pasture, how can a mix of successional stages be accomplished? This is in part a question of which herbivores should be utilized at Sjælegård and at what concentrations but will also include interventions to artificially ‘accelerate’ succession. And secondly, a rudimentary evaluation of the hydrological regimes at Sjælegård is carried out. As a backdrop to these challenges are the restrictions imposed by the laws of Denmark and a desire to conform to various subsidies defined under the agricultural support scheme (landbrugstøtte) to give the project financial viability. Thus, an evaluation of these will help tailor interventions and choose which subsidy schemes are most in line with the vision of Sjælegård.

A secondary objective in the rewilding initiative at Sjælegård is to improve the biodiversity value of a forest area already present - comprised primarily of light-open oak forest and spruce plantation. The main challenges are how to transform the plantation monocultures into light-open deciduous forest? Additionally, the forest area is dominated by an overgrowth of bracken (*Pteridium aquilinum*), a problematic species which outshades most other forest-floor species and poses health risks for livestock. Which management tools can be used to reduce the range and quell the spread of this species? As with the agricultural areas, there are legal restrictions to consider, these concern areas with ‘protected forest duties’ (fredeskov) which encompass most of the spruce plantation. There is also a prospective ‘subsidy towards biodiverse forest’ (tilskud til skov med biodiversitetsformål), which has several requirements.

What is a 'Vera Landscape'?

Also known as woodland-pasture or wood-pasture. This landscape type was outlined by the ecologist Frans Vera as a model for the dominant habitat in temperate Europe prior to the loss of its megafauna. Wood-pastures are characterized by a semi-open structure with a mosaic of successional stages, as well as the abundance of light-open trees, such as oak, lime, and hazel (Vera 2000).

Image 1. An example of a 'Vera landscape' or woodland-pasture from Knepp Wildland, showing various stages of vegetation succession but a generally open character. This image is used under a CC BY-SA 2.0 licence and was captured by Matt Ellery

Box 2. The definition and characteristics of a Vera landscape or woodland-pasture

To address these challenges and provide guidance on a suitable management plan, several approaches are taken. Firstly, a preliminary survey of the baseline conditions at Sjælegård is investigated. This survey serves multiple purposes: It provides information about the landscape present at Sjælegård including mapping of the geology, ecology and land-uses which can help spatially guide interventions and planning. The survey establishes an ecological baseline from which future monitoring can compare to establish a trajectory. Such survey components include: Raunkjær sampling of botanic diversity and composition, a vegetation structure analysis, a bioblitz of the total diversity present, photographic sampling of nature areas, mapping of bracken occurrences, a forest structure analysis and soil sampling.

Secondly, a supplementary literature review of the toolsets which may be used to accomplish the objectives of project is carried out to determine which are most prudent at Sjælegård. These reviews consist of bracken control measures and potential grazing regimes.

Thirdly, a review of the relevant laws and subsidy requirements will inform the constraints of any interventions. The animal welfare law (dyrevelfærdsloven), the forestry law (skovloven), the nature protection law (naturbeskyttelsesloven), the management law (driftsloven) and the agricultural law (landbrugsloven) are all reviewed to established the legal frame conditions at Sjælegård. Likewise, the various subsidy schemes which are supplied by the department of agriculture were also reviewed to investigate their compatibility with a management plan towards a wood-land pasture system.

These three approaches culminate in a management plan. This plan utilizes both short-term interventions and long-term recommendations which will influence the trajectory of Sjælegård, with an adaptive management strategy to complement it. The plan comprises measures to establish a wood-pasture, control bracken and establish a biodiverse forest in replacement of spruce plantation. It further identifies the most suitable subsidy regimes and is designed to accommodate the requirements of these subsidies.

5. Site Description

Sjælegård is located at the co-ordinates of 55°15'26.2"N 14°47'21.9"E on the Danish island of Bornholm, close to the towns of Allinge-Sandvig and Olsker. Bornholm is located in the south-west Baltic Sea, between the province of Scania in Sweden and West Pomerania in Poland (figure 1).

Figure 1. Map showing the location of Sjælegård within the West Baltic region, including the nearby countries of Sweden, Poland, Germany and Norway. Sjælegård is located on the island of Bornholm which is a part of Denmark (Shaded). Background map is the Natural Earth 2 Raster.

According to the Danish Meteorological Institute (DMI), the average temperature on Bornholm was 8.5°C between 1981 and 2010, with summertime temperatures averaging 16.3°C with average peak temperatures at 28.7°C. Wintertime by contrast averaged 1.7°C, with minimum temperatures of -9.0°C (Danmarks Meterologisk Institut 2023). These temperatures are all projected to rise in line with global warming (Danmarks Meterologisk Institut 2023). Average annual rainfall was 1.84mm/day, peaking in autumn at 2.32mm/day, and being driest in spring with an average of 1.18mm/day (Danmarks Meterologisk Institut 2023). Bornholm is projected to received increased rainfall due to climate change (Danmarks Meterologisk Institut 2023).

The property itself comprises 25.9 ha distributed across two cadastres, the larger cadastre (14a) extends 24.0ha and covers most of the estate; a second cadastre (16e) of 1.9ha is restricted to the south-west corner (corresponding to area 5 in figure 2). For the purposes of management and discussion, the estate can be sub-divided into 11 distinct areas (figure 2):

1. The north triangle - A small sliver of land in the far-north of the estate, separated by the road of Blåholtvej from the rest of the property. The north triangle contains an apple orchard alongside a small valley with overgrown slopes.
2. The manor house and garden – The area located south of Blåholtvej containing the manor house comprised of an L-shaped building and an associated barn. Immediately to the north of the manor house is a garden, which extends eastwards to a small artificial pond. The garden also contains a small teahouse and a chicken coop. To the west of the manor house is a small patch of woodland, as well as a semi-open area with beach rose (*Rosa rugosa*) bushes.
3. The north field – The north field is comprised of a large agricultural area which has been used for wheat cultivation in the year of 2022. A central path bisects the field into a western and eastern section. The western section runs along Blåholtvej and forms the northern and eastern boundary of the fallow field (area 4). Meanwhile the eastern section runs along a channelized stream which forms the boundary of the property in the east. Two major overgrown granite outcrops can be found in the north field, along with several smaller granite patches which have been integrated into the agricultural field.
4. The fallow field – A fallow field, rich in granite outcrops. Also containing patches of forest especially along the west fringe and centre. In the south-west is a planted row of common hawthorn (*Crataegus monogyna*) and guelder-Rose *(Viburnum opulus*). A dense patch of young black alder (*Alnus glutinosa*) is also present in the south-east.
5. The spruce plantation – A dense forest of primarily Norway spruce (*Picea abies*), though with some deciduous trees interspersed – especially around the edges of the plantation. The

south, west and northern boundaries of the area are delineated by an old stone fence. An artificially dug shallow pond is also present in the north of the area, with a small island present – planted densely with elephant grass (*Cenchrus purpureus*). The north-east section of the area is comprised of young growth forest primarily of birch (*Betula spp.*) and common hazel (*Corylus avellana).*

6. The central forest – A large expanse of light-open oak (*Quercus robur*) forest, though with patches dominated by European beech (*Fagus sylvatica*) and planted Norway spruce (*Picea abies*). bracken (*Pteridium aquilinum*) and brambles (*Rubus spp*.) are near-ubiquitous in the undergrowth, though some sections consist of various forest herbs and grasses. The eastern part of the forest is present on a hill known as 'Sjælebakken' and shows very steep slopes in places. Granite outcrops and wetland patches are found throughout the forest. Wetland patches comprise both low-lying areas and artificial ponds formed from old granite quarries. An old hunter's lodge is present in the western part of the forest, in the far-east is the main granite quarry, containing a point of geological interest.
7. The twin rocks field – A smaller area containing a field with two large granite outcrops, one of which is partially overgrown with vegetation. This area also includes the transition zone between the main forest and south field (area 10) which consists of a semi-open landscape dominated by bushes, primarily blackthorn (*Prunus spinosa*) and beach rose (*Rosa rugosa*). This includes a steep slope in the east.
8. The lakeside meadow – A small meadow area located to the east of the twin rocks field stretching to the banks of lake 'Sjælemose' (area 9). In the south there is a shed for grazing animals to take shelter.
9. 'Sjælemose' – A lake partially contained in the cadastre of Sjælegård, with the southern half and north-tip located within bounds. The neighbouring cadastre contains the middle section of the lake as well as part of the west bank. The lake is surrounded by forest of predominantly black alder (*Alnus glutinosa*).
10. The south field – An agricultural field, which grew wheat in 2022. The western periphery contains a dense growth of hedge, but there is no clear delineation with the adjoining field to the south.
11. The bulb – A smaller patch of woodland, with steep embankments to the south and east. Dominated primarily by oak and hazel. Named for its bulbous shape in the boundary with the south field.

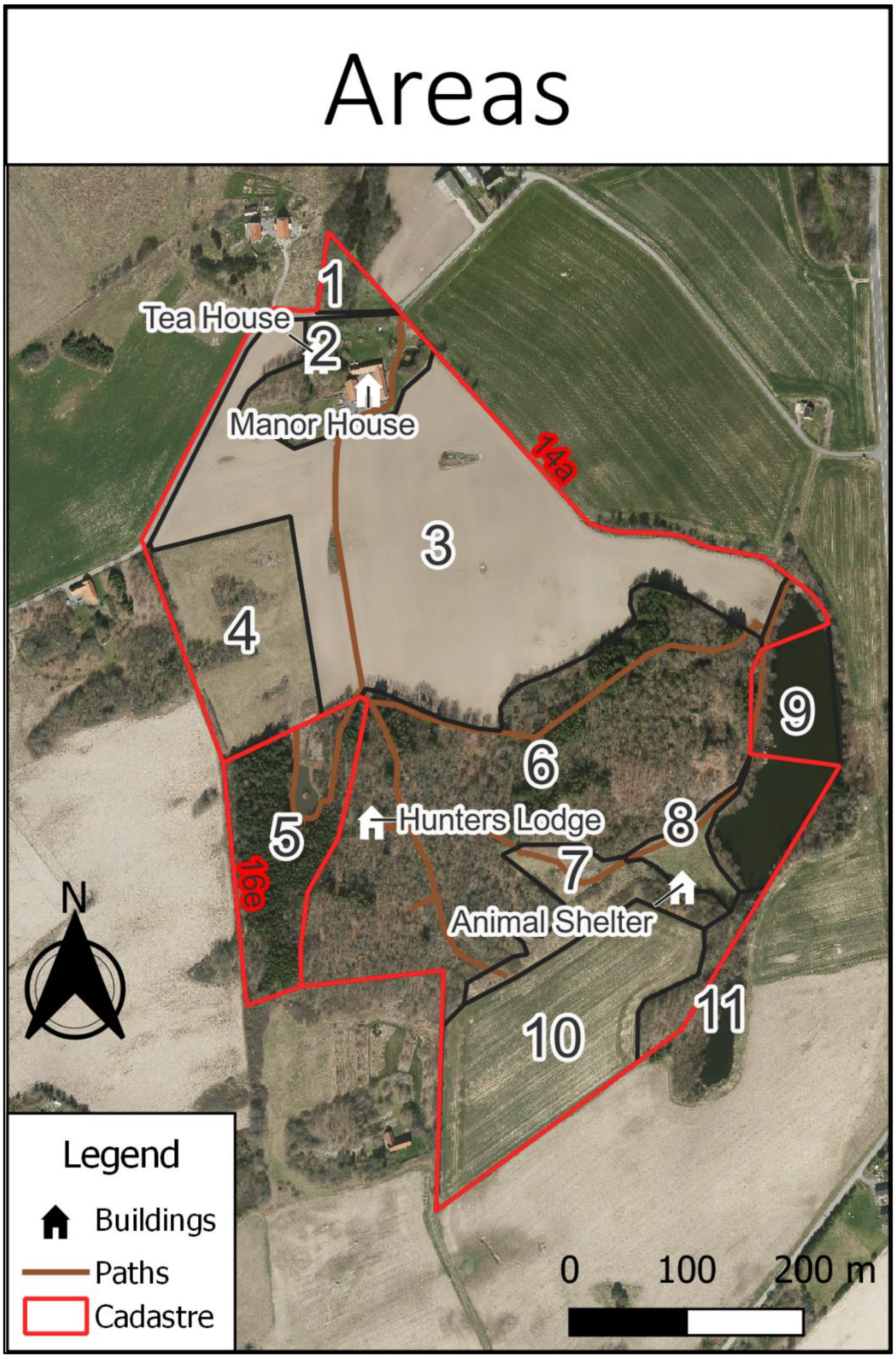

Figure 2. Map of the areas defined in the site description along with the paths around the property and the various structures on the property. Outlines of the cadastres are also displayed in red. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

Geology

Bornholm's geology is unique within the national context, as it has stronger affinities to landscapes seen on the Fenno-Scandinavian mainland (Olsens 1950; Gravesen 1996). The island's bedrock is comprised primarily of pre-Cambrian granite, which lies just below the surface on most of the island and in many places ejects above the soil (Olsens 1950; Gravesen 1996) - this is especially the case in the north of the island where Sjælegård is located. The granite on Bornholm is further sub-divided into various types, of note in this exploration are the red 'Hammer granite' and the darker and mottled 'Vang granite', both of which are relatively young species, dating to ca. 1.4 billion years ago (Gravesen 1996). A boundary between these two species is located on Sjælegård making it a point of geological interest (Gravesen 1996; Miljøstyrelsen 2022a).

Perched atop the pre-Cambrian strata are much younger quaternary layers deposited during the last 2-3 million years via the movement of glacial ice in northern Europe – and especially during the Weichsel ice age (Ca. 10kya to 120kya). Amongst the various Quaternary soil types, moraine till is by far the most prolific (Gravesen 1996). Unlike the rest of the country, Quaternary layers on Bornholm are generally quite shallow, usually between 0 and 20m (Gravesen 1996)

History

Agriculture island-wide dates to about 5000 BP (Olsens 1950), and the earliest evidence of humans on the cadastre is a pair of stone-age artefacts (Kultur og Slotsminsteriet 2023). Petroglyphs portraying ships are the most noteworthy archaeological discovery - estimated to be from the Late Bronze Age (ca. 3100-2600 BP) (Dodd & Dueñas 2014; Kultur og Slotsminsteriet 2023). There is evidence of a terrace-farm complex in the spruce plantation and a medieval road in the south-west of the property. Archaeological remains of a Viking Age/medieval house have been found in the south field (Kultur og Slotsminsteriet 2023). The kulturarv database contains registered historical discoveries in Denmark, Sjælegård had 10 such registrations (figure 3), including the aforementioned discoveries (Though not the medieval Road). Additionally, there are also cup-marks and unspecified discoveries included. None of these discoveries are considered protected.

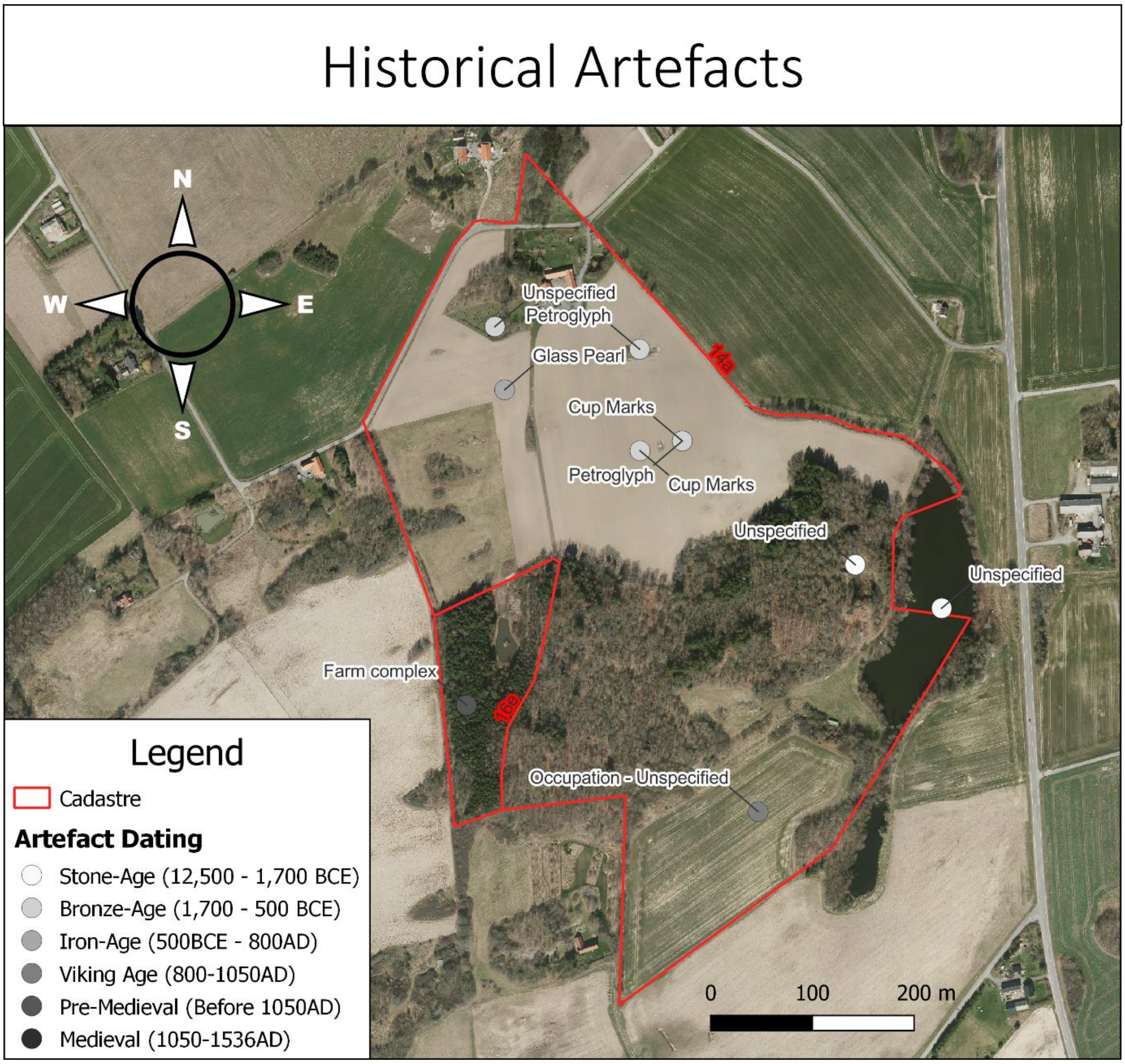

Figure 3. Map displaying the various artefacts discovered at Sjælegård which are registered at kulturarv as well the artefact ages and types. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

It is unclear when 'Sjælegård' itself was erected due to a lack of official records in the Middle Ages. The first official registration dates to 1598 (Bornholm Stamtavle 2023). In contrast to other parts of Denmark, most of Bornholm's estates were owned by the peasants who farmed the fields rather than local aristocracy, and Sjælegård was no exception (Bornholm Stamtavle 2023; Olsen 1950). By 1646 the estate was apparently reduced to its foundations known in Danish as 'Stæl' and is possibly where the original name 'Stællegård' is derived, which was with time bastardised to 'Sjellegård' and then 'Sjælegård' – which now translates as 'Soul estate' (Olsen 1950). The modern iteration was erected in 1857, according to a stone engraved at the front of the property.

Image 2. Aerial photo of Sjælegård from 1955 by Sylvest Jensen

Land use records on the estate are more difficult to pin down, likely agriculture in the area extends back centuries, but this can't be corroborated. The earliest known cartographic records showing Sjælegård are from a national map initiative from 1870-1899 (Styrelsen for Dataforsyning og Infrastruktur 2022) and shows the allocation of agricultural land as a close match to modern-day land use. Lake 'Sjælemose' was probably a former peatland, as is implied by the word 'mose' which means 'mire', though no historical records have confirmed this suspicion so far. In addition, there is evidence of a stream running between the manor house and spruce plantation, which has since been placed in underground channels. Aside from conventional agriculture there is also evidence of apiculture in the forest during the early 20th century (image 3) and orthographic evidence suggests spruce plantations were erected sometime before 1995 (Miljøstyrelsen 2023b). In addition, granite was mined on the estate, this constituted one of the primary export commodities of the island through the 19th and early 20th century (Olsens 1950).

Image 3. Undated photograph of apiculture in the forest of Sjælegård. Photograph received from previous landowners.

6. Methods

Ecotope mapping

Three types of ecotope maps were produced in QGIS 3.22.8 (QGIS Development Team 2022): A biotope map – Indicating the plant community, a geotope map – classifying the land topography and pedology, and a land use map – Indicating the primary functions of different patches. The co-ordinate reference system (CRS) used for this, and all other datasets was ETRS89 UTM N Fuseau 32. Bornholm is more compatible with UTM N Fuseau 33, but 32 was favoured due to most national datasets using this system.

Biotope mapping

Biotopes were classified based on the dominant vegetation and habitat structure with characteristics outlined in table 1. The mapping was performed by georeferencing the relevant boundary points using the data collection software mergin (Razmjooei et al 2023) on an iPhone 8 and corroborating this with orthophotos retrieved from dataforsyningen (Styrelsen for Dataforsyning og Infrastruktur 2022), using this data the biotopes were manually digitized in QGIS.

Table 1. Biotopes present at Sjælegård and their defining characteristics.

Biotope	Characteristics
Oak Forest	Light-open forest with high dominance of pedunculate oak (*Quercus robur*) and high undergrowth cover – primarily bracken *(Pteridium aquilinum*) and brambles (*Rubus spp*.)
Spruce Forest	Shaded forest with Norway spruce (*Picea abies*) monoculture. Little to no undergrowth cover.
Beech Forest	Shaded forest with high European beech (*Fagus sylvatica*) dominance. Little to no undergrowth cover.
Birch Forest	Light-open forest with high dominance of Birch (*Betula pendula & Betula pebuscens*). Medium to high undergrowth cover.
Hazel Forest	Mostly shaded forest with high dominance of Hazel (*Corylus avelina*). Medium to high undergrowth cover.
Alder Forest	Mostly shaded forest with high dominance of black alder (*Alnus glutinosa*). Medium to high undergrowth cover.
Mixed Hedge	Linear stretches or small patches of dense vegetation – bushes or trees. High variability in woody species which includes European blackthorn (*Prunus spinosa*), common hawthorn (*Crataegus monogyna*) hazel (*Corylus avelinea*) and sweet cherry (*Prunus avium*).
Oak Savannah	Semi-open habitat with abundance of beach rose (*Rosa rugosa*), pedunculate oak (*Quercus robur*) and grasses – most abundantly common bent (*Agrostis capillaris*)
Apple Orchard	Semi-open habitat with planted apple (*Malus domestica*) and grassy undergrowth (Not identified).
Fuki Stand	Dense monoculture of fuki (*Petasites japonicus*)

Garden	Wide range of mostly non-native species. Planted in select patches and surrounded by shortly cropped grass (Not indentifed).
Wheat Field	Dense monoculture of wheat (*Triticum aestivum)*
Xeric Grassland	Open habitat with dominance of grasses such as tufted grass (*Holcus lanatus*). Large number of granite outcrops.
Mesic Grassland	Open habitat. Dominance of wet grasses – particularly tall fescue (*Festuca arundinacea*).
Water	Permanent water bodies

Geotope mapping

A digital terrain model (DTM) was retrieved from Dataforsyningen (Styrelsen for Dataforsyning og Infrastruktur 2022) and cut to fit the extent of Sjælegård. The raster data was transformed into polygons at boundaries of 92m and 98m, which created lowland, midland, and highland areas. These values were chosen because they corresponded well to the geographic features found at the site, namely the lakes and valleys which lie below 92m and the main hill above 98m. The border between areas was smoothed out by manually removing exclaves.

In addition, a 2021 map of the soil types of Denmark was retrieved from ‘De Nationale Geologiske Undersøgelser for Danmark og Grønland’ (GEUS 2022) and cut by the extent of Sjælegård. The two layers were then combined using the ‘union’ tool to create a geotope map that integrates both variables.

Land use mapping

Mapping of the land use on Sjælegården was also carried out. As with biotope mapping, these were manually digitized based on point collection using Mergin as well as digital orthophotos. They were divided into the following categories:

Table 2. Land uses present at Sjælegård and their defining characteristics.

Land Use	Characteristics
Agriculture	Area containing crops which are removed annually – At Sjælegård this is exclusively wheat
Garden	Carefully managed area producing plants for decorative purposes
Field	Open areas with vegetation not for commercial sale. Though this may include grasses grown as a food source for livestock.
Hedge	Narrow slivers of vegetation used to separate different land uses
Plantation	Area with vegetation planted for long-term harvesting, e.g., fruit or lumber.
Forest	Non-plantation forest, covering large continuous areas (As opposed to hedge)
Infrastructure	Buildings and roads
Water	Standing bodies of permanent water

Botanical surveys

Botanical surveys were conducted using Raunkjær circles and sampled the plant species across different biotopes. Six primary biotopes (wheat field, oak Forest, spruce forest, xeric grassland, mesic grassland & oak savannah) were selected and sampled at 10 sites each, an additional 3 secondary biotopes (beech, birch and hazel forests) were selected and sampled at 5 sites each. The remaining biotopes were not sampled. Sampling locations were generated in QGIS using the 'random points in polygon' tool. An exception was made with the sampling of wheat fields where access was restricted to machinery tracks, because the land was leased out during 2022. These agricultural sample points therefore followed convenience but were spread out intentionally and then georeferenced using mergin.

Raunkjær circles were placed at the pre-defined points. Plant species were identified where possible using the botanical guides: Ny Nordisk Flora (Mossberg & Stenberg 2014) & Felt Floraen (Mossberg & Sternberg 2010) in conjunction with the plant identification apps 'Seek' (iNaturalist LCC 2022) & 'Picture This' (Glority Global Group Ltd 2022). Cover of each species within the Raunkjær was also estimated and categorized (table 3). In cases where a species could not be identified it was designated to the lowest possible taxonomic level, usually genus or family. Data was collected between 18th-21st of July 2022.

Data collected from Raunkjær circles was used to calculate biological indicators, this includes the mean plant species richness and species count in habitat. Shannon's diversity index and Shannon's equitability index were also calculated based on the plant coverage (table 3).

To use the plant composition as an indicator for the abiotic conditions, Ellenberg values were used. Because no published Ellenberg values specific to Denmark were available, the values for each species were retrieved based on a British dataset by Hill et al 1999. Ellenberg values range between 1 and 9 and are categorized into light (L), reaction/pH (R), nitrogen (N) and salt (S). Moisture (F) is also a factor, though this is scored between 1 and 12. Higher numbers reflect higher exposure to the factor in question (e.g. high R value reflects a high pH, low F values reflect dry conditions). Weighted Ellenberg values were calculated for each Raunkjær circle based on the pre-defined value of each identified taxon and its coverage, and then mean habitat values were produced based on all the samples in a habitat. Raunkjær circles lacking any species were omitted from the Ellenberg analyses.

Table 3. Relative weightings used in Ellenberg's, Shannon's and vegetation openness metrics based on coverage.

Coverage	Weighting
0-5%	0.05
5-10%	0.1
10-30%	0.3
30-75%	0.75
75-100%	1

Vegetation structure

An analysis of the vegetation structure at each selected biotope was also conducted – sampling was based on biotope results. However, seeing as many biotopes had multiple discrete patches, the vegetation structure analysis was carried out on a patch basis rather than an overall biotope basis. Patches were defined as an area of a biotope disconnected from other areas of the same biotope. A single exception was also made for the oak forest biotope, as there are large discrepancies in the topography and vegetation, thus two patches were defined: The 'oak hill' and the flat 'oak forest', despite the two being connected.

The vegetation structure was defined by the relative coverage of different classes of plant material with the following height categories: no vegetation cover, grasses/herbs under 15 cm, grasses/herbs 15-50cm, grasses/herbs over 50cm, shrubs and trees. The coverage categories follow the same classification scheme as the Raunkjær circles (table 3), except for tree cover, which has distinct classes (table 4). Both classification systems follow from Denmark's Miljøundersøgelser/Denmark's Environmental Studies (Fredshavn & Ejrnæs 2009). The coverage was estimated from visual observations and data was collected between 18th-21st of July 2022.

Table 4. Tree coverage classes used in the vegetation structure analysis as defined in Danmarks Miljøundersøgelser (Fredshavn & Ejrnæs 2009)

Tree coverage classes	Weighting
0-1%	0.01
1-10%	0.1
10-25%	0.25
25-50%	0.5
50-100%	1

Each vegetation class is further assigned a vegetation openness score (table 5), except for 'No vegetation over' because it is not light dependent (e.g., it can represent both dark forest floor and open bedrock) and thus makes a poor indicator. The vegetation openness scores were multiplied by the relative weightings and divided by the sum of weightings for each patch to create an openness index. Given that the minimum value for each class is 0.05 (or 0.01 in the case of tree coverage), this means the lowest possible index score is 1.4, and the highest score is 4.7. The mean index of patches across a biotope was also calculated to create a biotope openness index. Both the vegetation openness score and biotope openness index are simple systems developed as part of the baseline study.

Table 5. Vegetation openness score of each vegetation class, with higher vegetation contributing to a lower vegetation openness score.

Vegetation Class	Vegetation Openness Score
Grasses/Herbs under 15cm	5
Grasses/Herbs 15-50cm	4
Grasses/Herbs over 50cm	3
Shrubs	2
Trees	1

Bioblitz

A bioblitz was carried out independently of the sampling efforts of this exploration, however the data collected is used as part of the baseline analysis. The bioblitz was conducted between 12pm on the 23rd of July and 12pm of the 24th of July 2022 and involved a group of amateurs and specialists identifying as many species as possible within the allotted time. Data was recorded on Arter - a Danish database for species sightings. Arter allows each species sighting to be georeferenced. Planted species were omitted from the bioblitz, both because they did not reflect the local biota and because they are absent from the Arter database. The data produced is a list of taxa present on the estate.

Photo sampling

10 Photo points were defined around Sjælegård (figure 4). Images were shot with a Canon EOS 6D Mark II camera with a Canon EF 16-35mm lens using a wide-angle function. The photo points were georeferenced using Mergin and poles were erected at each point to accurately be able to find the positions. The angle of each photo was defined using a compass app. The first series of photos was taken on the 2nd of August 2022. These pictures were largely of the open-areas due to the ease of photographing those landscapes, though a single image of the spruce plantation and a photo of the oak forest were also included.

Figure 4. Defined photograph points with directionality of shots (Arrows) with the first round of photographs collected on August 2nd 2022. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.

Bracken Distribution

To monitor the spread and control of common bracken (*Pteridium aquilinum*), an atlas over its distribution at Sjælegård was established. A grid was created in QGIS with a cell size of 50x50m, and the extent of the grid was defined by the cadastres of Sjælegård, with the grid being defined to start with the furthest north and west limits (figure 5). The grid is comprised of square vector cells. Centroids of each of each grid cell were extracted and then N-S transect lines were established between them and cut by the cadastre limits (figure 5).

The transect lines were transferred to google maps so that they could be followed in the field. Observations to establish the presence or absence of bracken in each grid cell were taken walking along these transect lines. In places detours were necessary due to impenetrable terrain, fencing or other obstacles, in such cases observations were resumed on the other side of the obstacle. Observations were carried out on the 17th and 18th of November and though most bracken was wilted; it was still easy to identify ferns.

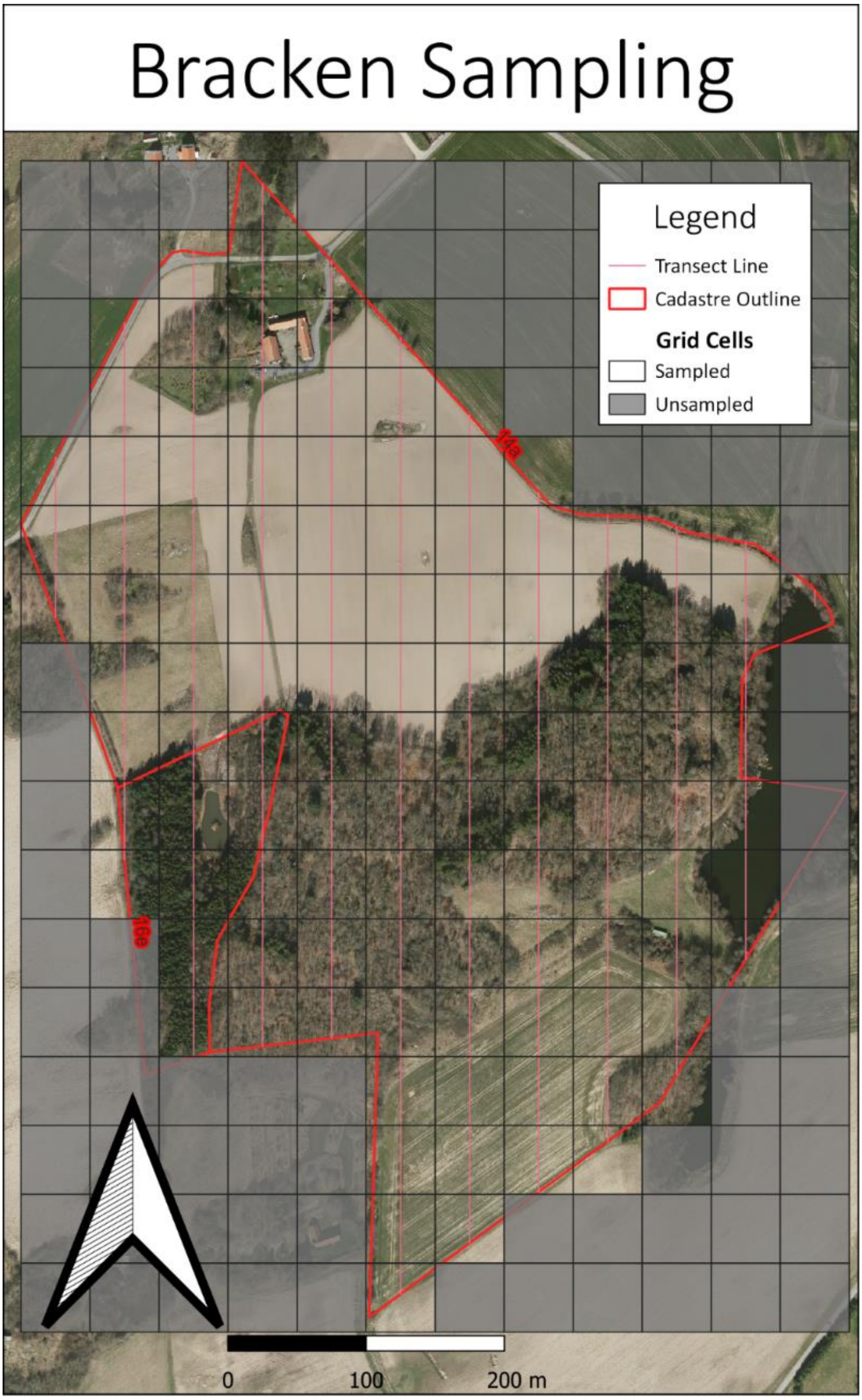

Figure 5. Sampling area for the bracken atlas, with a defined grid of 50x50m cells. Transect lines (Pink) connect the centroids of cells and extend to the cadastre boundaries. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.

Forest Structure Index

An evaluation of the forest structure was also carried out using the GEUS forest structure index (Møller 2005). The index was calculated based on yes and no answers to a questionnaire of a hundred questions (appendix 2). The questionnaire was broken down into the following categories: area, stand structure, tree species, trees independent of species, canopy, understorey, dead wood, flora, topography and soil, hydrology, and management impacts. The index score was calculated as a percentage of answers which were affirmative. Observations were made using the same transect lines as in figure *5*, though confined only to the central forest area and spruce plantation. Some information was also obtained in conjunction with soil sampling and inferred from the four samples collected within the forest. Further information regarding size and topology was discerned using QGIS. Field data collection was carried out on November 17th, and it should be noted that these were taken after the spruce plantation was felled (section 9 for more information). The entire forest was treated as a single area for the sake of the index, despite notable variations within.

Soil Sampling

A soil sample was collected at each geotope (except freshwater) – with an additional sample taken in geotopes with an area of over 1Ha. sampling points were randomly sampled using QGIS. All soil samples were taken on the 7th of December 2022.

Soil samples were extracted by placing a 1m soil core perpendicular to the ground and then driving it down using a rubber mallet. Where possible, the cores were driven down the full metre, however several sites had high bedrock which prevented this. Once the soil core was extracted, six variables were measured using a meterstick:

1. Depth to bedrock - measured by the total length of the soil core. In cases where soil core length was a full meter, this was simply recorded as N/A.
2. Depth to oxidised mineral layer - Length between the top of the soil core to the first traces of a reddish colour in the soil which indicates the absence of standing water in mineral soil.
3. Depth to pseudogley/gley – Length between the top of the soil core to the first occurrence of a blue green colour in the soil, indicating partial or permanent waterlogging.
4. Depth of peat – Length between the highest and lowest observation of peat in the soil core
5. Texture class – Whether the soil extracted shows primarily characteristics of clay, sand, silt, or organic soil. Clay determined by the ability to roll clay ‘sausages’, sand feeling grainy when rubbed between fingers, silt feeling slick when rubbed with water and organic soil determined by its black/dark brown colour.

6. Thickness of leaf litter – the length between the highest and lowest observation of organic material in the soil core.

Hydrology

No concerted effort was made to measure hydrological aspects at Sjælegård, due to limited time and resources. Nevertheless, some hydrological information has been gleaned from general observations as well as the results of other methods such as Ellenberg values, geotope data, soil samples and historical information. Furthermore, some information on drainage pipes was also obtained through exploratory excavations by Bornholm municipality, though this was restricted to the west side of the north field. These excavations were conducted along two west-east lines, one located near the estate in the north and one near the area 5 pond in the south (image 4).

Image 4. Excavation of the ground to look for drainage pipes immediately north of the pond in area 5.

Grazing Review

A non-systematic review of the potential herbivores which could be introduced at Sjælegård. Many species have been used in rewilding projects, and an exhaustive list is outside the purview of this investigation. Instead, the list was restricted to domesticated livestock. Only species native to northern Europe or – failing this - with native congenerics, were chosen. This limited the candidates to: cattle, domestic water buffalo, horses, donkeys and pigs. European bison (*Bison bonasus*) is used for livestock elsewhere in the country but was excluded as it can't be considered 'domesticated' and brings with it safety concerns with visitors.

Another aspect investigated was the large herbivore densities recommended. This involved a search for studies which estimate the natural herbivore densities in Europe as well as recommend levels by the Danish authorities.

Bracken Control Review

A supplementary literature review of how to effectively manage bracken was carried out on Web of Science and Google Scholar. Results were limited to literature published after the year 2000 and included literature was confined to the first thirty search results. the search terms used were: 'bracken control', 'eagle fern control', '*Pteridium aquilinum* control', 'bracken management', 'eagle fern management' and '*Pteridium aquilinum* management'. Studies or reviews not directly investigating control methods were excluded (e.g. papers on bracken toxicity). Both pertinent reviews and studies were included. Case studies and data pre-dating 2000 was also included when they were referred to in reviews. Furthermore, the included literature was restricted to European locations. Articles which Copenhagen University lacked access to were also omitted, as were non-English texts. The herbicide asulam is commonly utilized in bracken management but was excluded from this review due to its illegality in the European Union (Akpinar et al 2023). Further information about bracken ecology and toxicity was also investigated, though not systematically.

Law and Subsidy Review

A review of the following legal documents was carried out: landbrugsloven (Bekendtgørelse af lov om landbrugsejendomme) – in English the agriculture law, driftsloven (Bekendtgørelse af lov om drift af landbrugsjorder) – the management law, skovloven (Bekendtgørelse af lov om skove) – the forest law, naturbeskyttelsesloven (Bekendtgørelse af lov om naturbeskyttelse) – the nature protection law, and dyrevelfærdsloven (Bekendtgørelse af lov om dyrevelfærd) –the animal welfare Law. Accompanying 'guidance' documents issued by the relevant authorities were also reviewed. Paragraphs of importance to the management were identified and explained.

Additionally, a review of subsidy schemes in association with biodiversity and nature was also undertaken. These only include public schemes and not private organisations. The agro-schemes reviewed were released by the ministry of food, agriculture and fisheries – however as there is a reform in the subsidies starting in 2023 – the specifications for these schemes were limited to available information.

Finally, using Danmark's Arealinformation (Danmarks Miljøportal 2023), the areas protected under §3 of the Nature Protection Law were mapped in QGIS. Likewise, the HNV values for the open areas at Sjælegård were also mapped. The relevant HNV file was not available for download and thus could not be transferred to QGIS. As such a map was produced directly using Danmarks Arealinformation.

Management Plan

The management plan was ultimately constructed as a synthesis of the information gathered in the baseline analyses and reviews. The management plan consisted of both short- and long-term interventions and recommendations. This is additionally bolstered by monitoring schemes which feed into an adaptive management strategy. The interventions are subdivided into those implemented prior to the completion of this exploration and plan, those pertaining to the fields and finally those pertaining to the forest. The management plan for fields is supplemented with suggested small biotope locations, optimised to ensure a proximity to most of the open land. This optimisation was done by buffering 50m from each biotope in QGIS to ensure near-complete coverage. The plan for the forest is supplemented with a selection of trees for protection. These trees were selected throughout the central forest area as well as the spruce plantation (which has been harvested at this point) and were chosen on the basis of large size – with a tolerance for smaller individuals of non-oak species. Only native species were eligible. Selected trees had their diameter measured at breast height using a ruler and assigned to the defined size categories: 25-49cm, 50-74cm, 75cm or more. The tree species were also identified to species level (except in the case of birch which was only classified to genus) and each tree was georeferenced using Mergin.

7. Baseline Studies

Ecotope Mapping

Biotope Mapping

The biotope mapping showed that the largest biotope present on Sjælegård was wheat field, which covered approximately 10.6 ha (figure 6). This was followed by oak forest (6.2ha), xeric grasslands (2.2ha), spruce forest (2.0ha) and mixed hedge (1.1ha). All other biotopes covered an area of 0.8ha or less.

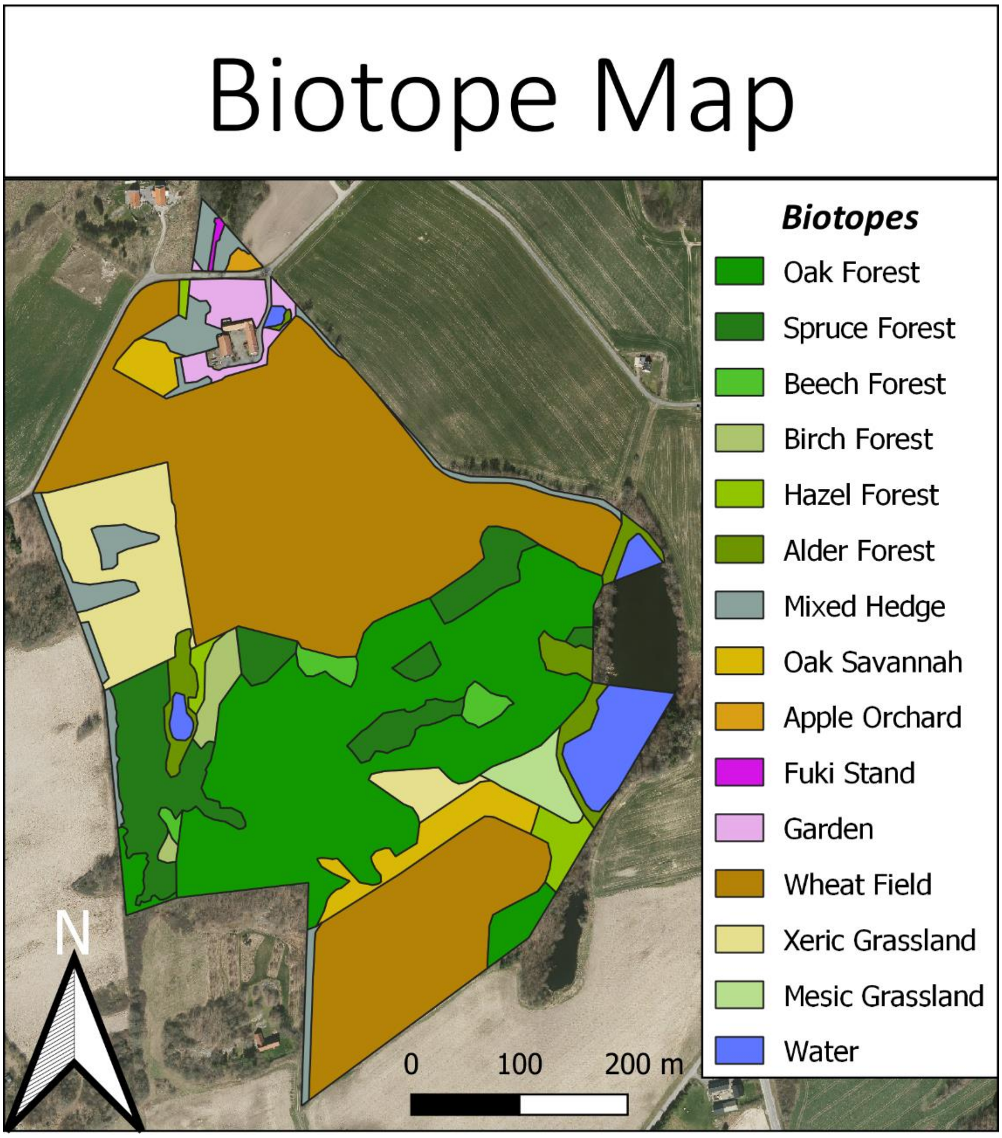

Figure 6. Map showing the biotopes present at Sjælegård and their spatial extent. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

Geotope Mapping

The geotope mapping showed that lowland areas occurred primarily in the north and east of Sjælegård, but also included a valley in the west and a patch in the south (figure 7). Midlands formed the transition between uplands and lowlands and was most prevalent in the south and centre. Uplands were only found in the centre of the estate, barring a small patch in the south. The three categories covered 9.5, 12.0 and 4.9ha respectively.

The dominant sediment type was moraine till which covers approximately 14.9ha, primarily in the low and midlands. Pre-Quaternary sediments covered 8.8ha. Finally freshwater gyttja covered 1.8ha, solely in the lowlands. Altogether, nine different geotopes can be defined based on the combinations of sediment types and elevation categories.

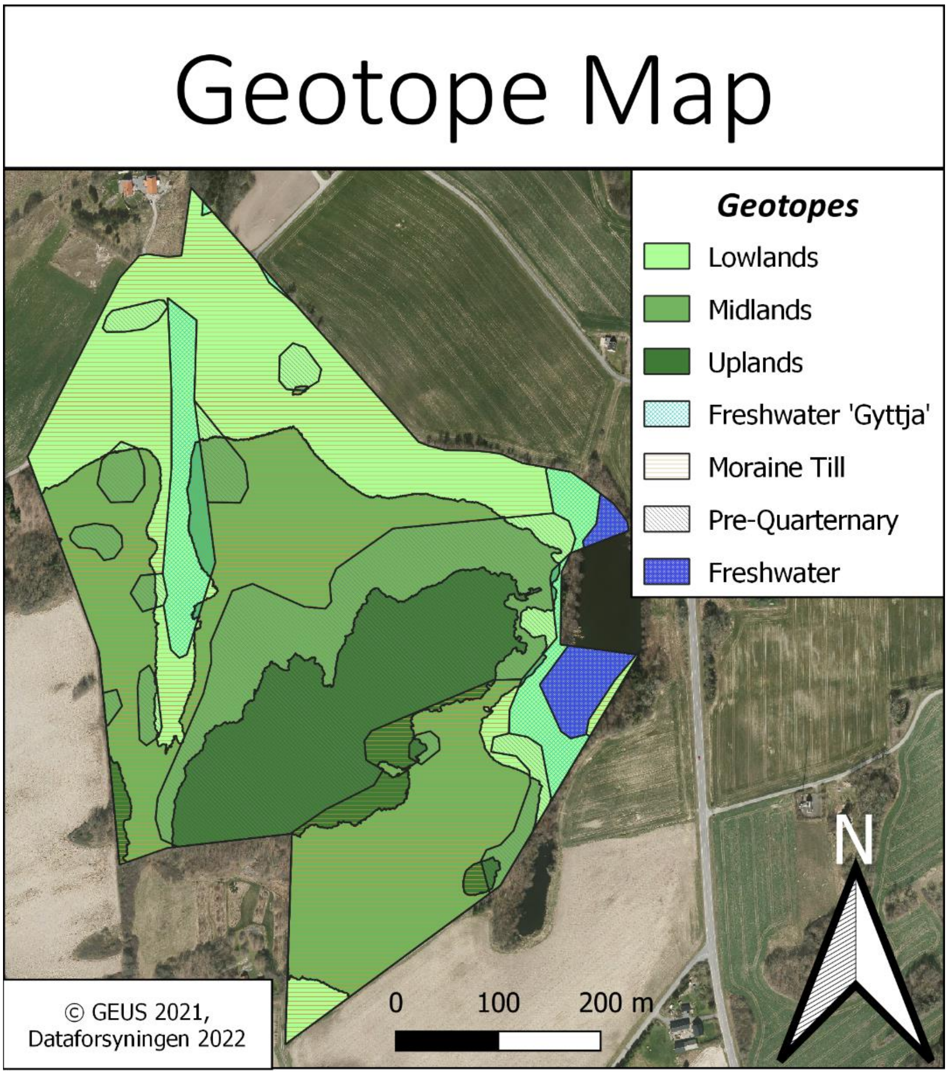

Figure 7. Map showing the geotopes present at Sjælegård and their spatial extent, elevation is displayed with background shades of green and sediment types displayed as overlaying patterns. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022 and Danmarks Højdemodel – Terræn. Also contains data from the Geological Survey of Denmark and Greeenland (GEUS), Jordartskort, 2022.

Land Use Mapping

The land use mapping demonstrated that agriculture was the primary function, taking up 10.6ha, followed by non-plantation forest (6.8ha) (figure 8). Plantations, hedges, and fields comprised 2.4, 2.3 and 2.2 ha respectively. All other land uses covered less than 1 ha.

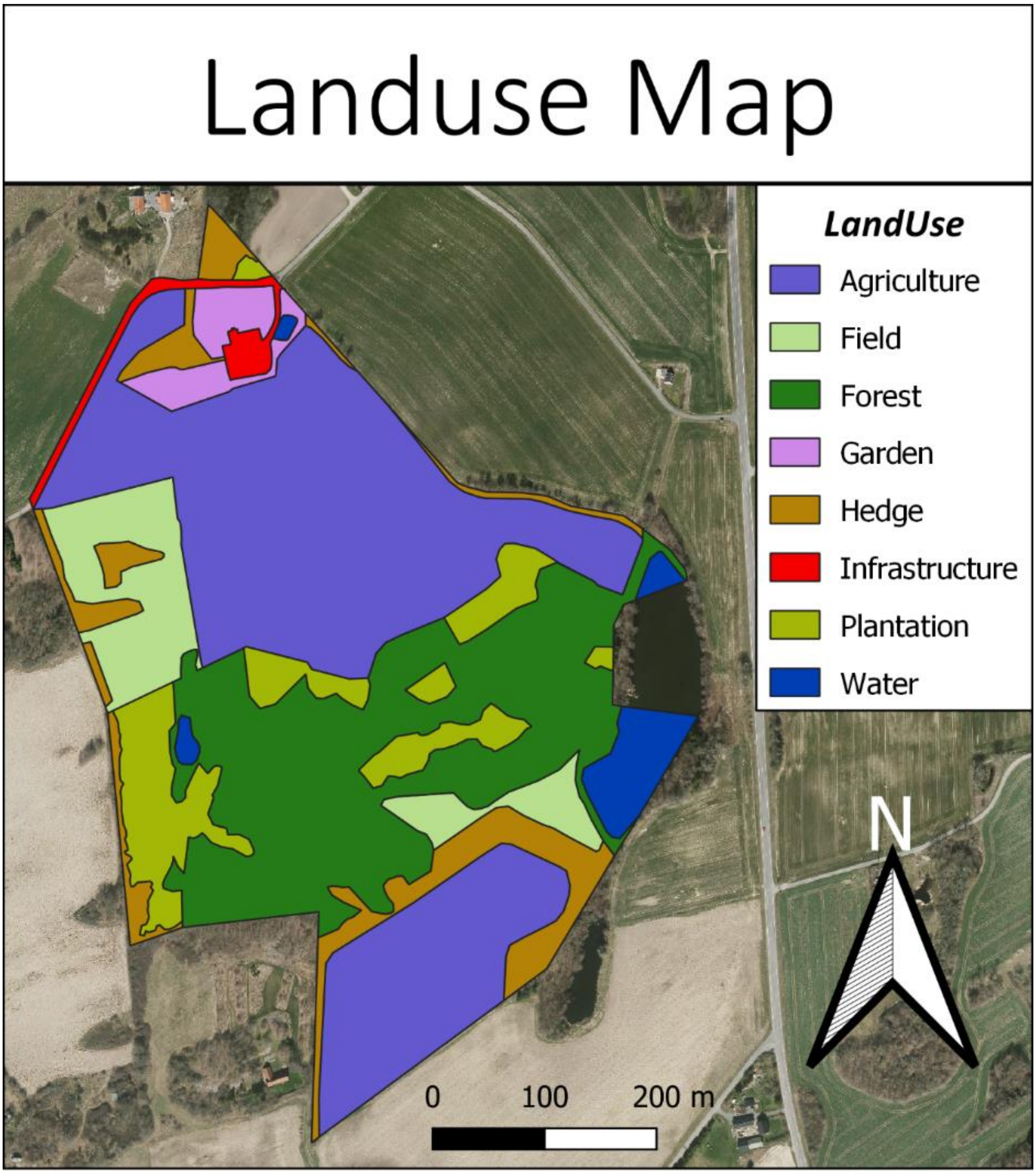

Figure 8. Map showing the dominant land uses at Sjælegård and their spatial extent. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

Botanical surveys

The number of species recorded within the Raunkjær circles at each biotope were: 23 in the oak savannah, followed by xeric grasslands (21), oak forest (14), hazel forest (12), mesic grasslands (11), spruce forest (7), birch forest (7), wheat fields (6) and the least were found in beech forest with only 4 recorded species. It should be noted that hazel, birch and beech forest had half the sample size, and the species richness reflects that. Species richness within individual Raunkjær circles ranged from 0 to 8, with the largest value being found in the oak savannah.

Shannon's diversity indices follow the pattern of species richness quite closely, the highest value was also the Oak Savannah followed by xeric grasslands. Oak, hazel and birch forest, along with mesic grasslands all took up intermediate values. As with species richness, spruce and beech Shannon's equitability indices were highest in hazel, birch and oak forest. Oak savannah and xeric grasslands were also high. Wheat fields and beech forest showed the lowest equitability (table 6).

The Ellenberg's values of the biotopes were very similar for salinity (S). Likewise, moisture (F) had a relatively low range across the habitats. Ranging from 6.05 in spruce forest to 5.00 in Wheat Fields. These are all indicative of near-average dampness in the soil conditions (Hill et al 1991). Some deviation was recorded in the light (L) values, where light-open habitats showed values between 6.77 and 7.85, which are indicative of well-lit habitats with a little shade (Hill et al 1991). The forest biotopes all showed L values between 5.90 and 4.73 all of which suggest a semi-shaded environment (Hill et al 1991). Some variation is also seen in the reaction (R) values, with the highest values seen in the wheat fields, mesic grasslands and hazel forest. Corresponding to neutral or weakly acidic soil. All other biotopes show R values in line with moderately acidic soils (Hill et al 1991). Lastly, the N values were similar across biotopes and can be classified as intermediate fertility (Hill et al 1991). The one exception was wheat fields, which can be designated as highly fertile (Hill et al 1991).

Table 6. Summary of results of botanical analyses, all figures provided are biotopic averages.

Index	Oak forest	Spruce forest	Beech forest	Hazel Forest	Birch Forest	Oak Savannah	Xeric Grasslands	Mesic Grasslands	Wheat Fields
Shannon's Diversity	2.10	1.26	1.56	2.00	1.56	2.45	2.27	1.54	0.67
Shannon's Equitability	0.79	0.65	0.37	0.80	0.80	0.78	0.74	0.64	0.38
Ellenberg S	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.54	0.03
Ellenberg F	5.52	6.05	5.43	5.21	5.54	4.57	5.31	5.90	5.00

Ellenberg L	5.43	5.05	5.90	5.42	5.00	6.77	6.99	7.50	7.85
Ellenberg R	4.68	5.37	4.52	6.00	5.80	4.73	5.20	6.21	6.83
Ellenberg N	4.72	5.07	4.86	5.42	5.10	4.57	4.81	5.50	6.90

Vegetation Structure

Patches were defined as in figure 9. In terms of the calculated openness index, 'mesic grassland' had the highest score at 3.9, followed by the various wheat fields and xeric grasslands. 'birch patch 1' was the most open forest patch with 2.4, followed closely by 'hazel patch 2', 'oak Forest', 'oak Hill', 'oak patch', 'spruce patch 2', and 'birch patch 2'. 'Hazel patch 1' and 'spruce Patch 1' were slightly more closed with 1.8 and 1.6 respectively. The lowest values were observed in the beech patches as well as 'spruce plantation' and 'spruce patch 3', which all had the minimum possible score of 1.4 (figure 10).

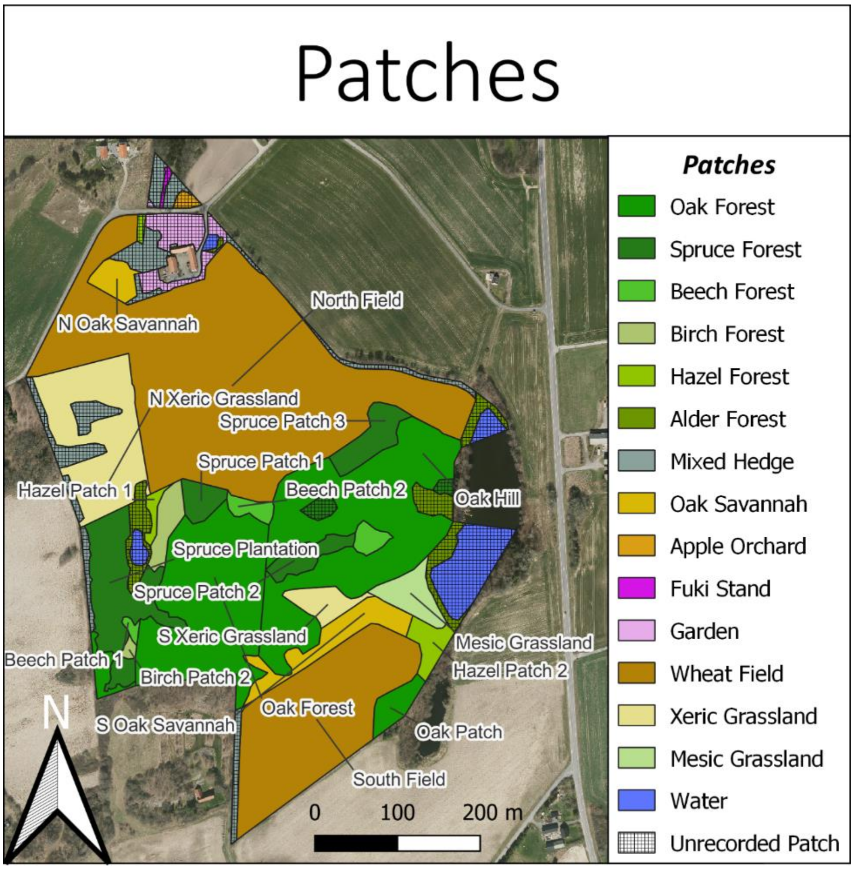

Figure 9. Map showing the patches constructed for the vegetation structure analysis, with each patch corresponding to an area of biotope not connected to other areas of the same biotope. A single exception was made for the Oak Forest and Oak Hill, which are connected but were split due to differences in terrain. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

When averaging across the whole biotopes, mesic grasslands are the most open with a score of 3.9, followed by xeric grasslands (3.3), wheat fields (3.1), and oak savannahs (2.7). Birch forest (2.2), hazel Forest (2.1) and oak Forest (2.1) were the most light-open forest types, whereas spruce forest had an average score of 1.6, and beech forest the minimum possible of 1.4.

Coverage without ground vegetation was not factored into the openness index. it was most prevalent in the 'spruce plantation' and the beech patches, where it covered 75-100% of the ground. It also had a high prevalence of 30-75% in the remaining spruce patches and in 'hazel patch 2' and 'birch patch 2'. About 10-30% of the ground was lacking vegetation in 'oak patch', 'hazel patch 1' and 'birch patch 1' and 5-10% in 'oak hill'. The remaining patches had coverage of less than 5%.

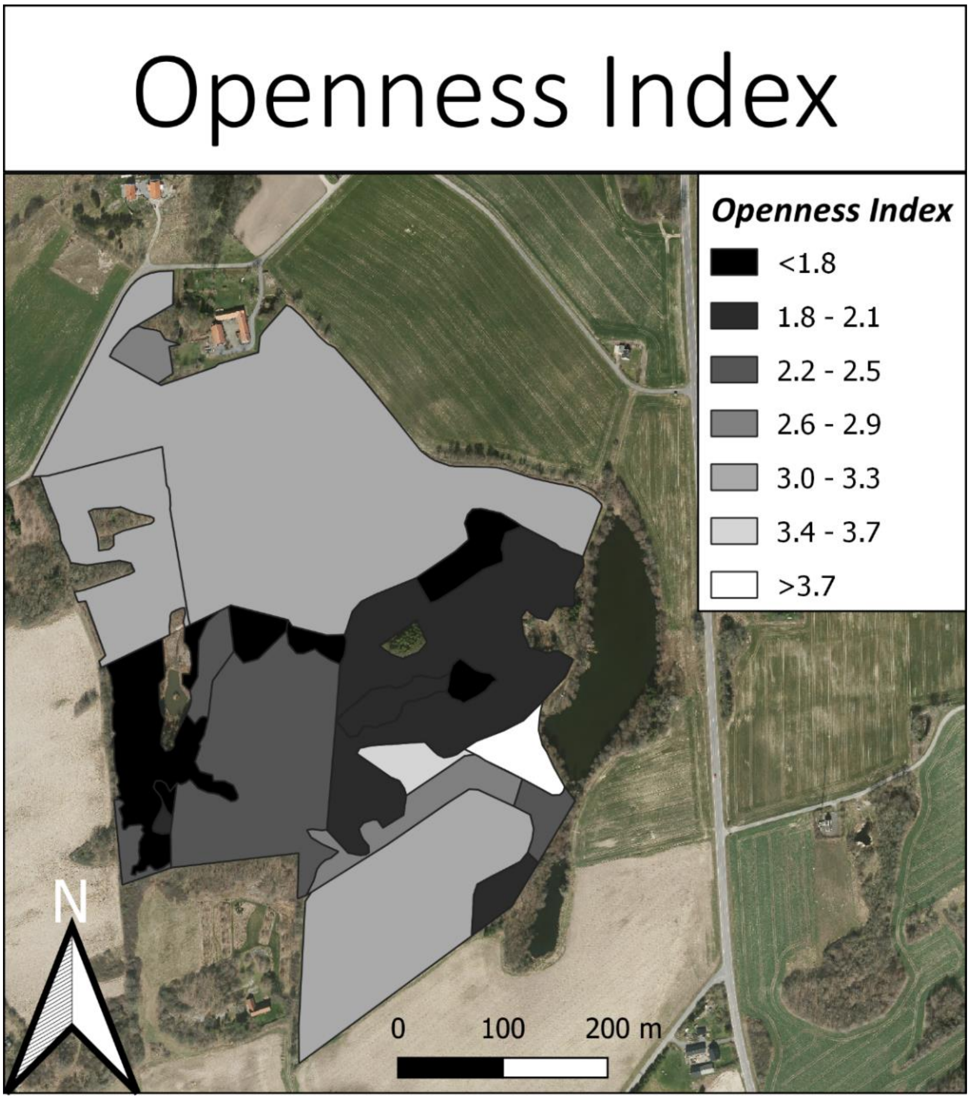

Figure 10. Map showing openness scores of each patch, with lighter colours signifying more open patches. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

Bioblitz

In total, 840 species were registered on Sjælegård during the Bioblitz (appendix 1), primarily composed of insects (439) and vascular plants (236) (table 7). 14 red-listed species were recorded, seven of these are birds: European greenfinch (*Chloris chloris*), yellowhammer (*Emberiza citrinella*), common swift (*Apus apus*), skylark (*Alauda arvensis*), common starling (*Sturnus vulgaris*), Eurasian collared dove (*Streptopelia decaoto*) and black-headed gull (*Chroicocephalus ribibundus*). Additionally, there is the common yew (*Taxus baccata*), three species of red-listed lichens (*Polycauliona candelaria*, *Umbilicaria deusta* & *Protoparmeliopsis macrocyclos*), a moth called the muslin footman (*Nudaria mundana)* and the beetles *Scolytus laevis* and *Harpalus griseus.* Of note also was the discovery of a moth of the *Genus Sorhagenia* which has not previously been recorded on Bornholm, unfortunately this could not be determined to species level. A single species – the northern crested newt (*Triturus cristatus*) – is included under annex II and annex IV of the EU Habitat Directive (Council Directive 92/43/EEC, 1992), whilst the Burgundy snail (*Helix pomatia*) is listed under annex V (Council Directive 92/43/EEC, 1992).

Ten species identified during the bioblitz are considered invasive in Denmark, as defined by the Danish Environmental Agency (Miljøstyrelsen 2022b). Two of these species are also included on the national list of particularly harmful species, these are: beach rose (*Rosa rugosa*) and giant goldenrod (*Solidago gigantea*) (Miljøstyrelsen 2022b).

Table 7. Overview of the species number and the number of red-listed and invasive species recorded on the bioblitz, broken down by taxonomic group

Taxonomic group (as defined by Arter.dk)	Species Number	Red-listed Species Number	Invasive Species Number
Vascular Plants	236	1	6
Mosses	7	0	0
Algae	1	0	0
Fungi	49	3	0
Vertebrates	33	7	1
Insects	439	3	0
Other Invertebrates	75	0	3
All	840	14	10

Photo Sampling

The ten images were successfully captured and can be seen in *figure 11*.

3

4

5

6

7

8

Figure 11. Images captured as part of the photo sampling effort on the 2nd of August 2022, the image order follows the numbering.

Bracken Distribution

Bracken was found in 44 out of 115 sampled cells (figure 12), giving them a distribution covering 38%. In these cells It should be noted that bracken density was not constant, occurring in high and dense stands in some cells, whilst being sparse and patchy in others. Bracken was only present in the central forest area and is absent in the smaller woodland patches around Sjælegård.

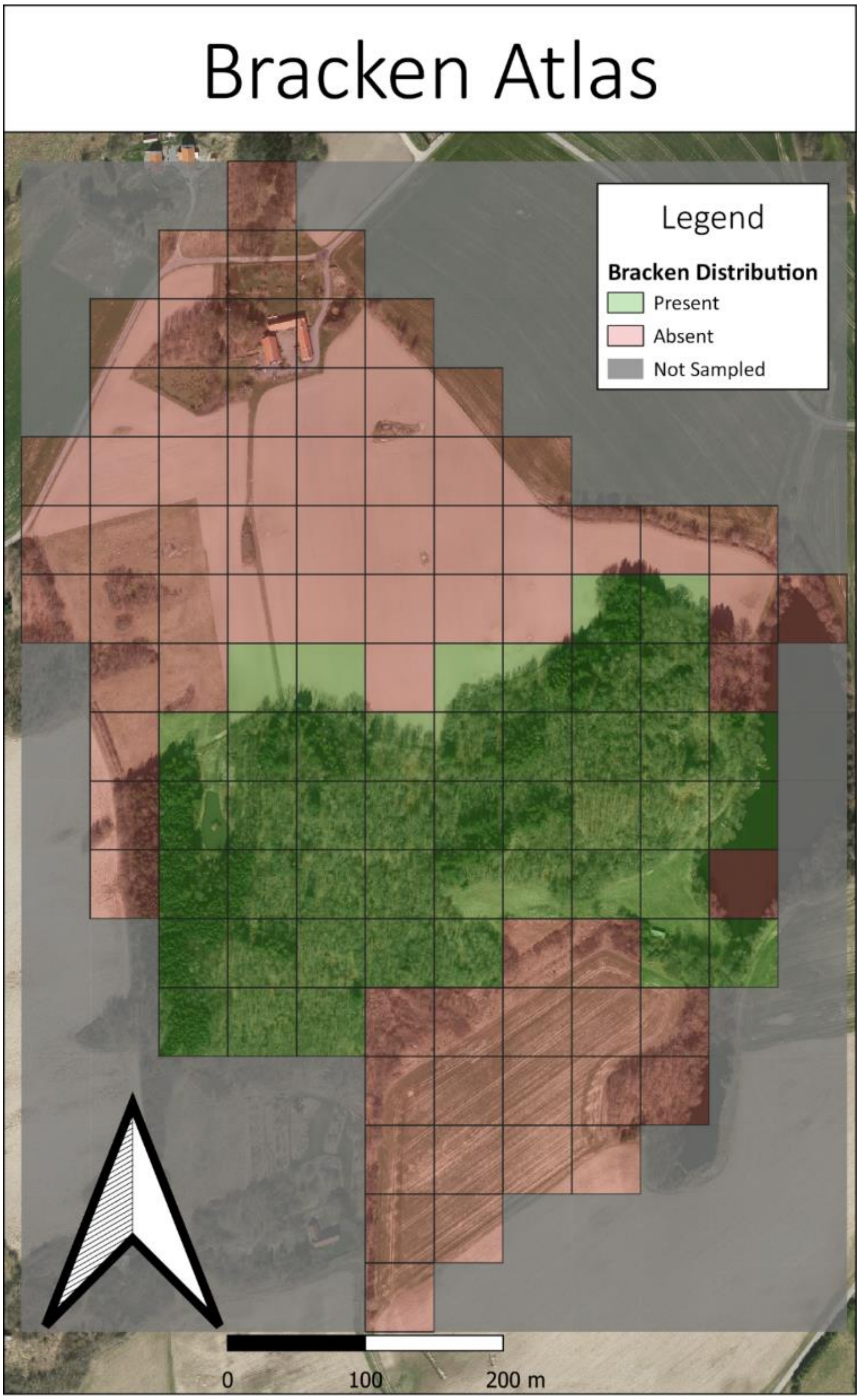

Figure 12. Bracken atlas, showing presence (Green) or absence (Red) of the common bracken (Pteridium aquilinum) at Sjælegård, using 50x50m grid cells. Grey area is unsampled. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022

Forest Structure Index

56 of the 100 questions of the in the GEUS forest structure index were affirmative, yielding a score of 56% (Appendix 2). A closer look at the individual subsections offers insights into where the forest at Sjælegård scores highly. Looking firstly at 'area', Sjælegård scores 1/5, this reflects that the forest area is relatively small and disconnected from other major nature patches. Standard structure scores 3/4 as there is a large variability in the structure, both in terms of clear patches and layer number and heights, only falling because the forest displays evidence of tree planting (i.e. the spruce plantation). Tree species score 8/10 with both missing points being attributed to the omission of the small-leaved lime (*Tilia cordata*). Trees independent of species scored 4/13. Though trees of all size categories were registered in the forest contributing to three points, large trees were only present in low concentrations. likewise, there was insufficient living trees with larger holes, hollows, and wounds to warrant any points. Smaller fallen or hanging trees which are still alive also contributed a point, but this was lacking for larger trees. Canopy scored 5/5, with a wide variation in canopy tree size, age, shape, and species. Understorey/regeneration scored 5/8, due to a moderately high species richness of trees and bushes in the understorey, as well as an overall large amount of understorey woody vegetation. With regards to regeneration, it was observed in patches, but not with a large variation in age in regeneration patches. Deadwood scored 11/28, due to presence of deadwood, standing deadwood, uprooted trees and dead logs. However, loss of points came due to the deadwood all belonging to small-medium sized trees, all under 50cm diameter at breast height. Furthermore, logs were only observed in decay classes 1-3, not 4 and 5 which reflect relatively young deadwood. Flora scored 2/3, due to abundance of lichens and vascular plants in the forest, but bryophytes were not plentiful enough to warrant a point. Topography and soil scored 6/9, but lacked surface chalk, mounds from storm-felled trees and large-scale topographical variation. Hydrology scored 5/8, lacking 5% coverage of treeless wetlands, 5% coverage of swamp forest and natural unregulated watercourses. Finally, management impacts scored 3/6, due to the presence of tracks from motor vehicle and tree stumps from cutting, including within the last 10 years.

Soil Sampling

Of the 13 soil samples taken, 6 had shallow bedrock and prevented a full soil core. These were spatially distributed across the whole estate, however three were concentrated in the central forest area with only a single forest site showing soil depth above one meter, which may indicate a general predominance of shallow soils in uncultivated areas. Three of the four forest samples also indicated a prevalence of mor, though a single site displayed a mull profile. In all four cases the leaf litter layer was shallow, extending no further than 14cm in depth. Depth of pseudogley/gley varied heavily between sites with 38cm being the shallowest and many sites not showing any in the top metre of soil. The lowest values of pseudogley/gley (i.e. the shallowest occurrences) are located in the lowlands and midlands, particularly in the south field, the lakeside meadow and the north field. Peat was only found at two sites – The lakeside meadow and by the former stream located on the north field, indicating the presence of a former mire in both locations. The depth of peat extended 18cm and 33cm deep respectively, though in both cases was mixed with inorganic soil in the deeper parts. The predominant soil character was clayey, though both a site by the lakeside meadow and the accompanying grassland area to the west showed sandy characteristics. A third site, in the forest, showed a silty character, however this sample was only 7cm long due to high bedrock and is unlikely to representative of the soil in the area.

Hydrology

The largest permanent body of surface water at Sjælegård is the lake 'Sjælemose' which covers an area of about 1.4 Ha (Area 9). The naming suggests that the lake may once have been a mire. This is supported by the presence of peat in soil samples taken in the adjacent meadow showing the presence of peat, and the geotope map shows freshwater gyttja as the surrounding soil type. No measurements were carried out to measure the water quality, however during late spring and summer there was low visibility due to algal concentrations, which would suggest eutrophication – likely because of runoff from the surrounding agricultural areas.

The second largest body of surface water is located within the spruce plantation (Area 5) and is a pond covering about 0.07 Ha. The pond is artificially dug by previous landowners and is very shallow – though permanent. It lies within a larger wetland area, extending north & southwards as an alder fen. Ranging northwards from the pond to the estate is an elongated area of peatland, identified from the geotope map and corroborated by soil sampling. This area corresponds to a stream documented on 19th century maps, but preliminary excavation by the municipality reveals that the area is drained by an old stone drain (image 5). Ceramic pipes were also found, but these were completely blocked with soil and thus had ceased to function.

Image 5. Stone drain discovered during excavation of the North Field. The drain is still functioning.

An additional pond exists east of the estate, this is artificially dug and fed by a pump from Sjælemose. Small ponds are also found within the forested areas of Sjælegård, these are artificial water bodies formed in patches where granite had been extracted. The forest also contains a few natural perennial water patches. During the winter of 2023, large puddles were also observed in various locations of the north field, though most of these formed in vehicle tracks.

8. Literature Reviews

Grazing

When contemplating the ideal grazing pressure at Sjælegård it is useful to consider what the baseline density for large herbivores in a natural system is. This value will undoubtedly vary across habitat and is driven primarily by the net primary production (NPP) (Fløjgaard et al 2022). Fløjgaard et al 2022 investigated the large herbivore (>5Kg) biomass concentrations across ecosystems in Africa, Asia, Europe, European rewilded areas, North America and South America. These were further subdivided into areas with low productivity (<500,000 kg C km^{-2} $year^{-1}$ NPP), medium productivity (500,000-1,000,000 kg C km^{-2} $year^{-1}$ NPP) and high productivity (>1,000,000 kg C km^{-2} $year^{-1}$ NPP). Only the European rewilded areas are of value for establishing a baseline for Sjælegård, and this existed exclusively in the medium productivity category. Herein the large herbivore biomass ranged from 40kg/Ha to 160kg/Ha, with a mean of about 120kg/Ha (Fløjgaard et al 2022). No other attempts to establish natural megaherbivore densities in Europe were found.

The Environmental Agency recommends differential grazing pressures based on the habitat type. Such recommendations are not based on biomass but instead on large grazer units – a system where livestock are assigned a value based on age and species – but independent of race (Miljøstyrelsen 2023a). The large grazer unit values for each livestock species can be found in table 8. Pigs are not classified as grazers by the authorities and thus are not included. The agency recommends grazing pressures for a range of natural habitats, but the two relevant to Sjælegård are meadow and pasture. A pressure of 0.3-0.8 large grazer units per hectare is recommend for pasture, whilst meadows can support a higher 0.5-1.2 Large grazer units per hectare (Miljøstyrelsen 2023a). No recommendations are available for light-open forest.

Table 8. The large grazer unit value of defined livestock. The units are independent of race (Miljøstyrelsen 2023a)

Livestock	Large Grazer Unit Value
Cow/bull over 2 years old	1
Horse over 6 months old	1
Cow/bull between 6 months and 2 years old	0.6
Sheep/Goat over 1 years old	0.15
Deer over 9 months old	0.15

In terms of grazing species, the cow (*Bos taurus*) is the most popular in agro-rewilding initiatives. Cattle act as stand-ins for their extinct wild ancestors - the aurochs (*Bos primigenius*). Aurochsen were found through most of the Palearctic, including Denmark (Ajmone-Marsan et al 2010). Whether cattle constitute suitable proxies for aurochsen is an open question, Noe-Nygaard et al 2005 demonstrated that the two differed in diet during the Early-Mid Holocene though this could reflect land use rather than ecology. An evaluation of the cow as a proxy is outside the scope of this investigation, but in most projects, it is assumed to be a close fit. Regardless, cattle are obligate grazers with a preference for grasses over herbs (Buttenschøn 2007) but may supplementally consume woody vegetation (Buttenschøn 2007; Cromsigt et al 2017). They also create mosaics by not grazing within 10-20cm of their excrement. The feeding technique of cattle is tugging which does not remove the bottom of the grass strands (Buttenschøn 2007). Cattle also come in an abundance of races which may differ in size and constitution, though only a handful of hardy breeds are used in rewilding – these include Scottish Highland, Galloway, and Dexter (Miljøstyrelsen 2020). Hardy breeds usually range from 350-800kg for fully grown individuals (Miljøstyrelsen 2020). Cattle have social needs as well and will naturally form herds of cows and calves (Landsberg & Denenberg 2014a).

The other prospective bovine species, the domestic water buffalo (*Bubalus bubalis*), is descended from the wild water buffalo (*Bubalus arnee*) of South and East Asia (Kaul et al 2019). This species is a close relative of the extinct European water buffalo (*Bubalus murrensis*), which has a sparse fossil record extended as close as Northern Germany during the Eemian interglacial – whether it ever inhabited Denmark is unclear (Vislobokova et al 2021); likely Denmark was near its northernmost occurrence. The idea of using water buffalo in rewilding projects is relatively new but has been carried out in various project including Gedelund-Kasted Mose & Kragelund Mose in Denmark (Wang 2007; Sandager 2023). Water buffalo are grazers with a specialty in wetland habitats and are particularly adept at keeping open waterside vegetation (Lundgren et al 2017). Adults are also very large, averaging 919kg (Lundgren et al 2017) and may form groups consisting of dozens of individuals (Tsiobani et al 2020)

Horses (*Equus caballus)* are another popular pick for rewilding project. They are descendants of the wild horse (*Equus ferus*) which once ranged across Eurasia, North Africa, and the Americas, but is now restricted to a few scarce populations in East Asia (Naundrup & Svenning 2015). Horses are selective grazers, which – unlike cattle – will bite grasses and herbs to very near the ground (Buttenschøn 2007). Horses consume a very limited amount of woody vegetation but are partial towards gnawing the bark off trees – in some cases killing them. They may also consume roots (Buttenschøn 2007). Furthermore, horses are very active animals and may have a disproportionately high impact on vegetation via trampling (Buttenschøn 2007). As with cattle, horse breeds show a wide range of phenotypes, which may range from the Shetland pony of about 145kg to around a metric ton for large races such as the Belgian draught horse (Buttenschøn 2007). Herein medium-sized ponies such as Exmoors or Koniks are closest in size to the wild horse. Horses tend to form herd structures, and thus should ideally be kept in groups (Buttenschøn 2007) (Landsberg & Denenberg 2014b).

Donkeys (*Equus asinus*) are relatives of the horse and descended from the critically endangered African wild ass (*Equus africanus*) (Burden & Thiemann 2015). Donkeys serve as a potential analogue of the extinct endemic, the European wild ass (*Equus hemionus hydruntinus*), a subspecies of the onager (*Equus hemionus*) (Bennett et al 2017). The European wild ass is not known to have occurred in Denmark but is corroborated as far north as Belgium (Bennett et al 2017). Donkeys are grazers which specialize in dry habitats such as deserts and considered keystone species, performing functions such as digging wells (Lundgren et al 2017). They are medium-sized grazers averaging about 180kg. Unlike the aforementioned grazers, donkeys do not tend to form large social groups and may live as solitary animals or in pairs (Burden & Thiemann 2015)

Finally, pigs (*Sus domesticus*) are descended from the wild boar (*Sus scrofa*). Unlike cattle and horses with extinct and endangered progenitors, the wild boar is common across Eurasia (Buttenschøn 2007). In Denmark it is nominally extinct but considered native and has been used in several rewilding projects already. The diet of the pig differs altogether from other 'grazers' in that it is not really a 'grazer' at all. Pigs are omnivorous and accordingly feed on a wide array of foodstuffs. Roots, mast nuts, and small animals comprise the bulk of their diet (Buttenschøn 2007). Pigs will also consume rhizomes, fruits, leaves, and grasses. As a result, pigs can rely on food sources not commonly utilized by other large animals and increase disturbances in the soil (Buttenschøn 2007). Breeds included in rewilding projects include Tamworth Pigs in Knepp Wildland (Tree 2017) and Mangalica in Kragelund Mose (Sandager 2023), both these breeds average around 200-300kg (The Livestock Conservatory 2023; Egerszegi et al 2003). Pigs tend to form smaller social groups of about 8 individuals, despite their wild counterparts being solitary (Landsberg & Denenberg 2014c).

It is imperative to note that a wide grazing guild with differing ecological functions between species is beneficial in a rewilding project. This may be exemplified by seed dispersal in Bialowieza Forest in Poland, which is contingent on a wide range of species, with many plant species being highly specific to a single vector (Jaroszewicz et al 2013). This specificity also extends to domestic livestock in rewilded areas. The nature area of North Westhoek is grazed both by cattle and horses. Of the seedling species found within their dung, 48% were unique to one species. In the neighbouring South Westhoek this number was 34% (Cosyns et al 2005).

Habitat use and food utilization will also vary between species. At North Westhoek cattle spent considerably more time in forest and bushland habitats than horses (Lamoot et al 2005). Cromsigt et al 2017 also investigated the diets of cattle, horses co-occuring at Kennemerduinen in the Netherlands. Though both livestock species consumed grasses, they had widely different supplementary feeding – cattle relying on leaves and twigs, whereas horses consumed roots and waterside vegetation (Cromsigt et al 2017). The synergies between the other livestock species remain to be studied, but in likelihood many are complementary.

Bracken Control

The common bracken or eagle fern (*Pteridium aquilinum*) is a prolific species of fern, forming dense groves in infertile light-open habitats such as heathlands and oak forests (Marrs et al 2000; Le Duc et al 2003). The species is adaptable, surviving in a wide range of temperatures, light conditions, humidities, soil types, slopes, and altitudes (Marrs & Watt 2006). The virility and versatility of bracken has allowed it to dominate landscapes in many parts of the globe, including Denmark (Marrs & Watt 2006).

Understanding what makes bracken so virile is key in guiding management practices. Bracken spreads to early successional communities usually via rhizomes from adjoining patches, however this rate of dispersal is limited to a few meters per annum (Watt 1955; Marrs et al 2000). Alternatively, bracken can also spread using spores, though reports of invasion via this mechanism are few (Marrs et al 2000). Once established, bracken forms dense clusters of fronds which block out light to the undergrowth and prevents the establishment of rival species (Marrs et al 2000). Even in winter bracken litter accumulates, blocking out light year-round (Marrs et al 2000). It has also been suggested that bracken releases toxins into the ground which inhibit germination in other floral species co-occurring with bracken (Marrs & Watt 2006).

The rhizomes of bracken are not only instrumental in facilitating spread, but they provide storage of carbohydrates which can provide nutrients for regrowth. The rhizomes may attain up to 85% of the total biomass which makes them resilient to above-ground disturbances (Marrs et al 2000; Le Duc et al 2003), this makes eradication of the plant particularly challenging. Furthermore, the rhizomes allow nitrogen fixation in bracken which enriches the soil with nutrients (Milligan et al 2018).

On top of the detrimental impact of bracken on biodiversity it can also cause health problems, as it contains the carcinogenic compound ptaquiloside which may cause cancer if consumed either by humans or livestock (Gomes et al 2012) and can even leach into water supplies (Rasmussen et al 2003).

Succession

One possible mechanism to combat bracken is by relying on vegetation succession. Simply put, bracken may be outcompeted by late-successional tree species which can shade out the ferns. A review by Marrs et al 2000 summarized that dense clusters of bracken made establishment difficult for late-succession species. However, in the light of disturbances and lower densities of bracken *Betula spp., Salix spp.* and *Pinus sylvestris* have all been recorded to be able to colonize (Marrs & Pakeman 1995; Marrs et al 2000).

Cutting and other Mechanical Damage

By far the most popular technique (barring herbicide use) for combatting bracken infestations is cutting the fronds, either annually or biannually. The works by depriving the plants of access to carbohydrate production via photosynthesis and starve out the rhizomes with time. Similar concepts have also been investigated such as bruising the fern fronds or using ploughs or harrows to disturb the rhizomes. Various studies have set out to evaluate these methods.

An 18-year series of plots with bracken was monitored between 1978 and 1996 in a dense bracken patch in a heathland in East Anglia, wherein different management strategies were applied. Tested herein were cutting and herbicide use (Marrs et al 2000). Cutting was performed once or twice per year in various plots, this was carried out for 6 years in half of plots and the full 18 years in the other half. In 18 years plots annual cutting reduced cover to 6% of control biomass, and bi-annual to 3%, however in plots where cutting was carried out for 6 years, there was rapid recovery once interventions ceased with the best result only being at a reduction to 40% of control after 18 years (Marrs et al 2000).

A study by Paterson 1996 in an oak woodland, tested plots between 1993 and 1995 with an annual and biannual cutting of bracken. It was found that biomass declined significantly with both interventions, but biannual cuttings were more effective. Furthermore, cuttings improved recruitment of oak seedlings (Paterson 1996).

Annual and biannual cuttings were tested at the Hodron Edge site - a moorland in the UK. Measurements were taken over 10 years by Tong et al 2006 and over 20 years by Milligan et al 2018. Tong et al 2006 found that annual cuttings had limited effect on the bracken cover – some years were comparable to the control plots. However, biannual cutting had a profound impact, in some years reducing cover by an entire order of magnitude (Tong et al 2006). Both annual and bi-annual cuttings showed a huge decrease in frond density and bracken litter cover after 20 years, though the effect of biannual cutting was greater (Milligan et al 2018). Furthermore, shrubs and grasses increased in abundance following cuttings. Interestingly, this study also demonstrated that controlling of bracken decreased soil N, P and C concentrations and increased the pH (Milligan et al 2018). Novel techniques were also investigated by Milligan et al 2016 at Hodron edge over an 8-year time at this site, these include: bi- and triannual bruising wherein ferns are crushed rather than cut, as well as plots with bi and triannual cutting. In areas where bi or triannual cuttings were conducted, bracken was eradicated from the core of treated plots and only clung on at the edges, perhaps due to connectivity to non-treated stands. Bruising showed comparable results to the control, even when carried out two or three times annually.

A UK study by Le Duc et al 2003 focused on the effect of cutting and herbicide use on the rhizome size of bracken across 7 sites over a 5-year period. It was found that cutting the bracken annually or bi-annually produced the best results of about a 60% decline compared to control, though in some cases only bi-annual cutting produced significant improvements – perhaps due to more fertile environments (Le Duc et al 2003). Le Duc et al 2000 likewise examined four British sites, some of which overlapped with the sites of Le Dec et al 2003, though in this case examining frond length and density. The study from 2000 investigated annual and biannual cutting as well as the use of asulam herbicide as treatments for bracken control, but notably also investigated whether subsequent seeding of native grasses aided in a reduction of bracken concentrations. The findings were that cutting and biannual cutting were the most effective control measures in the long-term, though initial results may be relatively minor. The results of seeding were inconclusive with a mix of positive and neutral results, and even a few negative results (Le Duc et al 2000).

Rather than examining the effect of management tools on density, Pakeman et al 2002 focused on their ability to curb the expansion of bracken groves. Herein experiments were carried out at various British sites and found that cutting around the edge of bracken groves was sufficient in halting or at least slowing expansion (Pakeman et al 2002).

Alday et al 2013 also tested out the effects of cutting, both on heathlands and acid grasslands around the UK (Alday et al 2013). Annual and biannual cuttings were tested over a 10-year period along with treatments combined with spraying. It was found that cutting twice per annum was the most effective strategy for moving towards both heathland and acid-grassland communities (Alday et al 2013). It also promotes more even and biodiverse communities than other tested methods (Alday et al 2013). Two of the sites investigated by Alday et al 2013 ceased treatment after a 10-year period (in 2003), and Akpinar et al 2023 undertook an investigation of the plots in the following 16 years. At one site where 10-year biannual cutting had been carried out, the bracken had recovered to pre-intervention levels but remained lower than the control plot. The annually cut plot was similar to the untreated plot. On the flipside, another site had similar bracken levels in untreated, annually cut and biannually cut plots. Both sites showed steep decreases in bracken in the initial 10-year management period (Akpinar et al 2023). Similarly, species richness and the abundance of non-bracken vegetation showed similar levels after 26 years in both the treated and untreated plots (Akpinar et al 2023).

Stewart & Pullin 2005 reviewed literature on bracken control prior to 2005, including studies on bracken cutting. The findings were as follows: Conway and Stephens 1954 investigated three frequencies of cutting over the course of 3 years. It was found that tri-annual cutting performed better than bi-annual, which in turn performed better than annual. Gordon 1916 tested annual, biannual, and triannual cutting, but also included a plot where bracken was cut whenever it appeared. The conclusion was that after a year constant cutting eradicated the bracken, whereas triannual and annual cutting reduced the fronds, biannual cutting was ineffective. Lowday et al 1983 carried out only single cuttings but differentiated by cut time. A plot was carried out for every fortnight from early June to September, and the results were investigated over a year. Cuts before July 18th were most effective. Whitehead 1993 carried out an experiment with a single cutting performed in one plot in late June, another in late July and a third plot had cuts in both time periods. The earlier cut was more effective than either the July or twice cut plots, the experiment was conducted over a single year. Paterson et al 1997 found that over a three-year period, bracken cut once and twice both reduced densities, but biannual cutting was more effective. Marrs et al 1998 found that biannual cutting was more effective than annual cutting or herbicide spraying over an 18-year period. Though, Snow and Marrs 1997 found the inverse - that cutting was less effective than spraying. Lowday 1987 also found biannual cutting to be more effective in reducing bracken density than annual cutting or spraying combined with cutting. Finally, Marrs et al 1993 also reached the conclusion that biannual cutting was more effective than annual cutting or spraying.

Cox et al 2007 conducted a UK multi-site analysis of treatment methods and found that annual and biannual cutting were the most effective long-term ways of controlling bracken, at least when compared to herbicide spraying (Cox et al 2007). A meta-analysis by Stewart et al 2008 further investigated whether annual and biannual cuttings were similarly effective across studies or if effects were site dependent. Biannual cutting was found to be almost universally more effective than annual cutting, spraying or a mix of spraying and annual cutting (Stewart et al 2008).

A study in the Apennine Mountains of Italy by Argentini et al 2016 investigated the effects of two different management techniques on the relative abundance of bracken, between 2004 and 2009. These control measures involve: 1. Bracken cutting followed by 30cm deep ploughing and seeding of native plants and 2. Cutting followed by harrowing and then seeding of native flora. The former proved effective in reducing bracken concentrations to low levels, however both had a significant effect (Argenti et al 2016). Godefroid et al 2017 investigated the effect of tilling using two different types of ploughs, as well as clearing using a bush cutter and clearing saw on bracken dominated beech-forest. The study was conducted in Belgium with between 1- and 4-year time spans depending on the plot (Godefroid et a al 2017). Metrics did not look at bracken concentrations, but rather on the soil properties and biodiversity metrics. Most of these saw no statistically significant results though clearing saws showed a slightly higher species richness, resulted in less competitive species and changed the soil moisture, reactivity, and nutrient indices (Godefroid et al 2017). Tilling using rotary ploughs diminished species diversity and using disc ploughs decreased the prevalence of forest species (Godefroid et al 2017). The results from Argentini et al 2016 contrasts those of Godefroid et al 2017, it is unclear whether the success of the former study was a result of seeding or whether biodiversity simply doesn't increase after bracken clearing.

Altogether cutting is supported as the most effective mechanical treatment, seemingly outperforming both bruising and ploughing/tilling. Furthermore, ploughing/tilling seems to possibly come at the cost of overall biodiversity. The literature suggests that more cuttings per year produce better results, though most studies only investigated annual and biannual cuttings. Only cuttings performed whenever the bracken appears had any success in complete eradication, all other methods were only capable of lowering the concentration and curbing expansion. Timing of cutting appears important, with cuttings conducted earlier in the growing seasons such as Late May or June generally producing better results, though few studies have been conducted on this. In some cases, single cuttings had little effect, and this may be site dependent but biannual cuttings appear universally effective. The literature also suggests that these interventions must be sustained indefinitely or else the bracken groves will re-establish, though in some cases seedlings may grow in the light of bracken cutting and shade out the underlying groves.

Pigs & Grazing

The removal of bracken by domestic pigs (*Sus domesticus*) or wild boar (*Sus scrofa*) has been touted as an alternative to cutting or herbicides (Henney 2012). The suggested mechanism for this is via uprooting of rhizomes when feeding (Henney 2012). Whether pigs naturally consume bracken rhizomes is an open question, but their palatability is well attested (Henney 2012). In supplement to damage by direct feeding is the exposure of rhizomes to the elements, the disturbance of the litter layers and trampling (Herney 2012).

Seven wild boars released into a 13.5ha enclosure in an Inverness Forest with pervasive bracken stands were shown to decrease the density of fronds by 43% between 2009 and 2011, and frond length by 31.5% (Trees for life 2011). A separate study from the same location conducted by Beaton 2011 compared the wild boar enclosure with patches which were open to red deer grazing and completely ungrazed areas, all over a 3-year period. The wild boar enclosure was found to have 78% less old bracken and 31% less newly recruited bracken when compared with the ungrazed area (Beaton 2011). Neither of these studies were peer reviewed, the former is from the Trees for Life Organization and is unpublished and the latter a master's thesis (Herney 2012).

Another study using pigs was conducted by Randall 2006 & Randall 2008 at a heathland on the Isle of Islay in Scotland, wherein 50 pigs subsisted in an area of 140ha. Data collected on bracken control was gathered in the form of photos and did not employ empirical data. Nevertheless, the studies showed that the presence of pigs caused a visible decline in bracken (Randall 2006; Randall 2008). These studies were not peer reviewed. Likewise, three pigs were released in an enclosure in the Wyre Forest in England and showed a thinning of bracken though this was based on comparative photography and floral surveys and did not have the corroboration of statistical analysis behind it (Cleaver 2009; Cleaver 2012; Henney 2012)

A two-year experiment was carried out at Langley Wood in the UK where pigs, rolling (using a machine) and herbicide were all used on two 30x30m plots of dense bracken. Pigs were only used during the autumn. Though herbicides were shown to diminish bracken concentrations the most, pigs took the second-place spot and encouraged regeneration of understory plants to a higher degree than herbicides. In addition, pigs were the only method which cleared sections of undergrowth from litter (Henney 2012). This data was not-peer reviewed.

Likewise, a two-year experiment was conducted in Burnham Beeches, also in the UK. Herein pig grazing and rolling, and the two combined, were tested against bracken density. Pigs alone were found to be the most useful tool, causing an 83.5% decrease in bracken frond density and 42.9% decrease in frond length (Henney 2012).

Birch et al 2000 conducted a more general modelling analysis using a novel program called VegeTate, which examined the ability of grazing (independently of species) to control bracken concentrations by modelling the interactions of plant species in response to disturbance. The findings were that grazing was only sufficient to control and stem the spread of sparse growths bracken but altogether incapable of tackling dense groves (Birch et al 2000).

When considering using pigs in management systems, Henney 2012 contrasts intensive and extensive systems. Intensive systems involve using high densities of pigs in shorter periods of time to effectively uproot entire patches. Intensive use is very effective in reducing bracken concentrations but is also likely to denude areas of ground vegetation altogether. Alternatively, extensive systems can be used wherein pigs are stocked at low densities probably with a diminished impact on bracken concentrations, no studies have been conducted to examine pig density as a variable in bracken control, so this framework remains conjecture.

The carcinogenic aspect of ptaquiloside also poses a problem for potential use of pigs in bracken management, which may cause gastric, oesophageal, and other cancer types (Henney 2012). The effect of ptaquiloside on pigs has not been studied but has been readily demonstrated in cows (Potter & Baird 2000).

Additionally, the enzyme thiaminase is contained in the rhizomes of bracken and can cause thiamine deficiency in animals which can be fatal in some cases (Evans et al 1963). Evans et al 1963 investigated the effects of bracken consumption on pigs and demonstrated that pigs are also at risk of this disease, however, are resilient when given a moderate dose with access to supplementary food containing thiamine (Evans et al 1963). Pig deaths due to bracken poisoning have been reported but are very rare (Harwood et al 2007). According to Harwood et al 2007 a few subsequent analyses have attributed these deaths to thiamine deficiency (Harwood et al 2007). Bracken poisoning in Gascony, France was demonstrated by Waret-Szkuta et al 2021 which resulted in the death of 6 pigs, it should be noted that this was in a paddock with 85 pigs in 4 hectares, a very intensive system (Waret-Szkuta et al 2021).

This leaves pigs as an intriguing management tool, the results indicate that they are highly effective but the studies are few, limited in scope, and often not peer reviewed. On top of this there are legitimate animal welfare concerns, which are not aided by a lack of medical knowledge of bracken poisoning in pigs. These concerns may only apply in intensive systems, or they may simply be slow acting in extensive systems.

In summation cutting and pig grazing present the most interesting options for bracken control. Both have been demonstrated to lower concentrations considerably within a timespan of only a few years. Generally, bracken cutting shows more promising results than pig grazing and other techniques, however it is also highly labour intensive. Pig grazing by contrast offers a low-maintenance option. No studies exist of the two in concert, nor does a direct comparison study between the two strategies exist. Other techniques such as rolling, ploughing or succession do not currently yield promising results.

Law and Subsidy Review

The Agricultural Law & The Management Law

Landbrugsloven, in English 'the agricultural law', applies to all 'agricultural' estates, of which Sjælegård is one. The latest iteration is from the 29th of June 2018, and future law changes may render recommendations brought forth by this plan null and void. §11 of the agricultural law demands that agricultural estates must conduct some form of agricultural activity (Known as 'landbrugspligt – In English 'agriculture duty'), though the degree and intensity of this are not specified. Such agricultural activities can range from conventional crop farming and livestock rearing to apiculture or aquaculture. There is no formal requirement for the area covered by this activity, but the guidance document does recommend that it exceed the area of the estate used for habitation. Furthermore, the paragraph stipulates that non-production areas must contribute to nature or the agricultural landscape (Landbrugsloven 2020). No other part of landbrugsloven is pertinent to the management plan, and to shed light on the requirements and dispensation on agricultural land use, one must look to 'driftsloven' – in English the 'management law'.

The management law applies to all 'agricultural' estates, which are subject to agriculture duty and outlines requirements on how to manage the land. The latest iteration of this law was adopted on the 10th of July 2017. Of note in this law is §4 which outlines the land uses allowed within an area with agriculture duty (Driftsloven 2021):

1. The farming of crops, including fruit bushes, Christmas trees and bio-energy fuel.
2. Extensive agriculture in the form of low-intensity grazing or haying, these areas are required to consist predominantly of low vegetation and must be light-open.

3. Forest. As defined in the forest law: a forest must cover at least 0.5 Ha and be 20m wide, be covered with trees and be expected to reach a high-canopy forest within a reasonable timeframe (not defined in the law). This may include production forest or ‘nature forest’.
4. The law also recognizes ‘kultur-tekniske foranstaltninger’ (culture-technical Measures) which is a category comprising various aspects of agricultural infrastructure such as hedgerows, paths, ditches and other such structures. Hedges are defined as trees and bushes in rows of maximum 10m width.
5. ‘Small biotopes’ which are small patches which are distinct from the surrounding land and acts as a habitat for plants and animals and may include bodies of water, patches with bushes and trees, dikes, etc. These may not exceed 1 Ha in size.

Without specific dispensation, all the areas within Sjælegård, but outside the area of habitation must conform to one or more of these 5 categories (Driftsloven 2021). The exception being areas designated as ‘fredeskov’ (protected forest), as stated in §3.

In §5 the law also states a legal requirement to prevent open areas from becoming overgrown, herein bushes and trees must be cleared before they reach 5 years of age – this is known as clearing duty (rydningspligt). The law does not require that cleared material be removed from the premises and may be left as deadwood if desired. Several different areas are exempted from this duty, relevant to Sjælegård are the following (Driftsloven 2021):

1. Forest areas, which have been officially recognized as forest area by the municipality.
2. Hedgerows and other agricultural infrastructure
3. Small biotopes
4. Solitary trees and bushes in the landscape, which may not form clusters (defined as more than 3 trees or bushes per 100 square meters) or exist in a concentration of over 100 trees and bushes per Hectare.
5. Especially wet areas which are impractical to clear

It should be noted that whilst small biotopes are exempted from clearing duty, they may not dominate to the extent that the whole area is no longer considered light-open. The clearing duty also does not apply to areas protected by the nature protection law, which must be maintained in the state they are in unless a dispensation from the municipal government is granted (Driftsloven 2021).

The Forest Law

skovloven, which may be translated as 'the forest law', applies to all areas in the country designated as 'fredeskov' – which may be translated as protected forest (Skovloven 2019). These areas are defined in §3 as subject to 'fredeskovspligt', which means protected forest duties (Miljøstyrelsen 2015a). This is pertinent to Sjælegård as the smaller cadastre which encompasses the spruce plantation is designated as protected forest (Geodatastyrelsen 2023). Furthermore, according to §72 oak thickets are also subject to protected forest duties, though if such areas have not been registered by the authorities (as is the case with the oak forest at Sjælegård) they are exempt until a registration has been made (Skovloven 2019). Under §4 additional forest may be raised or registered as protected forest, but only under the auspices of the authorities (Skovloven 2019).

Under §8 protected forest duties require the predominance of high-canopy forest in the area or at least a trajectory towards a high-canopy forest in the foreseeable future (Miljøstyrelsen 2015b). It does, however, allow for other forest types to comprise up to 30% of the total area and there is the possibility to request dispensation for more. Light-open nature types may comprise up to 10% of the protected forest area, though this does not include 'protected' areas (Miljøstyrelsen 2015b). Further decreed under §8 is the requirement that only mature forest may be clear-cut harvested, though thinning of young trees is allowed. Deforested areas must within 10 years of harvest be on a trajectory towards high-canopy forest. If this has not been attained within the allotted time, active planting of seedlings will be required. Forest may be established from natural colonization, seeding or active planting (Miljøstyrelsen 2015b). Rearing of animals is forbidden within protected forest areas, though dispensation may be given by the authorities in the case of grazing for the purposes of nature enhancement – without dispensation the maximum allowed grazing area of protected forest is 10% (Miljøstyrelsen 2015b; Miljøstyrelsen 2015c).

§25 declares that protected forest areas may attain the status of 'naturskov', or nature forest in English. These are forests with an especially high nature value, which are not recognized under the European Union's Natura 2000 initiative (Miljøstyrelsen 2015f). Additionally, the §26 of the forest law pinpoints Oak thickets as of particular interest and such registered habitats are required to be kept in good condition (Miljøstyrelsen 2015g). §27 defines the importance of forests edge, both exterior and interior (around openings) and require that such areas which feature high diversity in vegetation be preserved (Miljøstyrelsen 2015g). §28 Requires that lakes, mires, heathlands, meadows, and pastures present in the protected forest area not be altered – though interventions to maintain these nature types are allowed (Miljøstyrelsen 2015g).

The Nature Protection Law

Naturbeskyttelsesloven may be translated as the nature protection law and was last revised on the 8th of June 2021 (Naturbeskyttelsesloven 2021). The single-most pertinent section of the nature protection law is §3, which outlines protected nature types. Areas of 0.25Ha or more comprising one of the following nature types are protected under §3: meadows, pastures (rough translation of 'overdrev' in Danish), heathland, mires, coastal meadows, and coastal swamps (Miljøstyrelsen 2019). Furthermore, lakes over a size of 0.01 Ha and designated streams are also protected. These nature types may not be altered, though interventions to maintain the condition of a protected area are allowed. It is the responsibility of the regional authorities to register these protected areas, not the owner (Miljøstyrelsen 2019).

The Animal Welfare Law

Dyrevelfærdsloven – in English the animal welfare law – is a law outlining the legal obligations towards animals kept in captivity (Dyrevelfærdsloven 2021). Pertinent to the project is §2 which calls for the minimisation of pain and suffering and §3 which compels the owners of animals to ensure that animals are well fed, watered and are in good health (Dyrevelfærdsloven 2021). §9 stipulates that such animals need to be monitored daily, though section 2 of the paragraph extends this to a 'frequent' monitoring for animals freely grazing. Section 3 mandates the examination of the animals by a veterinarian at least once a year (Dyrevelfærdsloven 2021). §18 requires that all animals have access to movement, food, water, suitable areas for resting and protection from the elements befitting their needs, this latter requirement does not necessarily call for a shelter if the animals are hardy and have access to natural shelter (e.g. forest) (Dyrevelfærdsloven 2021). Under §25 an owner may euthanise an animal provided it is as quick and painless as possible and §27 allows for operations provided they are carried out by a veterinarian (Dyrevelfærdsloven 2021).

Agricultural Subsidies

The first relevant subsidy scheme to be discussed is 'grundbetaling' – or in English - the base subsidy. To qualify it is required that the land in question is either permanent grazing land or cropland and be actively put to agricultural use. Permanent grazing land is considered valid, when an area has supported grassland in at least 5 consecutive years. Alternatively, an area may also be in a transition of being converted from one agricultural use to another, though in such cases may not support any production, though extensive grazing is allowed. These criteria need only be met in the period between the 15th of March and 25th of October. Furthermore, these requirements can be superseded by other subsidy schemes, without losing the base subsidy. The sum consists of about

1.900kr pr. ha annually, and applies not only to the agricultural area, but also associated small biotopes (Landbrugsstyrelsen 2022a). It is required that at least 4% of the total area is left unproductive (i.e. not cultivated or grazed).

The island subsidy – 'ø-støtte' in Danish – is a subsidy specifically for Danish islands unconnected by bridge to the mainland, wherein Bornholm is included. This subsidy contributes approximately 500kr per ha per annum, and only requires the area in question to be located on an island and be part of the base subsidy. (Landbrugsstyrelsen 2022D).

A recent subsidy scheme which has been erected is the nature-care subsidy ('pleje af græs- og naturarealer'). This is focused on maintaining and promoting light-open nature areas. Areas need to be either hayed or grazed extensively. Grazing subsidies are 2,600 kr/Ha per annum and haying subsidies 1,650kr/Ha per annum without the base subsidy. With the base subsidy, they are 1,650 and 1,050 kr/Ha per annum respectively. Nature-care also supersedes the need for agricultural activity in base subsidies. If grazing is chosen it requires that areas are either visibly grazed down by September 15th or a year-round grazing pressure of 0.3 large grazers units per hectare (table 8). Fertilizing, pesticide use, and additional feeding are all prohibited under this subsidy, with allowances for dispensation – feeding in connected areas not under this subsidy is allowed (Landbrugsstyrelsen 2022E). Authorization for this subsidy is given to Natura-2000 areas and areas with a High Nature Value (HNV) of over 5 (box 3). This subsidy is only possible for areas over 2 ha but may include nearby areas which have HNV values below 5 (Landbrugsstyrelsen 2022E).

The climate-grass subsidy – in Danish 'miljø- og klimavenligt græs' – is a subsidy of 1,500kr per ha per annum. This is with a focus to sequester carbon and applies to most grassland-types. The subsidy will require two years of unploughed grassland prior to application. Furthermore, this is not suitable in areas defined under §3 of the Nature Protection Law, nor wetland areas, nor areas with a HNV of 5 or more (Landbrugsstyrelsen 2022F). It can't be combined with the Nature-care subsidy.

High Nature Value (HNV)

High Nature Value (HNV) is a metric used by the Danish Authorities to evaluate the importance of a light-open area in terms of its biodiversity. An additional HNV evaluation also exists for forest areas. The value is scored between 0 & 13, with one point scored for each criterion attained. The criteria are listed below (Ejrnæs et al 2012):

1. Botanical registrations of Average Species Score of at least 2.5*
2. Botanical registrations of Average Species Score of at least 3.25*
3. Botanical registrations of Average Species Score of at least 3.75*
4. Registration of at least 1 threatened and/or near-threatened species on the National Red List or in appendix 2 or 4 of the habitat's directive
5. Registration of at least 2 Red List and/or appendix species
6. Registration of at least 4 Red List and/or appendix species
7. Area is designated as a protected area under §3 of the Nature Protection Law
8. Area is either designated as a protected area or within 50m of a protected area
9. 50m proximity to a small biotope**
10. Organic agriculture***
11. Extensive agriculture***
12. Within 1km of Coastline
13. Peatland
14. Slopes with a steepness of over 15 degrees, which are not intensely cultivated.

*A score is given to every plant species based on how 'desirable' it is in the Danish open landscape according to the authorities, the present species are averaged to generate an Average Species Score

** Small biotopes refer to surrounding structures which support biodiversity such as forests, hedges, lakes, etc and may exceed 1Ha in size. It is therefore not exactly synonymous with the definition offered in the context of subsidies.

***Organic and Extensive agriculture are not compatible; thus, the maximum score is 13, not 14.

Box 3. The metric of High Nature Value (HNV) and how it is calculated

The last pertinent agricultural scheme is the biodiversity and sustainability subsidy (biodiversitet og bæredygtighed). This concerns the productive areas which are transitioned to non-productive small biotopes and provides 2,740kr/Ha and can be combined with the Base Subsidy and the Island Subsidy, but no other. This subsidy does not apply in §3 areas or in areas with a HNV of 5 or more. This can comprise up to 50% of the total agricultural area. No grazing, haying, fertilization, or cultivation is allowed within the subsidised area. An exception for grazing is allowed within areas where the biotope is comprised of 75% trees and bushes. The subsidy also does not support the initial 4%, but rather everything on top of that that. If small biotope area exceeds 7%, the subsidy scheme will cover everything after the initial 3%.

In addition to the agricultural subsidies granted by the Danish Agricultural Agency, there are a few additional subsidies available. The subsidy towards biodiverse forest ('skov med biodiversitetsformål') will continue in 2023, however details have not yet been released (Landbrugstyrelsen 2022j). Based on the 2022 details, this scheme is a yearly subsidy which funds activities which promote biodiversity in forest areas, including grazing, removal of undesired species, restoration of hydrology, preservation of trees and preservation of focus species. There are also one-time grants for projects relating to these activities. The scheme is prioritized for Natura 2000 areas but is also available in forests with valuable nature types. Recipient forest areas are subject to protected forest duties. As of the 2022 scheme, forest grazing may be supported at up to 1,480kr/Ha per annum for grazing provided that the forest area is grazed year-round and show definite signs of it (Landbrugstyrelsen 2022i). Removal of undesired species does not have a defined subsidy amount but can cover up to 100% of expenses and must promote biodiversity. This support is however contingent on the species being listed as 'undesired' by the Agricultural Agency; this does not include bracken (*Pteridium aquilinum*) (Landbrugstyrelsen 2022i). Likewise, the scheme can support up to 100% of costs in re-establishing wetlands, and 300kr/ha per annum in preserving them – these restoration efforts need to be professionally evaluated prior to any activities (Landbrugstyrelsen 2022i). Between 5-20 native trees per Hectare may be preserved under the subsidy, with subsidy amount ranging from 35kr to 125 kr annually per tree, depending on the width and species of the tree. These trees may not be harvested or intentionally damaged. An exception may be made with Veteranization for biodiversity enhancement, which may be carried out on up to 25% of the designated trees – though such trees must remain standing. The protection extends to the trees even after death. At most 50% of protected trees may be located at the forest edge – defined as 20m from the edge of the forest (Landbrugstyrelsen 2022i). Lastly, support may also be provided towards protection of focus species, these include species under appendix IV of the habitats directive, the birds directive and forest species on the Danish Red List. Measures towards these species should focus on improving the habitat quality and there must be proof of the presence of the desired species (Landbrugstyrelsen 2022i).

All told the subsidies offered by the Danish Agricultural Agency allow for a wide range of prospective land uses, ranging from forest to open grassland and a wide range of local variation within either. Nevertheless, the details of the schemes do impose some restrictions on the implementation and planning of various landscape types, at least if they are to be financially supported. A summary of the schemes discussed above can be found in *Table 9*.

Table 9. Summary of the relevant subsidy schemes, including both agricultural and forest schemes. The subsidy amount and its primary requirements are displayed along with the compatibility with other subsidies.

Subsidy Scheme	Financial Support (kr/Ha)	Primary Requirements	Compatibility with other subsidies
The base subsidy	1,900 per annum	• Agricultural Activity (May be exempted if other schemes apply) • >4% of land not productive	All except forest subsidies
The island subsidy	500 per annum	• Area in located on an island included in the scheme (e.g., Bornholm)	All except forest subsidies
The nature-care subsidy	Grazing - 2,600 per annum Haying – 1,650 per annum Grazing w Base Subsidy – 1,650 per annum Haying w Base Subsidy – 1,050 per annum	• Visible signs of grazing or 0.3 animals per Hectare • No fertilisation, pesticides, or supplementary feeding • Natura 2000 area or HNV Value >5 • Area over 2 Ha	Base subsidy & Island subsidy
The climate-grass subsidy	1,500 per annum	• 2-years of grassland and no ploughing prior to application • HNV value <5 and not §3 Area	Base Subsidy, Island Subsidy
The biodiversity & sustainability subsidy	2,740 per annum	• Conversion of productive land to unproductive land • Does not include the minimum mandated unproductive land for the base subsidy • HNV value <5 and not §3 Area • No Grazing, Haying or Cultivation	Base Subsidy & Island Subsidy

	1,480 per annum for grazing 175-2500 per annum for protected trees	• Visible signs of grazing (For grazing support) and year-round grazing with no supplementary feeding • 5-20 protected trees per Ha – must not be cut or damaged (For protected tree support)	
The subsidy towards biodiverse Forest	Up to 100% of cost for wetland restoration, species habitat improvement or undesired species control 300 per annum for wetland preservation	• Expert validation for wetland projects • Species Habitat Improvement only for species on annex IV of the habitats directive, Birdsdirective or Red Listed woodland species. • Controlled species need to be defined as 'unwanted' by the Agricultural Agency • Natura 2000 or Valuable Forest	None

Areas and HNV

Three nature types protected under §3 of the Nature Protection Law are present at Sjælegård: Lake, meadow, and pasture (figure 13). Three lakes are present at Sjælegård, first and by far the largest is Sjælemose, however the small lake adjacent to the house is also protected as is a small lake located within the oak forest. The artificially dug lake in area 5 is not designated as protected. A single meadow area is found corresponding roughly to area 8 (the lakeside meadow). Lastly, a pasture is registered comprising the south part of area 7 (twin peaks field).

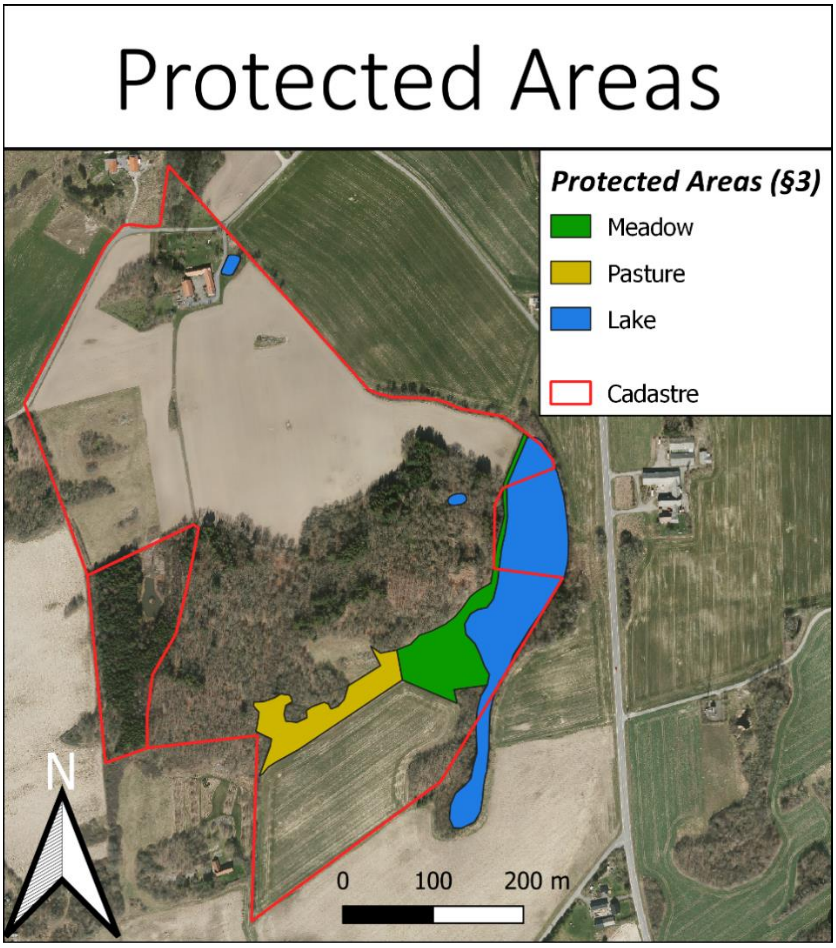

Figure 13. Map displaying the protected §3 *areas present at Sjælegård. These include Meadow, Pasture and Lake areas.Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022. Contains data from Danmarks Areal Information, Beskyttede Naturtyper.*

High Nature Values (HNV) for most of the open areas at Sjælegård were between 0 and 2 (figure 14). A few notable exceptions to this exist, the highest HNV value can be found in the protected pasture area which has a score of 5, along with the adjoining areas to Sjælemose. The protected meadow has an HNV of 4. The remaining area of the twin rocks field has a HNV of 3, as does a small area of peatland on the north field corresponding to part of the former stream. It should be noted that points at Sjælegård was only scored in 6 of the possible 14 categories: §3 Area, within 50m of §3 area, peatland, extensive agriculture, within 50m of small biotope and average species score of at least 2.5. This last criterion was only registered in the protected pasture.

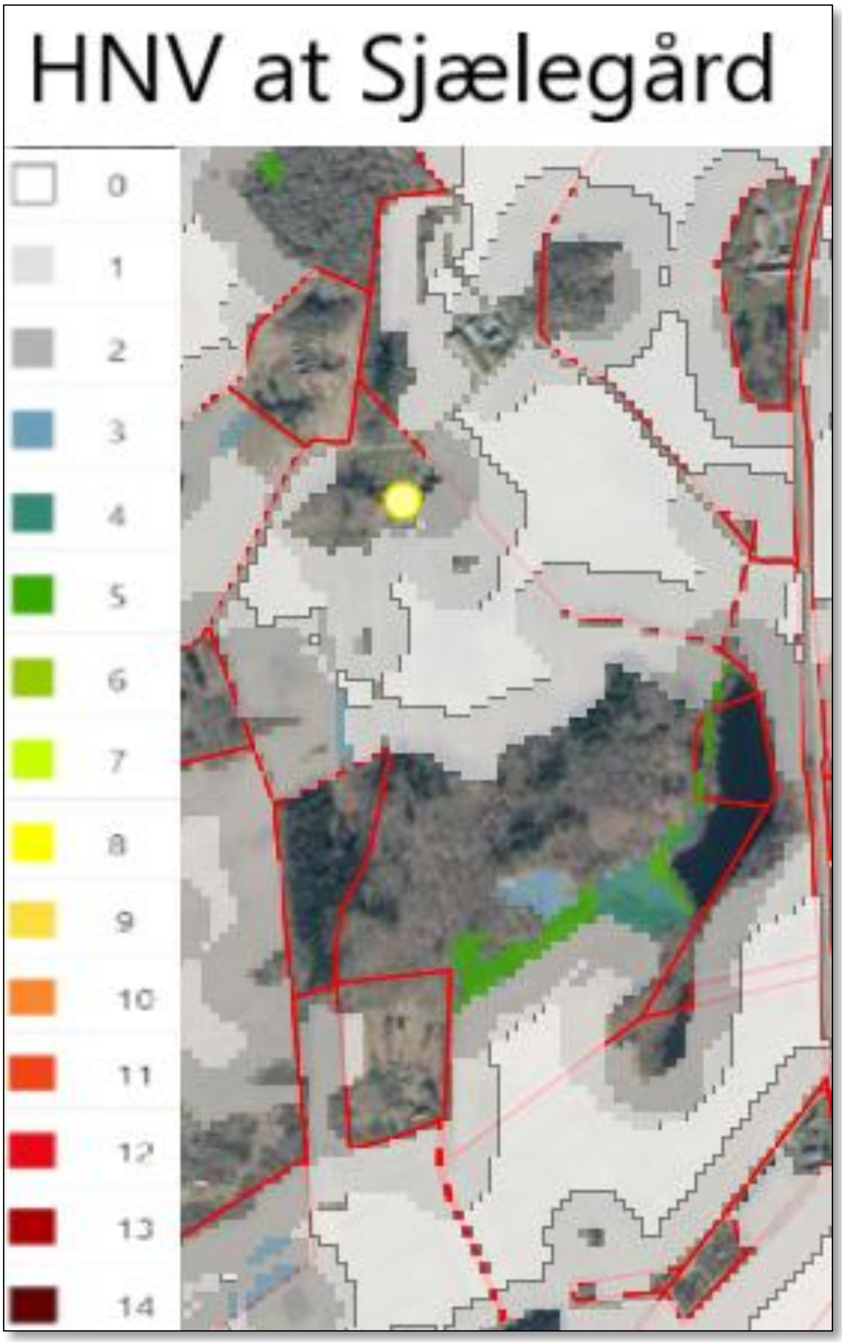

Figure 14. Raster map of the High Nature Values (HNV) of Sjælegård and its surrounding area. Image was constructed in and used data from Danmarks Arealinformation.

9. Management Plan

The Work So Far

Prior to the completion of the management plan, some time-sensitive interventions were being taken at Sjælegård. These interventions were adopted with considerations guiding the plan, and with my auspices but prior to the full analysis and literature review.

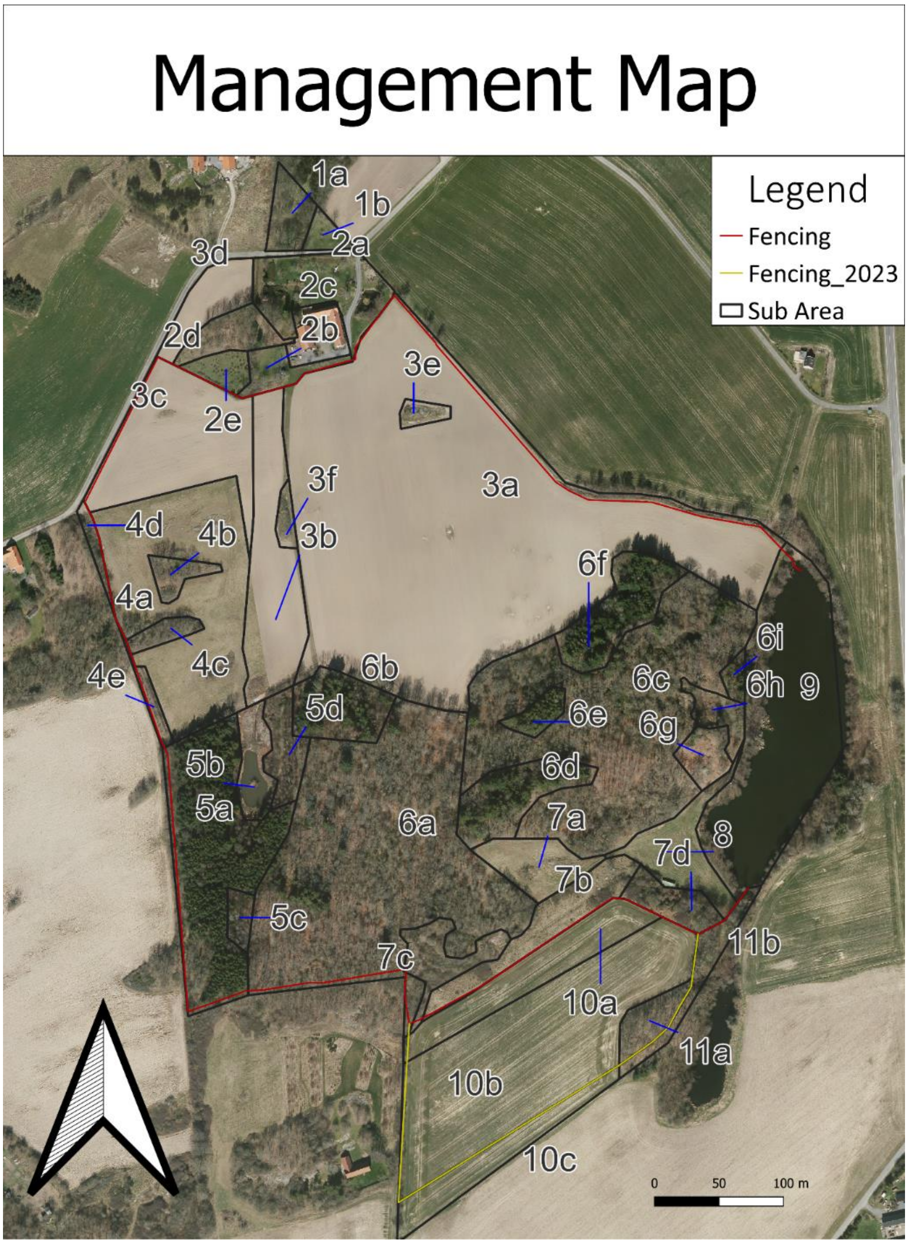

Figure 15. Site areas sub-divided into management units. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.

The wheat fields were harvested in August 2022 and left thereafter as stubble fields - No ploughing, harrowing, cutting, or seeding was done in conjunction with this. At around the same time, logging was carried out in the spruce plantation (image 6). This includes the main spruce patch in area 5e, but also the patches of area 6d-f & 6i (figure 15). This logging left deciduous trees unharmed wherever possible. Furthermore, several spruce trees were left untouched (individuals chosen at the discretion of the forestry company), others had their tops removed and were left as standing deadwood. In addition, a 10-year dispensation has already been approved for grazing within the protected forest area, provided that the grazing pressure is sufficiently low to allow re-establishment of new forest – elsewise active planting and removal of livestock will be mandated (Miljøstyrelsen Pers comms. 2022).

Image 6. Photos of the Spruce plantation before (Top) and after (Bottom) logging. The before image was taken on the 2nd of August 2022 and the 17th of November 2022. Taken at Photo point nr. 5.

Forest and hedge in area 7b-d was cleared under an initiative by the municipality to restore an area of §3 protected pastureland, which had become overgrown. The clearing consisting mostly of European aspen (*Populus tremula*), beach rose (*Rosa rugosa*) and blackthorn (*Prunus spinosa*). Individual trees and bushes were intentionally left. Clearings were carried out in September/October. The granite quarry (6h) was also cleared of trees and bushes. This was carried out by the municipality in accordance with the wishes of the Environmental Agency (Miljøstyrelsen 2022b).

In November/December followed the addition of a fence encompassing most of the property (figure 15). The fence was left open in the East, where it extended into lake Sjælemose. The south field was fenced in February 2023 (figure 15). In December 2022 the denizens of this enclosure were introduced in the form of Galloway cattle: four adult cows with four calves. The individuals were moved from 'Ekkodalen', another nature location on Bornholm. The four cows are expected to produce offspring in the spring of 2023 and the area will be further stocked with the introduction of three Shetland ponies, also in spring 2023.

In November 2022, the exploratory excavations for drainage pipes were carried out and following their discovery a feasibility study is currently being carried out to restore the hydrology of the former stream in the north field (3b) by filling in the stone drain. A small section near the pond has already been dug up (5b north of the lake).

In terms of monitoring, two citizen science initiatives have been set up so far to enable data gathering. Firstly, the Danish Ornithological Society (DOF) has a database where amateur birdwatchers and ornithologists alike can upload sightings of birds. Rather than being point-data, these sightings are spatially divided into pre-defined areas, to ensure that such monitoring can be carried out at Sjælegård, it has been defined as an area distinct from the adjoining properties (DOF Pers Comms 2022). Secondly, using the 'community' tool in Arter, a database has been created that encompasses all eukaryote sightings registered on the premises of Sjælegård – including those gathered during the bioblitz.

Fields

In terms of subsidy schemes, up to 5 will be implemented in the agricultural areas of Sjælegård: the base subsidy, the island subsidy, the nature-care subsidy, the climate grass subsidy, and the biodiversity & sustainability subsidy. Initially all agricultural areas will be eligible for the base subsidy and the island subsidy. Additionally, small patches of agricultural land will be fenced and taken out of production (figure 16), these will have an aggregate area of 0.9Ha, comprising 6.5% of the total agricultural land. These unproductive areas qualify as small biotopes. Fencing of said small biotopes only needs to be adequate for excluding the livestock. The initial 4% of non-productive area will be eligible for base and island subsidies, whilst the additional 2.5% will also support the biodiversity and sustainability subsidy. Currently, the only area with a HNV high enough to qualify for the nature-care subsidies is the §3 pasture; this area is too small to obtain subsidies but may be combined with the adjoining south field and meadow to comprise a single area under the subsidy. It should be the long-term goal to encompass all productive land under the nature-care subsidy. To boost the HNV score small biotopes should be distributed as in figure 16, as this covers almost the entire area of the fields within a 50m radius of a biotope. Furthermore, documentation of plant species using the app 'Naturbasen' should be carried out during spring and summer time to attempt to boost the average species score – boosting the HNV further. Nationally red-listed species or those belonging to the annexes of the EU Habitat Directive should also be recorded on Naturbasen. Any areas which do not qualify for the nature-case subsidy after 2 years, can instead be assigned to the climate grass subsidy until they reach a HNV score of 5 or more.

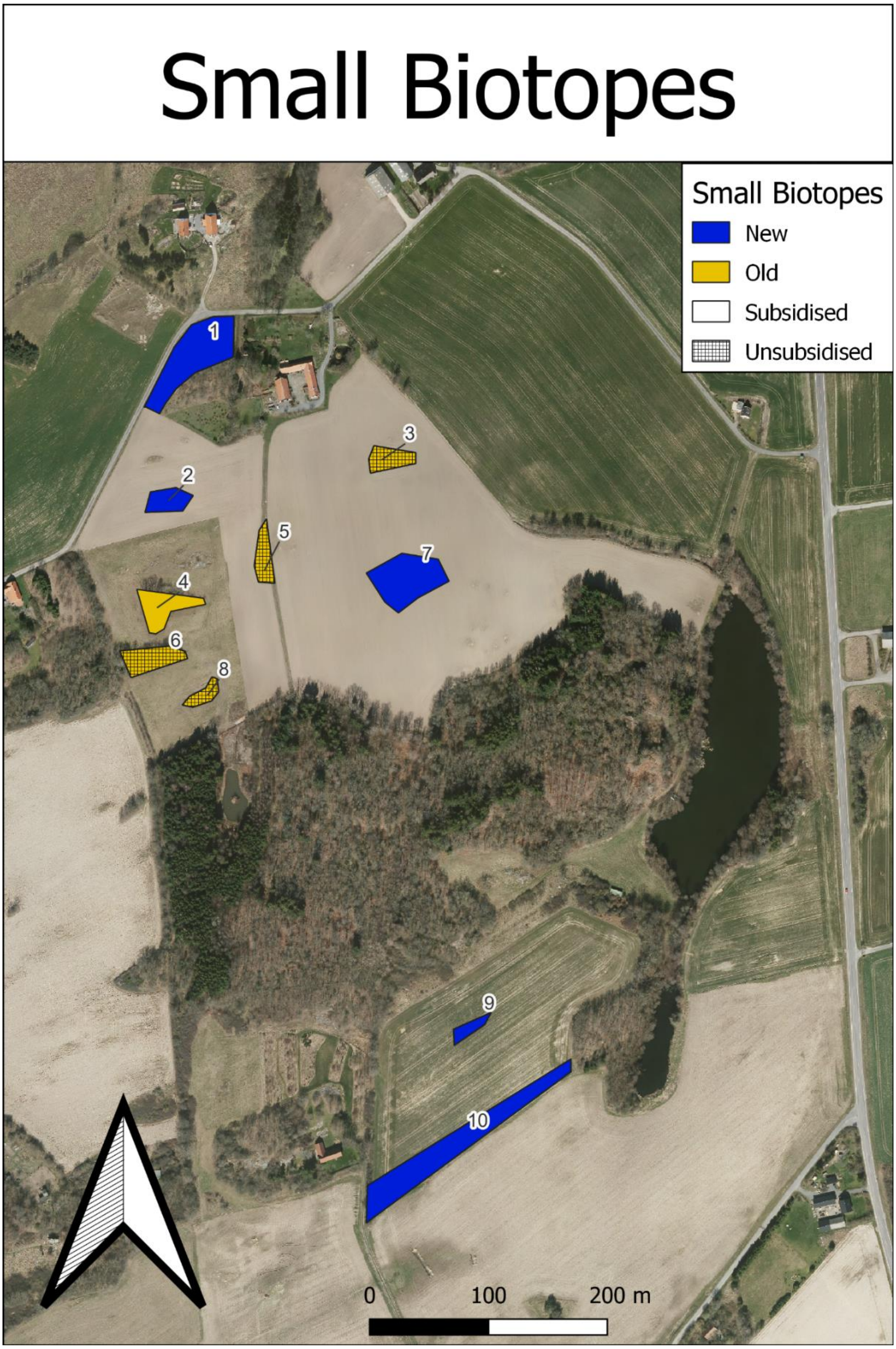

Figure 16. Small biotopes which are pre-existing (Yellow) or planned (Blue) at Sjælegård. *Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.*

Shedding a little more detail on the small biotopes, a total of 10 are planned, 5 of which are pre-existing and do not count towards the non-productive area (figure 16). More biotopes may follow in the future. Biotope 1 comprises 0.26 Ha and is slated to be transformed into a forest patch via active planting, herein sessile oak (*Quercus petraea*), small-leaved lime (*Tilia cordata*) and European hornbeam (*Carpinus betulus*) will be planted, but space will be left between individuals to allow for natural colonization from the trees in the adjoining patch as well as bushes. This area will require fencing capable of excluding deer. This patch was designated as forest at the wishes of the landowners to provide a buffer between the estate and road. Biotope 10 encompasses 0.35Ha and will also be placed outside the main perimeter. There will be planted a hedgerow of a mix of bird cherry (*Prunus padus*), common dogwood (*Cornus sanguinea*) and European spindle (*Euonymus europaeus*) in the southern-most section, with any area remaining between the fence and hedgerow being left to natural colonization and succession. The hedgerow is to create a delineation to the neighbouring field. The remaining novel small biotopes will require cattle-fencing and range from 0.03 to 0.2 Ha in size. The existing small biotopes are unsubsidised except for biotope 4, because it contains a small lake. In cases where a small biotope has established forest or bushland, the fence may be removed so long as the tree or bush cover exceeds 75%. When this is the case, fencing may be moved elsewhere to create new biotopes – provided the HNV score of the new area does not exceed 5.

Additionally, planting of individual trees in the open landscape should be carried out, though each tree will require a small perimeter of deer-proof fencing. This may not exceed 3 trees/bushes per $100m^2$ or 100 trees/bushes per hectare, however this allows approximately 1300 trees to be planted. A few hundred tree plantings are encouraged; however, their number will be dependent on budget and time constraints. Plantings should be of the following species: small-leaved lime (*Tilia cordata*), sessile oak (*Quercus petraea*), field maple (*Acer campestre*) and Scots pine (*Pinus sylvestris*), as a means of hastening the presence of trees in the landscape. Plantings should take place over many years or even decades to encourage age variation. The landowners are encouraged to not remove bushes or trees in the productive area which establish through succession until they reach 4-5 years of age – after which they are compelled to do so due to the ‘clearing duty’ imposed by the management law. Due to the novelty of the subsidy regimes, it is unclear if it is legal to simply redesignate an overgrown patch to an unproductive area, rather than clearing it. If a precedent for this does evolve in the coming years, it would be a useful tactic to employ at Sjælegård – though here bushes/trees must exceed 75% coverage in the patch to count. If redesignation is not possible, an alternative strategy may be to leave a few individual trees and bushes uncleared, so long as they comply with the 3 trees/bushes per $100m^2$ rule. Some deadwood from thinning and clearing in the forest and overgrown may also be moved to the open landscape, such that branches, and thorny shrubs may provide patches with protection from grazing – potentially allowing new shrubs or trees to establish within. Additionally, these will also serve as perching spots for birds, which may act as seed vectors. boulders which have been moved to the edges of the field should be spread back out. Aside from the planted trees and bushes, no assisted dispersal is currently planned at Sjælegård. The issue should be carefully considered in the future but is outside the scope of this plan.

The choice of Shetland horses and Galloway cattle as the grazers should be maintained, and at least initially no further species should be adopted, though in the long-term pigs could be considered. The desired initial biomass is around 120kg/ha, based on the review. The scheduled number of individuals is in excess of this grazing pressure; thus, it is suggested that four of the older calves or fully adult cows be butchered or sold off prior to the autumn of 2023. This will drop the herbivore biomass to about 120kg/ha for the first winter. Whether this grazing pressure is adequate or insufficient will be evaluated through the average vegetation height in open areas. 20 points in the open landscape should be randomly sampled using QGIS, the height of grass/herbs should be measured at these sites using a ruler. Sampling should be conducted in early March as this will indicate food availability at the scarcest time of year. The results can be categorised as outlined in table 10 (Miljøstyrelsen 2023a). A medium grazing pressure is desired; thus, if the pressure is high grazers should be removed and if low, they should be added. Additional vegetation structure analyses should be carried out as in the methods, ideally annually or every two years.

Table 10. Vegetation height as a proxy for grazing pressure – figures from Miljøstyrelsen 2023a)

Grazing Pressure	Vegetation Height (cm)
High	<5
Medium	5-8
Low	>8

If the hydrological feasibility study returns an affirmative result, the stone drain should be removed to re-establish a wetland in area 3b. To avoid flooding the estate and garden, some drainage will need to be maintained at the north-end of the field. If resources allow additional excavations for drainage pipes should be conducted, particularly in the areas near lake Sjælemose. If drainage is present, measures should be taken to remove or block pipes. The artificially dug pond in 5b should be filled back in to recreate the original swamp, though this will be dependent on permission from the municipality. Monitoring of water bodies will be carried out in the form of water samples collected thrice a year, once in May, once in July and once in September. These should be collected at the top of the water column. Water samples should be collected from Lake Sjælemose as well as the pond in 5b and stored in a freezer with labelled containers. The use of these water samples can be determined at a future date, and will depend on future needs of the project. These may range from investigating the long-term effects of rewilding surrounding area on water quality to ptaquiloside concentrations in water bodies following bracken management.

Forest

An application should be filed for the subsidy towards biodiverse forest. The central forest area will be placed under forest protection duties, if this is accepted – it will preclude grazing. Therefore, a dispensation towards forest grazing will also be needed, simultaneously. The subsidy should cover forest grazing as well as protection of individual trees. To prepare for this application, A total of 131 trees were selected, and the predicted subsidy amount from them totals 6595kr per annum. Of the trees, 37 were within 20m of the forest edge, which is less than the 50% maximum allowed under the scheme (figure 17). With 8.9Ha connected forest, the subsidy allows between 44 & 177 trees for protection. This allows a further 46 protections in the future if desired.

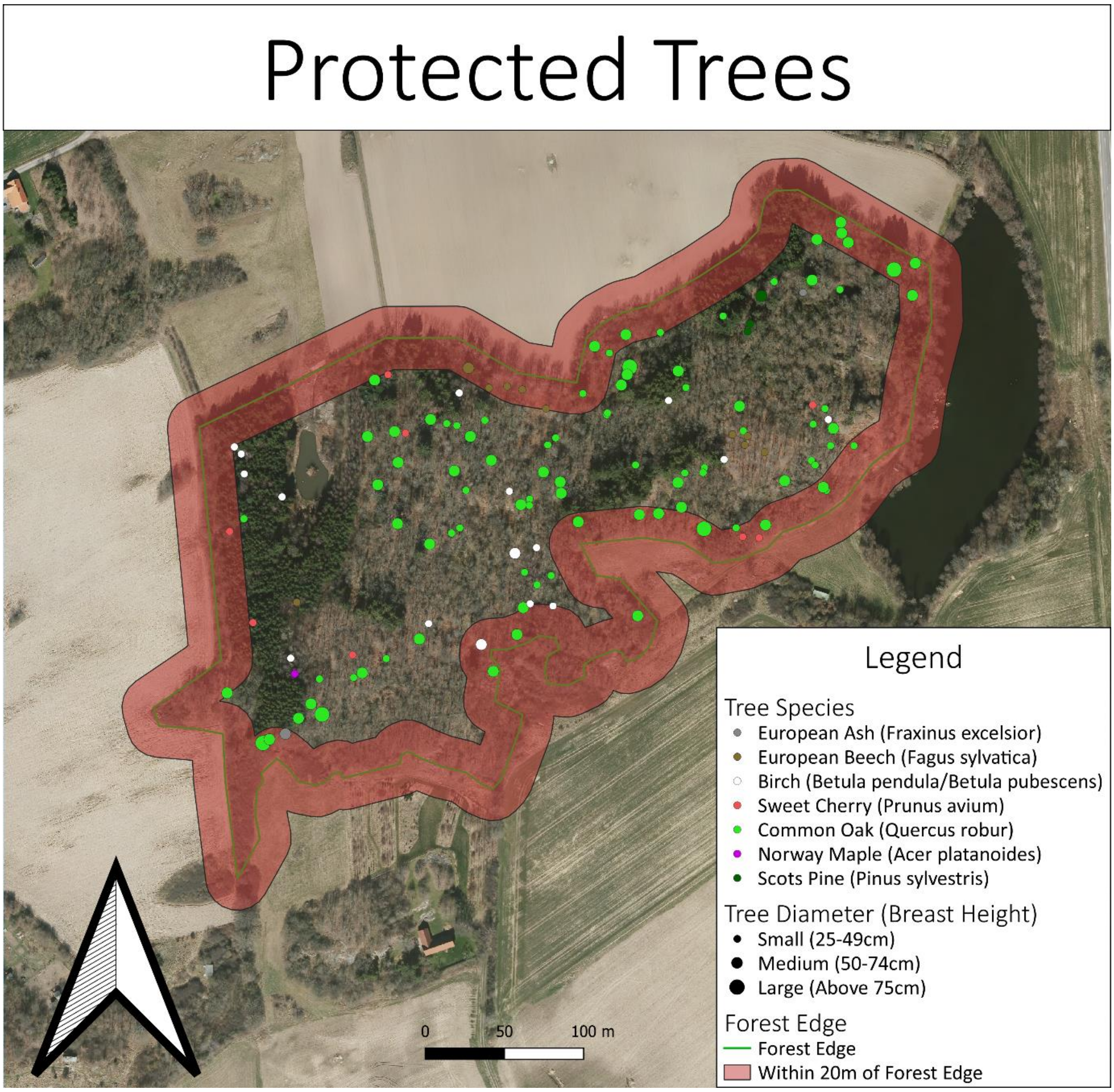

Figure 17. Trees selected for protection (Dots), broken down by tree species (Colour) and tree size (Dot size). The forest edge (Green line) is also displayed along with a 20m Buffer (Red). Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.

Generally, no tree species at Sjælegård needs to be discriminated against and actively be removed – aside from the dense Norway spruce (*Picea abies*) monocultures which have already been harvested. Area 6f which has been cleared of Norway spruce should be treated as a new transition zone between the forest and field, here recruitment of new trees and bushes ought not to be cleared. In area 5a trees should also be left to establish themselves, if this does not occur throughout the area before 2032, it will be required to be surrounded by deer-proof fencing and actively planted with trees. In case a tree planting is necessary, pedunculate oak (*Quercus robur*) should be favoured as the dominant tree species to seamlessly integrate with the central forest area. Compatible species which are absent or rare at Sjælegård, such as sessile oak (*Quercus petraea*) and European hornbeam (*Carpinus betulus*) might be suitable picks for co-planting. Other harvested areas (i.e. 6b, 6d-f, 6i) should be left to natural succession. Area 6h should be cleared of dense vegetation and be left open in line with the wishes of the municipal government due to the point of geological interest.

Cutting of bracken should be conducted biannually in novel clearings (i.e. 5a, 6b, 6d-f, 6i), as well as at the periphery of existing groves. First cut should be done in late May/early June followed by a second cut in late July. bracken fronds should be removed after cutting. Should more time and resources be available, additional cuttings (annual or biannual) maybe conducted in the interior of the forest (6a & 6c) but should be repeated every year. Gloves and long sleeves should be worn during cutting. Salt licks should be placed in dense bracken groves to facilitate increased trampling by livestock. If possible, a small population of pigs should be introduced. This will require an upgrade of the fence to accommodate them as well as increased veterinarian oversight due to bracken concerns. Furthermore, permission to graze pigs on §3 areas and in protected forest areas must be granted by the municipal government (Naturbeskyttelsesloven 2021).

Monitoring of bracken will be essential in evaluating the success of the management and may well redirect management practices. Two elements are crucial to evaluate: bracken extent and bracken densities. A methodology for the former has already been outlined, this should be carried out every 2 years.

To measure bracken densities a simple frond count and stem count should be used. Sampling should be carried out in 6g. 6 plots should be erected of 1m x 1m, two of which should be placed within an actively managed patch cut once annually, two cut biannually and two in a patch with no interventions. Stems should be counted if they spring up within the square, and all fronds counted on ferns with stems within the square. The squares should be left year-round, though need to be moved during cuttings but returned afterwards. Measurements should be taken during August or September, well after the cuttings.

10. Discussion

Methodology and Data

Given the breadth of scope of this exploration, limitations were inevitably imposed on the depth of investigations, both in terms of data acquisition and analysis, as well as literature reviews. Nevertheless, information can be gleamed from the data gathered.

Ecotope Mapping

Overall, the ecotope mapping offered precious spatial context to subsequent baseline surveys and to the management plan at large. This is especially true in informing sampling practices for botanical surveys, vegetation structure analyses and soil sampling. The results of the land use mapping highlight a roughly even division between productive agriculture/silviculture and 'nature' areas. Biotope mapping further reveals a degree of heterogeny in biotopes in areas of Sjælegård, particularly in and around the central forest area. Geotope mapping also illustrated some variety in the underlying pedology and topography, including the presence of freshwater gyttja which indicates potentially wet areas, which tend to be desirable as nature areas.

The data is however not perfect. Several biases and limitations may be identified in the mapping practices. In terms of the biotope mapping, the categories were necessarily conceived prior to systematic botanical investigations as it was used to inform the raunkjær sampling strategy. As a result of this they were based on the most conspicuous species – usually trees and bushes. This was further complicated with the difficulty in identifying grasses, leading perhaps to a finer distinguishing of forest types than open habitats. Furthermore, boundaries between biotopes were not always clear cut leading to a level arbitrariness. Compounding this is the uncertainty of the iPhone GPS tracker which Mergin identified to be 5m. The land use mapping suffered from the same limitations as the biotope mapping, though the categories were more easily identified and delineated. Geotope mapping on the other hand had clearly defined categories based on empirical data, and as no data was directly measured all such biases were external to this investigation. One thing to note is that the category of Pre-Quaternary soils is imprecise. As the data was provided by GEUS it was not possible to specify any further, but qualitative observations in the area suggest this category predominately consisted of granite. The datasets used for the geotope analysis only cover two aspects of the geomorphology, and do not investigate factors such as inclination, hydrology, aspect, etc. Despite all these limitations the spatial guidance offered by the mapping of biotopes, land-use and geotopes is valuable, and should not compromise the management plan in any major capacity.

Botanical Survey

The botanical surveys indicated that the open habitats at Sjælegård support a higher floral diversity than the forest habitats and highlighted the high botanical value of light-open forest habitats – especially oak forest. Ellenberg values also indicated that the conditions across all biotopes were relatively similar, showing only slight deviations in reactivity, light availability, nutrient richness, and moisture, with no biotopes showing any extreme conditions. The largest benefit of the botanical surveys is in providing a point of comparison for both floral diversity and community composition for future surveys, allowing a quantification of how the site has improved.

These results should however be taken with an awareness of the shortcomings of the botanical survey. The uncertainties of biotope mapping would have knock-on effects as it guided botanical surveys sampling efforts. Sampling efforts were based around the categories defined in the biotope mapping, but randomly sampled within which eliminated any deliberate selection bias. Nevertheless, this rendered the efforts vulnerable to randomly generated biases such as clustered points and likely excluded interesting microhabitats. GPS uncertainty also meant that circles may have been placed a few metres from the 'planned' locations. Of course, the different sampling strategy for wheat fields also meant that the sampling bias was not consistent across all biotopes. The decreased number of points within 'secondary biotopes' were adopted due to time constraints; however, it made direct comparisons between primary and secondary biotopes difficult – especially in non-average metrics such as total species. Of course, the omissions of smaller biotopes also left a knowledge gap, particularly Alder Forest may in hindsight have justified sampling – though accessibility was difficult due to wet conditions.

Identification of taxa was a significant issue during sampling, primarily amongst grasses (Poaceae spp.), though other difficult taxa included *Rubus* and very young tree seedlings. Of course, the time of sampling affects species identified because flowering species are easier to distinguish. This inevitably skewed results by under sampling species richness and skewing Ellenberg values in favour of easily identifiable species. This may leave the dataset as a poor baseline. The dataset was too small to allow any meaningful statistical analyses but allowed a general overview of the current biodiversity through the metrics used. Statistical power could however be attained through continual sampling in the years to come. It should be noted that the botanical studies were inevitably biased in favour of light-open habitats as they only measured the floral biodiversity on the ground, which does not integrate the multi-layered biodiversity of forests, nor did it integrate mosses or fungi.

The results of the Ellenberg indicators were questionable, for instance dark beech forests have the highest L value of any forest type. It is similarly puzzling that the mesic grasslands and xeric grasslands are very similar in F value. After conducting the botanical surveys, it becomes unclear if the xeric grasslands were even xeric at all. Such an assessment was made based on the superficial character of long dry grass, however this likely resulted from an exceptionally dry summer in 2022 rather than the typical habitat conditions. Likewise, can the mesic grasslands truly be categorised as such and not a wet grassland? The Ellenberg values would certainly suggest that both these initial classifications were incorrect. A larger discussion can be had regarding classifying habitats based on wetness in an age of climate change, but that is beyond the purview of this discussion. Nevertheless, it is still doubtful that these two biotopes would not differ in their moisture Ellenberg indicator value, if only due to the 'mesic' grassland corresponding to an area with freshwater gyttja and shallow gley in the soil profile. The exact source of these counter-intuitive Ellenberg results is unclear but may arise from dominance of planted species in some biotopes, which may not otherwise have established in the local abiotic conditions.

The biases, limitations and questionable results of the botanical surveys may suggest that limited reliance can be placed on them. This does not altogether prevent future use of botanical surveys as a means of tracking biodiversity progress at Sjælegård, but it should be interpreted with caution.

Vegetation Structure

The results of the vegetation structure analysis indicated a high variability in openness and suggested that the patches with spruce forest and beech forest had very little light availability, which is interesting when considering that these were also the biotopes with the lowest species diversity. Conversely, the most light-open patches correlated loosely with the high biodiversity biotopes. Elsewise, the most important function of the vegetation structure analysis is in providing a baseline, to which future landscapes can be compared. This is particularly of interest because it is a metric that can track the effects of vegetation succession and grazing.

Vegetation structure was a 'quick and dirty' methodology, it was very time efficient but came with several issues. For one, rather than relying on empirical data it consisted of coverage categories with wide ranges which were estimated rather than measured. As a result, there were cases where coverage was near the boundary and an arbitrary assignment to one of two categories was carried out – such determinations are likely to differ between observers. Though observers were constant in 2022, they may differ in future monitoring. Furthermore, getting a 'big picture' view of the vegetation cover can be exceedingly difficult in larger patches. The decision to sample vegetation structure on a patch basis rather than a biotope basis was intuitive as structure varied substantially between patches, however it will make it more difficult to compare with future datasets or with other datasets which were sampled by biotope. Nevertheless, the speed at which the analysis could be carried out makes it an excellent metric to track consistently going forward and allows the calculation of an openness index that can be useful information for adaptive management of grazing pressure.

Bioblitz

It is difficult to evaluate whether the number of species registered in the bioblitz was high or low, but some useful information can be discerned. Firstly, the proportion of protected or red-listed species can be used as a metric for the conservation value of Sjælegården and the documentation of such species will improve the HNV value. In 2022 red-listed species comprised a very small proportion of species present, implying a limited conservation value at baseline. Half of the red-listed species were relatively abundant birds which are on the decline nationally (Dansk Ornitologisk Forening 2023), several of these are linked to open and semi-open habitats and may well see a recovery at Sjælegård following management practices to promote more biodiverse open landscapes. The presence of beach rose and giant goldenrod as highly invasive species, might prove an ongoing concern and future investigations should be wary of these species. Perhaps a monitoring approach comparable to that carried out on bracken extent would prove beneficial in tracking these two species at Sjælegård in the future.

The BioBlitz had a few significant limitations. Firstly, due to the presence of amateurs as data collectors, risk of misidentification does exist. For example, the Eurasian collared dove was registered during the bioblitz, but has not been observed before or after – nor does the species generally frequent rural landscapes (Dansk Ornitologisk Forening 2023), likely it was a misidentified common wood pigeon (*Columba palumbus*). Furthermore, there were biases in the specialists present: two Lepidopterologists and a botanist, this will likely skew the representation in favour of their studied taxonomic groups, and identification bias is further exacerbated with amateurs sampling more recognizable groups such as plants and birds. Also, the identified species were likely far shy of the total biodiversity at the site, primarily limited by sampling effort and lack of expertise in more obscure groups. Despite all these limitations, bioblitz data can offer a treasure trove of other data. Each species occurrence can provide information about the ecology of the site, an exhaustive analysis of this may be useful in future examinations but is mighty time-consuming and is contingent on adequate species knowledge – therefore not included in this investigation. Breaking down species by habitat preference may also indicate where the biodiversity is distributed and could be a useful analysis tool in the future. This wealth of information would be even more useful if it was georeferenced. In theory this was done, though in practice many sightings were simply noted down and uploaded without a georeference or an incorrect one.

Photo Sampling

Photo sampling allows visual evidence of changing landscapes and though not an empirical metric can provide a simple visual guide. Two primary difficulties have arisen from this methodology. The first is replicability, the GPS used is only accurate to within 5m, so finding the exact spot is difficulty without erecting a physical place marker. This was done, but many of these poles were knocked over or removed due to heavy machinery moving through an area. So exact duplications have proven difficult. Secondly was that the number of points defined have been altogether inadequate in capturing the differences occurring at Sjælegården, especially within forest habitats where photography only penetrates a small distance. Nevertheless, even if duplicates are off by a few meters and do not sample the entire sum of changes, a time series of the selected sites will still provide a comprehensive record of development.

Bracken Distribution

Bracken has a substantial distribution within Sjælegård but is limited to a single contiguous area extending across most of the forest. This would suggest a single source of dispersal in the future, though sources from outside of Sjælegård can't be precluded. The absence of bracken from the oak forest in the southeast of the property is peculiar, as it appears a similar habitat to the remainder of the oak forest where the bracken is dominant. One possible explanation of this is that the bracken at Sjælegård has primarily spread slowly via its rhizomes and simply has yet to reach the patch. Bracken is also capable of spreading via spores, but this seems to account for very little of their dispersal (Marrs et al 2000).

An atlas constructed from observations along transect lines is a fast method which can be replicated without need for technical skills. It is not without faults, however. Observations along transect lines are subject to visibility, and this will inevitably lead to a bias in ease of detection in open habitats compared to forest – though given the near ubiquitous distribution within the oak forest the effects of this bias may be negligible. More profound is the issue of resolution, with a cell size of 50x50m it may be difficult to monitor a retraction or expansion of the bracken given its slow spread rate – nor does it offer clarity of where bracken is present in grid cells with multiple habitat types. Nor give any indication of bracken concentration. As such the method is pragmatic but limited in the data quality which may be produced.

Forest Structure

The Forest Structure Index offers insights into the aspects of the forest which could potentially be improved upon at Sjælegård. Altogether, the forest structure at Sjælegård is relatively healthy, but certainly shows a room for improvement. When breaking the score down by points it becomes clear where the forest is lacking. Sjælegård has low nature connectivity and the key species of *Tilia cordata* is missing. There is a lack of larger trees - both living and dead, and a low degree of wounds is present, deadwood is also both age-limited. Understorey biodiversity and regeneration is lacking - the high dominance of bracken is likely repressing this. Finally, management impacts have resulted from initial interventions, and this may continue in the wake of management.

The toolset is developed for a Danish context, which made it easily applicable within the grounds of Sjælegård and enables direct comparisons to other wooded areas. It is easily replicable as it is based on a questionnaire which can be filled out with limited instruments and technical knowledge. It enables an understanding of which structural components may be lacking in a forest – though a few categories are practically unalterable (e.g. chalk visible in soil) and therefore of limited value to a management plan. One potential issue with the GEUS forest structure analysis is a bias towards late-succession forests (rooted in a high-forest assumption), which ultimately is not the goal of the Sjælegård project. Furthermore, the relatively interspersed trees in oak forest make density based metrics problematic and these are quite plentiful in the GEUS Forest Structure Index. On Sjælegård this structure analysis was conducted on the entire forest area, rather than subdividing into different smaller forests. This was done in the interest of time and replicability but therefore also makes tracking of changes in select areas more difficult.

Soil Sampling

Limited information can be obtained from the soil sampling conducted at Sjælegård, above all due to a low sample size – only a sample per two-hectare area – insufficient for gaining a big-picture perspective of the pedology. Nevertheless, the soil data does corroborate some of the information provided by GEUS and used in the geotope mapping, lending credibility to the viability of the map as a guidance. It also provided some general information about the area, including a high bedrock and predominance of clayey soils.

Hydrology

Hydrological studies were outside the purview of the investigation. Hydrological interventions have therefore mostly been left aside. That does not mean that they wouldn't be useful and future endeavours should be taken to better understand the hydrological conditions and intervene accordingly. Even so, the joint ownership of Sjælemose makes it difficult to manage the main body of water on the property. The risk of affecting neighbouring properties or archaeological remains when altering hydrology means that such future interventions should be taken with care. The information which was available was gathered either by the municipality or was gleaned indirectly from other methods such as the Ellenberg values, soil sampling and ecotope mapping and will be subject to those biases. Nevertheless, the understanding of drainage on the north field because of excavation is of value when constructing the management plan, as it informs where hydrological interventions are possible. And these possible interventions are further guided by the understanding of soil conditions from sampling and geotope mapping.

Grazing

Constraining the search to the 5 native or near-native herbivores may have been overly strict. Other species such as goats, alpacas and sheep are utilized in rewilding projects nationally – often with success. The decision hinges on the assumption that the domesticated species take on the same ecologies as their native progenitors, which is not fully demonstrated. The rationale was that local flora and fauna are co-evolved with the native (or near-native) herbivores and thereby complementary. Likewise, non-domestic native species weren't considered despite potentially serving as pivotal species, because these do not fit with the vision of having nature accessible to visitors nor with the legal definition of an 'agricultural area'.

Judging a good estimate for a herbivore density baseline was exceedingly difficult. Very few studies have been conducted on the subject and accurately estimating densities prior to human arrival is practically impossible. The study that relied on rewilded European Areas provided some guidance for a ballpark estimate, but of course it showed a wide variation in density.

The recommendations provided by the Environmental Agency also conflicts with the baseline, as they seem to indicate a much larger carrying capacity than Fløjgaard et al 2022. Of course, the large grazer units do not allow a direct comparison with herbivore biomass, but a rough estimate can be carried out. Assuming a typical mass of about 500kg for a fully grown cow (Miljøstyrelsen 2020), this corresponds to one large grazer unit. Then the recommendation is about 150-400kg/ha for pastures and 200-600kg/ha for meadows, vastly exceeding the natural systems. The Environmental Agency does not elaborate if this is year-round grazing or simply summer grazing with supplementary fodder during wintertime. The requirement of at least 0.3 large grazer units per hectare for year-round grazing, mandates a minimum grazing pressure of 150kg/ha (if applied to typically sized cattle), already in excess of the average findings by Fløjgaard et al 2022. Furthermore, whilst the Environmental Agency provides recommended grazing pressures for light-open habitats, they make no mention of potential forest grazing and it is unclear how much additional fodder such an area provides. The exclusion of pigs is also problematic, although their food sources have limited overlap with other livestock, they do still place a pressure on vegetation and would certainly contribute a de facto grazing pressure.

Perhaps the government recommendations are excessive and aimed at creating systems with an unnaturally high grazing pressure to maintain completely open landscapes, they also assume the possibility of supplementary winter fodder and so are not subject to natural population controls. Conversely, it is possible that herbivore densities at European rewilded sites are inadequate to maintain open landscapes, either owing to a falsity of the Vera hypothesis or due to a still depleted faunal guild (e.g., absence of elephants, rhinoceroses, etc.). If such is the case, an above baseline herbivore density would be required to maintain an open landscape. Ultimately, current literature is insufficient to establish a baseline, and the issue of natural grazing pressures is still a matter of debate. This leaves a good starting point rather elusive for Sjælegård, guided by limited and conflicting information.

Bracken Control

All in all, the bracken control literature quite conclusively pointed towards two effective models: cutting and pig grazing, both of which have very encouraging results. The two are also unlikely to be mutually exclusive as the former targets the fronds and the latter the rhizomes. Some detail was also shed on the ideal time to cut bracken, towards the beginning of their growing season – though this was based on limited experiments. The literature was not without its shortcomings, however. Many studies on bracken control are confined to heathlands rather than light-open oak Forest as is present at Sjælegård. Likewise, there is a strong bias towards research from the United Kingdom with no included studies from Denmark or Southern Sweden. Numerous studies from France were unavailable due to both a language barrier and the presence of pay walls. Nearly all studies were focused on evaluating cutting of bracken and the use of asulam, with only a few devoted to less orthodox techniques such as bruising, ploughing, succession or pigs. This undoubtedly has led to a bias in the recommendations given in the management plan towards cutting, as recommendations are based on the findings of this review. The few studies that were conducted on pig management were small-scale and not peer-reviewed, restricting the weight that can be placed on them. Nevertheless, the limited results on pig experiment were very promising and offer an opportunity for Sjælegård to expand on the limited dataset of bracken control if pigs should ever be introduced.

Laws and Subsidies Review

Legal documents were often imprecise in their meanings, this was usually supplemented with legal interpretation documents but even so did not necessarily shed light on particularly issues. There were some uncertainties. For one, it is puzzling that the forest at Sjælegård is not designated as protected ‘oak thicket’ – if the area is indeed eligible for such a categorisation it may well be subject to protected forest duties in the future. A similar confusion exists regarding the man-made pond in 5b, despite being a waterbody exceeding 0.01Ha, it is not designated as a §3 area. Furthermore, high-canopy forest is not clearly defined in an ecological context but relates to forests with high production value. In general, it is quite clear that both the management law and the forest law are production-focused laws which lack ecology-focused provisions - to the detriment of nature projects. Of course, these laws are subject to change. With a general revision of the agricultural sector to address biodiversity concerns, many of the limitations imposed by the legal system on rewilding projects may cease in the years to come.

Unlike the legal regimes, the subsidy system had recently received such an overhaul. This was done so recently that subsidies for 2023 were also not fully fleshed out yet, so amounts or precise requirements may deviate slightly. In terms of the forest subsidies no details for 2023 had yet been released at all, so the review relied entirely on documents from 2022. Subsidies were only pursued in the public sector via the Danish Agricultural Agency, though as a rewilding project there were likely alternative private sources of funding. There is also the concern that the management plan was tailored to optimising monetary gains rather than increasing biodiversity, however economic considerations are imperative when considering the viability of a project like Sjælegård.

Management Plan

The overarching goal of the management plan was to promote a diverse landscape at Sjælegård with the agricultural fields replaced by a wood-pasture, ideally regulated by an adequate grazing pressure. Habitat heterogeneity was a guiding principle in this. In the pre-existing forest area, replacement with a Vera landscape was not desired, as the area already supports a valuable ecosystem. Nevertheless, optimisations to support biodiversity where possible were favoured, such as controlling the ubiquitous bracken. The preferred approach to attaining these goals was the reintroduction of natural processes, however as the project goes hand in hand with an eco-tourism initiative, shortcuts were considered. Furthermore, natural processes in some cases could not be restored, and here alternative solutions were sought. Further concessions were made to ensure financial viability, through the use of subsidies which come with requirements.

Fields

The main obstacle encountered when constructing a plan for the open areas of Sjælegård was the conflict between a dynamic woodland-pasture and the management law. Above all is the issue of natural succession. Simply put, areas left for natural succession must be pre-defined as non-productive. If they are not so defined, the management law declares that within 5 years any woody vegetation must be cleared. Thus, it is illegal to establish a woodland-pasture simply through grazing dynamics. Furthermore, non-productive areas must be fenced and can't be integrated in the grazing regimes of the area, unless they form 75% bushland/forest cover. Dispensations from the management law are only possible under specific or exceptional circumstances, two dispensation scenarios are relevant to Sjælegård. Firstly, in §3 areas, which must simply be maintained in their current state regardless of the management law. It may be an option once a Vera landscape has been created to register it as a §3 area pasture, but that is a long-term solution. The second dispensation scenario is for particularly inaccessible areas where machinery is difficult to operate, at a stretch this could apply to the newly establish wetland area on the north field, but such a claim is tenuous. Besides the recreated wet meadow is likely going to be registered as a §3 area, superseding the management law.

This forces a more hands on approach to establishing the woodland-pasture by manually creating heterogeny. This was tackled in a range of different ways. One was by taking areas out of 'production'. This is far from an ideal solution as it creates a hard boundary between grazed and ungrazed areas but at least allows some structure in the habitat. These areas set aside for natural succession will transition from grassland to bushland and eventually forest, when 75% coverage of trees or bushes are attained, fencing may be removed, and the patch can be integrated. These are however entire small biotopes rather than the granular mosaics of a Vera landscape. A second approach was manual tree plantings in legally acceptable concentrations. These will create more variation in light availability, structure, and availability of dead matter in the open landscape. Solitary or small clusters of trees and bushes are typical of other rewilded woodland-pastures such as Knepp Wildland and manual planting may be a way of recreating these features. Manual planting of hundreds of trees with fencing is contrary to the principle of utilizing natural processes to promote a nature area but may be necessary in the promotion of a Vera landscape in the face of highly constraining legal regimes. Tree planting is furthermore expensive, labour-intensive, and visually unappealing, therefore a small-scale and incrementalist approach might be beneficial. This will allow reuse of some of the fencing as it can be removed once trees have reached a satisfactory height. It will also prevent a homogenous age. Field maple, Scots pine, small-leaved lime and sessile oak were all favoured due to their preference for light-open habitats. Furthermore, except for Scots pine, the species are all regionally abundant but locally absent (Hartvig 2015) – thus it is an effort to boost tree diversity at Sjælegård. Small-leaved lime was especially favoured because of its central role in the theoretical Vera landscape and its prominence in Danish landscapes during earlier stages of the Holocene (Vera 2000). Despite already being present, Scots pine was considered an ideal species for the areas with especially high bedrock as they are capable of subsisting in nutrient poor conditions (Hartvig 2015). Besides the species is relatively uncommon at Sjælegård.

Birch, pedunculate oak, hazel and aspen were excluded from tree planting as they are expected to colonise naturally, two strategies are used to integrate them. These strategies will also apply for common bush species such as blackthorn, hawthorn, and juniper. Since clearings are mandated by law they must be carried out. However, since a 5-year window is permitted, there is the possibility of establishing metapopulations of these species with growths allowed to reach 5 years of age. Furthermore, whenever clearings are carried out, solitary trees and bushes may be left in accordance with the legally allowed concentrations. The second strategy is the introduction of deadwood into the landscape, in the form of thorny bush materials, branches, logs and small dead trees. These will create refugia from grazing and allow a higher variety in grazing pressure. Furthermore, it is hoped that some of these patches may offer perching spots for birds, which act as seed vectors, allowing for dispersal of trees and bushes to these refugia. In these cases, only small patches are expected to spring up, thus staying within legal bounds. Deadwood has the added benefit of featuring naturally in old wood-pastures but will not appear through natural processes for many decades due to the time taken for trees to mature and die. It is hoped that species dependent on - or benefitting from – deadwood will be supported by the introduced material in the interim. Reintroducing boulders is also thought to provide local variations in thermal and shading conditions and may be beneficial.

The subsidy schemes also impacted the management plan. Recommendations conformed to allow for the economic sustainability of the project. The endgame is to have the entire open area be supported under the nature-care subsidy as well as the base subsidy and the island subsidy, this is because the nature-care subsidy offers the highest sum of money whilst being compatible with a high-quality nature area. To this end measures must be taken to increase the HNV score as an area must have a score of at least 5 to qualify. Of the 14-point criteria of HNV, there are several which are potentially achievable for the open areas of Sjælegård. Most easily achievable is a point for extensive agriculture. Another low-hanging fruit is placing areas within 50m of a small biotope; thus, patches were designed to give HNV coverage for nearly the entire area (figure 20). A point for §3 areas and a point for 50m proximity to §3 areas should also boost the score around the area where a stream will be restored on the north field. Identification of plant species and uploading to Naturbasen may also well allow a sufficiently high Plant Species Score to allow an increase of 1 to 3 points in some places. Of course, the recording of any red-listed species or annex species of the habitat's directive could also increase the score. This suggests that for at least parts of Sjælegård a HNV score of at least 5 might be achievable within a year or two and thus enable the nature-care subsidy. Only part of the area needs to achieve a HNV of 5 to qualify for the nature-care subsidy. For areas where a high HNV will take a longer period to generate, the climate-grass subsidy may be relied on in the interim. Though this is only possible after a 2-year period. The climate-grass subsidy is not as lucrative as the nature-care subsidy but does not particularly come into conflict with the management plan. The biodiversity & sustainability subsidy also offers financial viability of the non-productive areas with the highest per ha subsidy rate. This is offset by cost of fencing such non-productive areas. Nevertheless, given the desire for heterogeneity and small biotopes to boost HNV score, the subsidy of these non-productive elements is useful but can't be seen as a means of financing other aspects of the project.

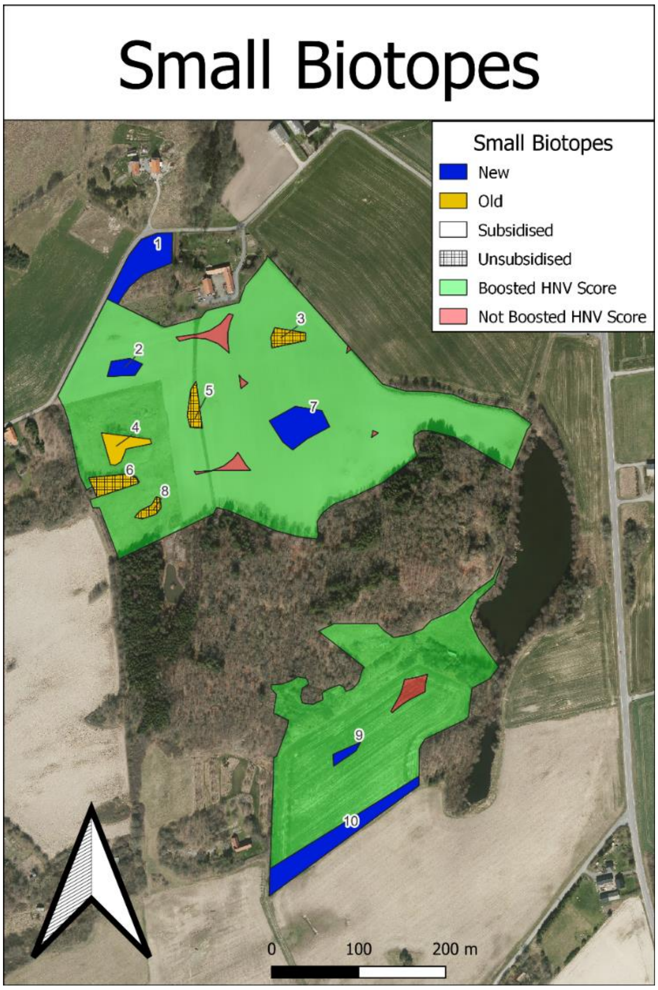

Figure 18. Small biotopes which are pre-existing (Cyan) or planned (Purple) at Sjælegård in 2023 as well as a 50m buffer around each to show where HNV values are boosted by 1. Contains data from the Agency for Data Supply and Infrastructure, Forårs Orthofoto, 2022.

The non-productive elements were distributed strategically to minimise fencing cost and to optimise HNV values. Biotopes 1 and 10 (figure 18) were left outside the main enclosure and were not intended as part of the Vera landscape, this was done to account for the minimum mandated 4% unproductive land. This allows for additional biotopes to be set up when time and resources allow without having to worry about the base subsidy requirements. Planting of tree and bush species new to or uncommon at Sjælegård were chosen for biotopes 1 and 10 to promote seed sources and adjoining overgrown biotopes. Habitat preferences were consulted for potential candidate species based on descriptions in the Atlas Flora Danica (Hartvig 2015). Despite presenting tempting candidates both Scots elm (*Ulmus glabra*) and field elm (*Ulmus minor*) were discounted due to concerns of Dutch elm disease.

In the ‘productive’ field areas, it was decided to not conduct any seeding, planting, or harrowing after the crops were cultivated to allow the floral community to develop through the seeds in the seedbank and colonization from adjacent areas. The rationale behind this was to not instigate further soil disturbances nor to prop up species unsuitable to the local conditions, passive colonisation will hopefully allow for the promotion of local species adept at subsisting in the new niches. Nevertheless, future assisted dispersal should not be discounted as it is unclear how diverse the seedbank is at Sjælegården or if species will colonize from adjacent patches of nature. Sjælegård is over a kilometre away from any sizable nature areas, so there may be few dispersal opportunities. Evaluating whether the biodiversity at Sjælegård is dispersal-limited is exceedingly difficult, any benchmark will be depend on the type of community will develop in the area. Such comparisons will need to wait several years. This will be a topic outside the scope of this exploration, but worth revisiting in the future.

Of the five grazing candidate species evaluated in this exploration, cattle and horses presented the best options. The rationale behind this was multifaceted. Water buffalo and donkeys are wetland and arid specialists respectively, and though Sjælegård contains both wet lowlands and drier uplands, these do not comprise the bulk of the area. Both cattle and horses are unquestionably native, compared to the water buffalo and donkeys which have relatives that can only be corroborated to the general north European region. Also, cattle and horses are direct descendants of aurochsen and wild horses, whereas the water buffalo and donkeys are descended from an African and Asian species that act as proxies for the extinct European relatives. On top of this, the complementarity of horse and cattle grazing is well attested, and their widespread use makes them easy to acquire or sell off depending on the needs of the grazing project. Of course, the pig has gone altogether undiscussed in these arguments, that is because the pig is an excellent candidate for Sjælegård as it is an unambiguously native forest species, which has a diet that does not overlap much with cattle or horses. It furthermore performs ecological functions which neither horse nor cattle carry out. The main reason pigs have not concretely been included in the plan is that they are by default incompatible with §3 areas, and legal dispensation will be required. Likewise, a dispensation for pigs in the protected forest area will be required. It will further require an upgrade in the fencing of Sjælegård, thereby incurring large financial costs. As such, the management plan has recommended that pigs be adopted at Sjælegård if possible, and at an undefined point in the future.

A notable gap within the herbivore guild of Sjælegård is that of browsers. This is to some extent covered by free-ranging roe deer which primarily feed on woody vegetation. Cattle and fallow deer are also capable of mixed feeding and contribute slightly. This does not appear an issue given that young woody vegetation is relatively uncommon at Sjælegård, due to a lack of regeneration in the forest and open habitats. Still, this may well change in the wake of the new management regime, and such a browsing species may be considered in the future. No native browsers have domestic analogues, thus this would require the introduction of a non-native browsers, such as goats or alpacas. This may be addressed when it becomes a relevant issue.

In terms of races, Galloway cattle were chosen due to their small size, with smaller individuals favoured during selection (Miljøstyrelsen 2020). Furthermore, the breed is well known for having an easy temper and lacks horns, making them suitable to use in an eco-tourism initiative (Miljøstyrelsen 2020). The individuals were taken from ‘Ekkodalen’, a nature area similar to Sjælegården, this includes the presence of bracken which was not foraged by the herd (Pers comms Buhl-Madsen & Buhl-Madsen 2022) – alleviating bracken poisoning concerns. Shetland ponies were also retrieved from a nature area with year-round grazing. Like Galloway cattle, the ponies were favoured for their hardiness, small stature and also due to an attractiveness to visitors.

In terms of grazing pressure, by spring 2023 the herd will consist of four fully grown cattle, 4 calves, and approximately 4 new-born calves and 3 Shetland ponies. This corresponds to 9.4 large grazer units on 12.8 ha of productive land and a grazing pressure of about 0.73 large grazers per ha. This meets the minimum required concentration of 0.3 grazers per hectare without issue but comes close to the maximum recommended grazing pressure for pastures. However, this number is a poor representation of the actual grazing pressure proposed for a few reasons. Firstly, Shetland ponies are amongst the smallest breed of ponies, averaging 145kg but count for the same large grazer unit as a fully grown cow or horse (Miljøstyrelsen 2020; Miljøstyrelsen 2023a). Galloway is also a relatively small cattle breed and the individuals selected tend towards lower masses. Additionally, the 12.8 Ha figure, does not consider the feeding possibilities within the main forest of Sjælegård which supports both an abundance of woody vegetation, but also a range of grasses growing in much of the open woodland. The de facto available feeding grounds encompass about 22Ha when excluding fenced biotopes, though several hectares of this are inedible bracken.

Supposing that the 'large grazer units' are a misrepresentation of grazing pressure given the choice of breeds, it makes more sense to work in large herbivore biomass concentrations. An exact figure can't be produced prior to the final adoptions of the Shetland ponies and four additional Galloway calves. Nevertheless, an estimate can be made. Assuming an average weight of 145kg for the Shetland ponies (Miljøstyrelsen 2020) and 450kg of a small adult Galloway cow (Miljøstyrelsen 2020). Assume that year old calves have an average mass of about 320kg, and around 30kg for new-born calves (The Belted Galloway Foundation 2018). the total herbivore biomass of the livestock comes to 3925kg – or about 178Kg per Ha. This does not consider the small population of roe and fallow deer which may inflate the figure slightly. This is in excess of the average herbivore biomass for European rewilded sites and thus seems quite a liberal starting concentration. Sustaining this grazing pressure in late spring, summer and early autumn should be relatively easy as net primary productivity ought to be in far excess of consumption. Thus, it is suggested that four of the older calves or fully adult cows be butchered or sold off prior to the autumn of 2023. Whether this herbivore biomass should be increased or decreased in 2024 and beyond will depend on the finding of the vegetation height monitoring. The technique of measuring vegetation height was adopted because it is a fast method not contingent on technical knowledge, but nevertheless provides adequate information to make an adaptive management decision. If more animals are needed, this should be covered by additional Galloway cattle and Shetland ponies. If the landscape is becoming overgrown it will be noticeable in the vegetation structure analysis – with a higher representation of trees and bushes. If either category exceeds the 10% cover - adding browsers should be strongly considered. Ideally, in the long term the vegetation openness metric should be of intermediate value to reflect a Vera landscape, somewhere between 2.5 and 3.5, but with a representation of all vegetation classes. Concerns with pigs and grazing pressure are minor, this is because pigs have very little dietary overlap with either horses or cows, therefore would not strain the available grazing resources much.

The intervention of restoring the hydrology in area 3b is suggested to create variations in the wetness of the open landscape. Wet meadows tend to support especially high biodiversity (Vinther 2015). Furthermore, this will be registered as a §3 area which will boost the HNV of the area and its immediate surroundings – likely making it eligible for the nature-care subsidy. Water samples may be used to track changes in conditions over time. Because the water itself is collected and stored the investigations can be tailored to the future monitoring needs of the project.

Forest

The primary goal of the management of forest areas is to generate a biodiverse light-open oak forest. The two primary obstacles to this state are the presence of biodiversity-poor spruce plantation and the predominance of bracken throughout the woodland area and as such interventions are focused on addressing these. Finding a funding mechanism for woodland areas was also a priority. Thus, conforming to the biodiverse forest subsidy, as well as to the forest law, was crucial.

The subsidy towards biodiverse forest is an excellent way of generating income for the Sjælegård project. Both subsidies for preserving individual trees and forest grazing should be utilized. It could also finance future interventions in the forest, should they prove necessary. The main caveat to the subsidy towards biodiverse forest is that it will place the entire forest under protected forest duties, thus placing limitations on interventions. For one, it will be impossible to create light-open areas in more than 10% of the forest. Secondly, it will preclude grazing without dispensation. An inability to graze in the forest is unacceptable as it would run counter to the aims of a light-open forest and require large amounts of additional fencing, thus any subsidies will be contingent on this dispensation. Ideally the entire contiguous forest area can be placed under the subsidy towards biodiverse forest, however in all likelihood only the central forest area will be included as it supports old-growth oak forest. Nor is there any guarantee the forest will even qualify for the subsidy. Prioritisation is given to Natura 2000 habitat types – herein the main forest is a close fit to habitat type 9190 (old acidophilous oak woods with *Quercus robur* on sandy plains), at least in its species composition. The habitat is characterised by the dominance of pedunculate oak (*Quercus robu*r) with secondary trees of: silver birch (*Betula pendula*), downy birch (*Betula pubescens*), common rowan (*Sorbus aucuparia*) and European aspen (*Populus tremula*). All these species are common within the central forest area. This habitat type is however characteristic of sandy, acidic soils - yet the limited soil sampling suggested a clayey character. If this classification is not approved, secondary priority is given to areas with a forest HNV score of 8 or more – however this system appears to be discontinued in 2023 or at least information was not readily accessible, thus it is unclear if the forest is eligible outside of the Natura 2000 habitat designation. Assuming a successful application, trees were selected for protection and priority was given to large trees, exceeding 50cm in diameter at breast height. All barring two individuals in this size category were oaks. To obtain a higher number of protections, individuals of 25-50cm diameter were also included – here a preference was given for oaks close to the 50cm cut-off point and large individuals of other species. Altogether 7 distinct taxa were included (figure 17). There were no issues with an overabundance of individuals in the periphery of the forest.

Numerous introduced tree species are found in the forest at Sjælegården, including Sitka spruce (*Picea sitchensis*), Serbian spruce (*Picea omorika*), European fir (*Abies alba*), grand fir (*Abies grandis*), Douglas fir (*Pseudotsuga menziesii*) and Japanese larch (*Larix kaempferi*) (Hartvig 2015). None of these introduced species have shown invasive tendencies at Sjælegård. Additionally, several tree species may be considered near-native – that is occurring natively in the neighbouring countries and having co-occurrence with many native species. These include sycamore maple (*Acer pseudoplatanus*) and Norway spruce (*Picea abies*) (Hartvig 2015). Both near-native and non-invasive introduced species will be accepted, provided they don't show domineering tendences. Thus, no discrimination of trees is necessary.

Spruce plantations were removed as they were biodiversity poor monocultures, as was corroborated by the botanical analyses. The decision to harvest most trees was financially motivated and had the intended effect of sponsoring biodiversity-focused interventions. Deciduous and a few spruce trees were left to provide some diversity in stand age and canopy height. Furthermore, most of the remaining conifers are expected to fall in storms in the coming years, creating lying deadwood and creating mounds from toppled roots. Some Norway spruce individuals were also left as standing deadwood; this was all to create structural diversity in the forest and accommodate detritivores within the former plantation. A dispensation to allow forest grazing in the former spruce plantation was required so that separate fencing of the protected forest area could be avoided. Furthermore, it will aid in the establishment of a light-open forest in the long-term by reinforcing open patches through grazing. A legitimate concern however is that grazing pressure by livestock and deer will be sufficient to prevent a new forest area from establishing itself within the allotted 10 years. Therefore, a contingency plan of active planting and fencing is needed. Herein pedunculate oak (*Quercus robur*) was favoured to create a biotope contiguous with the central forest area, though sessile oak (*Quercus petraea*) and European hornbeam (*Carpinus betulus*) were selected as co-plantings in order to introduce the former to the area and reinforce populations of the latter – boosting tree diversity.

Areas 6b-f and 6i are not currently subject to protected forest duties – though if subsidies are accepted, they will be. As with area 5a, natural regeneration is preferred for these areas to allow seamless integration with the oak forest. Currently at Sjælegård the transition between forest and open landscape is very abrupt and offers limited opportunities for edge-specialists, therefore 6f was set aside as a transition zone, to a lesser extent 6d and 6b also offer this opportunity. It is expected that forest will naturally spread to the periphery of the open landscape, though this needs to be cleared after 5 years following the management law.

Clearing of the granite quarry (6h) was carried out in accordance with the wishes of the municipality to make the point of geological interest accessible to the public. This also comes with the benefit of enabling visitors to see the feature and potentially disseminate some information of the geology of Bornholm.

The issue of bracken management should be tackled through several strategies. Cutting was chosen as the primary technique because it is the tool which is best corroborated by the relevant studies and is relatively simple to apply. It does have limitations in the project. Firstly, the dense bracken groves at Sjælegården are present largely within the oak forest, where cutting using heavy machinery is impossible due to the density of trees. This will therefore require hand-held equipment and be very labour intensive. Biannual cutting is favoured as the literature review suggested it to have a demonstrably higher effect than annual cutting, the timing of the cuts follows the practices used in most studies – with the evidence suggest earlier cuts as more effective. Cut fronds should be removed as this will allow light to reach other undergrowth species and hopefully help shift towards a different community. One major concern with regards to bracken cutting is that it appears to increase the ptaquiloside content in fronds, which may magnify toxicity in the local environment – potentially harmful for the grazing livestock and any products derived from them (Rasmussen et al 2015). Veterinarians should be consulted during annual check-ups to investigate effects of poisoning. Human safety should also be considered when cutting bracken, no studies have been conducted on ptaquiloside exposure to skin, but it is prudent to wear gloves and long sleeves to avoid any carcinogenic effects. With all these considerations in mind, cuttings will be limited to new clearings and peripheries to stem the spread of bracken with the hope of adopting more passive methods for the interior. It is important to maintain cuttings over time, so it is better to be consistent in smaller areas than sporadic in the area at large.

One such strategy for the interior is animal trampling. No studies showed the effects of animal trampling on bracken, but it has been suggested to reduce bracken concentrations (Henney 2012). Therefore, the movement of livestock through bracken patches could be beneficial and requires relatively little effort. It is expected that it will occur as livestock move between foraging patches, however the erection of salt licks in dense groves will hopefully further promote trampling. There are limited concerns of cattle ingesting the bracken, as the population present has been adopted from another area with bracken where it was avoided (Buhl-Madsen & Buhl-Madsen 2022 Pers comms). Nevertheless, care should be taken to keep an eye on the foraging patterns of the livestock present to ensure bracken consumption isn’t an issue.

The use of pigs also offers a low-maintenance supplement. Though no studies have been conducted on combining cuttings and pigs, they could be complementary as the former targets the fronds and the latter the rhizomes. Nevertheless, there is the challenge of constructing infrastructure and obtaining permits – thus pigs are a long-term goal. Pigs require more effective fencing which extends into the ground to prevent them digging under, such fencing is expensive to acquire and with legal dispensations required for both protected forest areas and §3 areas, the introduction of pigs is contingent on both adequate funding and permission. The further issue of ethics and animal welfare is one that should be considered, it is unclear if a small population at Sjælegård would be subject to bracken poisoning, but since the possibility exists vigilance - in the form of veterinarian monitoring – is crucial. It should be noted that §3 of the animal welfare law implores owners to ensure animals are in good health, as such introducing pigs into an area to consume the poisonous bracken is a legally ambiguous act, and if significantly detrimental effects of this management are observed the pigs should be removed or receive supplementary fodder rich in thiamine. The long-term carcinogenic effects of ptaquiloside may also be grounds for disallowing pig grazing. Certainly, if an individual develops cancer, it must be put down, but an argument could certainly be made that any health concerns of long-term bracken exposure may be offset by quality-of-life benefits of a naturalistic lifestyle. That is to say availability of a wide diet, abundance of space and behavioural stimulation.

Monitoring of bracken distribution once every two years should suffice. Because of the slow dispersal rate of bracken via rhizomes and the difficulty in completely eradicating the species from an area, changes are likely to be slow to develop. Nevertheless, dispersal via spores is possible, even if uncommon. If bracken spreads to a novel area it would be important to detect it relatively quickly such that control can be carried out immediately before an extensive rhizome net is formed. Choosing a measure for bracken concentration was inherently problematic since fronds and rhizomes respond differently to control measures (Le Duc et al 2003). Stem and frond counts were favoured because they are simple and can be carried out by a layman. Though sampling at each site where cutting takes place would be ideal, this is time and effort demanding, which is problematic in a project with limited resources. Therefore, sampling in a single location where cutting takes place may be prudent to maintain consistent monitoring, despite not being completely representative of all areas. Area 6g was chosen as it is a dense bracken grove which is hidden away. This remoteness makes the presence of plots less conspicuous to guests and prevents undesired disturbances which may alter data.

The Plan at Large

The management plan is insufficient to address all relevant facets and interventions, and areas not covered by the plan may be considered independently. Such potential topics include: veteranization, The introduction of fire regimes to Sjælegård, nutrient loading, control of problematic species other than bracken, species-specific conservation, dispersal, stakeholder involvement and conflicts, communication of the project to guests, and many more. Indeed, the facets covered by the management plan are vastly outnumbered by those not covered, such are the limitations of most plans and can be attributed to time and resource constraints.

With the absences addressed, the contents can be evaluated. Perhaps most significantly is the conflict between 'rewilding' through natural processes and the constraints placed on the management plan by legal and subsidy regimes. The mismatch is near omnipresent in the plan, and has rendered the ambition of creating a wood-pasture through natural processes impossible. This has ultimately forced a much higher degree of intervention and active management than initially desired. Since the management law dictates that growths of bush and trees must be removed or fenced to be 'unproductive' it is impossible to create wood-pasture through a grazing regime. This forces 'unnatural' interventions such as active planting, fencing, and control of natural growths to promote the habitat heterogeneity. Hydrological restoration is also contingent on the co-operation of adjacent landowners and municipal permission. Likewise the restrictions of the forest law and nature protection law constrain the possible interventions in areas by mandating the type of landscape that should be present. These limitations are a result of a traditionally production-focused legal regime, concerned primarily with generating provisions, without allowing for extensive systems focused on biodiversity and nature. Changes have occurred within this regime to accommodate nature-projects such as the nature-care subsidies and the nature protection law, but these are still relatively rigid systems which are focused on creating particular 'types' of nature. Nevertheless, continued revisions in favour of biodiversity projects may well loosen some of the restrictions on Sjælegård in years to come.

Additional constraints are placed on Sjælegård due to its size and the time-scale of the project. With a small area it is impossible to establish a wide grazing guild, with the current plan limited to just cattle and horses (though fallow and roe deer are also capable of penetrating the fence). This means a 'natural' grazing regime is impossible. Even if unlimited space was available, the concern of guests-wildlife conflicts precludes wild animals which occupy key niches such as European bison, moose, or hippopotamus, to not even mention niches that are lost altogether. Hydrology is size-limited, because without full ownership of streams and their drainage basins, interventions are difficult. The upshot of the small size of Sjælegård is that active management becomes feasible, at least in some cases. In terms of the time-scale, the project is a long-term one, but with the caveat that as an eco-tourism initiative early results are desirable. Several steps were taken to 'fast forward' processes, such as tree plantings and introduction of deadwood into the open landscape in order to generate the characteristics of a wood-pasture which may otherwise take decades to naturally form.

Further compromises were also made to make the management plan financially viable by on the one hand leaving costly interventions optional: e.g. the introduction of pigs and tree planting magnitude. And on the other hand, tailoring the management plan to accommodate subsidy schemes. Further compromises were also made for easy implementation and fast non-technical monitoring which the landowners are capable of carrying out themselves. Other considerations also impose constraints on the biodiversity focus of the plan such as points of historical or geological interest and guest needs.

After summing up all these concessions to legal, spatio-temporal and financial considerations, can Sjælegård even be called a 'rewilding' initiative? The answer is a tentative 'no'. At least not in the adopted definition by Navarro & Pereira 2015 "Passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing human control of landscapes". This is because the management is neither 'passive' nor is there arguably reduced human control of the landscape. It can only really be called 'rewilding' in the most loose definition of the word as the reintroduction of more natural processes – which is the case through the re-establishment of a grazing regime and perhaps some hydrological aspects. Nor is Sjælegård 'open-ended restoration' which would be accepting the resulting landscape from reintroduction of natural processes. Instead Sjælegård can be characterised as a restoration project with a fixed goal of a wood-pasture and light-open oak forest. This is necessarily the case due to limitations, despite open-ended projects elsewhere establishing wood-pastures by restoring diverse grazing regimes with moderate grazing pressure – such as at Knepp Wildland. This goal-oriented perspective requires continual management, and it should be a priority to move towards a more 'open-ended' approach should restrictions loosen in the future.

The Broader Context

Sjælegård in many ways represents part of a new national movement towards more sustainable options for agriculture and is viable due to the latest revision of agricultural subsidies which are scheduled to be in place until at least 2027. By relying primarily on government funding to sustain the nature area and utilizing animals and tools which are widely available to other landowners, Sjælegård may act as a model for other small agricultural estates.

In a more scientific context, Sjælegård can serve as a useful location for research. The baseline study offers some limited data to draw upon, but there is also potential for new datasets to be built by experts. Whilst many rewilding projects are carried out on relatively unproductive soil, this serves as case study for a full conversion from productive agriculture to nature.

The long-term future of the project will be shaped by the political landscape of the country. Attempts to gain legal protection for the project in the form of newly established §3 areas and high-quality nature may aid in providing longevity but only time will tell. The importance of Sjælegård as a nature area should not be overstated either. It will likely take many years before it takes on conservation significance. Nevertheless, the local biodiversity is likely to see improvement and a remediation of the long-term impacts of intensive agriculture should improve the abiotic conditions of the site.

11. Conclusion

All in all, Sjælegård is a new ‘agro-rewilding project’ which has become possible in light of political developments in Denmark and an increased focus on the biodiversity crisis. Though the site faces many biodiversity challenges due to its agricultural legacy, it is also somewhat of a blank canvas allowing a variety of nature types. A baseline study was performed to ascertain the starting conditions both in terms of abiotic and biotic variables – supplying both useful information for the development of a management plan but also as a comparison point when evaluating change. This was supplemented by a review which outlined both tools for control of bracken and considerations for grazing regimes, but also provided the frame conditions imposed by the legal regime and the subsidy regime of Denmark. This was synthesised into to a management plan which has attempted to create a financially viable woodland-pasture supporting a high biodiversity. This is to be done through an intermediate grazing pressure from cattle, horses and possibly pigs along with the creation of a heterogenous landscape via planting, fencing and selective clearing. The management plan also addresses how to optimise biodiversity in a pre-existing woodland area. Plantation forest was harvested and left to regrow through natural succession, whilst the focus in the deciduous woodland is on managing dense bracken groves through cutting and possibly pig grazing. These practices are regulated using an adaptive management strategy informed by simple monitoring schemes. The management plan is funded through subsidy schemes both in the forest and open landscape, which offers a long-term financial viability. It will be interesting to see how the interventions put forward will affect the biodiversity at Sjælegård in the years to come.

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13. Appendix

Appendix 1. Table of taxa recorded during the bioblitz on 23/7/2022 and 24/7/2022. Danish Red-listed species have their associated conservation status displayed following the IUCN notation, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, DD – Data Deficient. Additional 'I' signifies a species considered Invasive by the Danish Environmental Agency. Species included in the habitat directive are noted the letter 'P' along with the relevant paragraph in question, e.g. Paragraph 5 – P5. Animal species are in the Right Column and non-Mammals in the left.

Bioblitz Species List

Plants	**Mammals**
Acer platanoides	*Capreolus capreolus*
Acer pseudoplatanus	*Lepus europaeus*
Achillea millefolium	*Microtus agrestis*
Achillea ptarmica	**Birds**
Aegopodium podagraria	*Alauda arvensis* (NT)
Aesculus hippocastanum	*Apus apus* (NT)
Aethusa cynapium	*Asio otus*
Agrimonia eupatoria	*Chloris chloris* (NT)
Agrostis capillaris	*Chroicocephalus ridibundus* (EN)
Agrostis gigantea	*Circus aeruginosus*
Agrostis stolonifera	*Columba palumbus*
Aira praecox	*Corvus corax*
Alchemilla sp.	*Corvus cornix*
Alisma plantago-aquatica	*Delichon urbicum*
Alliaria petiolata	*Emberiza citronella* (VU)
Allium oleraceum	*Fringilla coelebs*
Allium scorodoprasum	*Grus grus*
Alnus glutinosa	*Hirundo rustica*
Anchusa arvensis	*Motacilla alba*
Anemone nemorosa	*Passer domesticus*
Anisantha sterilis	*Phasianus colchicus* (I)
Anthoxanthum odoratum	*Phoenicurus phoenicurus*
Anthriscus sylvestris	*Streptopelia decaocto* (NT)
Arenaria serpyllifolia	*Strix aluco*
Arrhenatherum elatius	*Sturnus vulgaris* (VU)
Artemisia vulgaris	*Sylvia atricapilla*
Avenella flexuosa	*Sylvia borin*
Bellis perennis	*Troglodytes troglodytes*
Betula pendula	*Turdus merula*
Betula pubescens	**Amphibians**
Bromus hordeaceus	*Bufo bufo*
Callitriche sp.	*Lissotriton vulgaris*
Calluna vulgaris	*Pelophylax sp.*

Campanula rotundifolia	*Triturus cristatus* (P2)(P4)
Campanula trachelium	**Arachnids**
Capsella bursa-pastoris	*Aceria cephalonea*
Carex hirta	*Aceria nervisequa*
Carex leporina	*Aceria pseduoplatani*
Carex spicata	*Alopecosa sp.*
Carex vesicaria	*Anelosimus vittatus*
Carpinus betulus	*Anyphaena accentuata*
Centaurea cyanus	*Araneus diadematus*
Centaurium erythrea	*Araniella cucurbitina*
Cerastium fontanum	*Clubiona comta*
Chamaenerion angustifolium	*Diaea dorsata*
Chelidonium majus	*Dicranopalpus ramosus* (I)
Chenopodium album	*Enoplognatha ovata*
Cichorium intybus	*Eriophyes inangulis*
Cirsium arvense	*Eriophyes laevis*
Cirsium vulgare	*Eriophyes sorbi*
Convallaria majalis	*Evarcha falcata*
Convolvulus arvensis	*Haplodrassus sp.*
Corylus avellana	*Heliophanus sp.*
Crataegus monogyna	*Ixodes ricinus*
Crepis capillaris	*Labulla thoracica*
Dactylus glomerata	*Larinioides cornutus*
Deschampsia cespitosa	*Leiobunum rotundum*
Digitalis purpurea	*leiobunum rupestre*
Digitaria sanguinalis	*Leptus sp.*
Dipsacus fullonum	*Linyphia triangularis*
Dryopteris carthusiana	*Lophopilio*
Dryopteris dilatata	*Mitopus morio*
Dryopteris filix-mas	*Nuctenea umbratica*
Eleocharis palustris	*Oligolophus hanseni*
Elytrigia repens	*Oligolophus tridens*
Epilobium hirsutum	*Opilio canestrinii* (I)
Epilobium montanum	*Opiliones sp.*
Equisetum arvense	*Parasteatoda lunata*
Euonymus europaeus	*Pardosa sp.*
Euphorbia peplus	*Philodromus albidus*
Fagus sylvatica	*Phyllocoptes goniothorax*
Festuca rubra	*Phylloneta sp.*
Filipendula ulmaria	*Pirata sp.*
Frangula alnus	*Pisaura mirabillis*
Fraxinus excelsior	*Scotophaeus sp.*
Galeopsis bifida	*Steatoda bipunctata*
Galeopsis tetrahit	*Tetragnatha sp.*
Galium aparine	*Xysticus cristatus*

Galium verum	*Xysticus lanio*
Geranium dissectum	**Insects**
Geranium molle	*Zygiella x-notata*
Geranium pyrenaicum	*Abraxes sylvata*
Geranium robertianum	*Abrostola tripartita*
Geum urbanum	*Acleris forsskaleana*
Glyceria fluitans	*Acronicta aceris*
Gnaphalium uliginosum	*Adelges sp.*
Hedera helix	*Adelphocoris quadripunctatus*
Heracleum sosnowskyi (I)	*Aelia acuminata*
Heracleum sphondylium	*Aeshna grandis*
Holcus lanatus	*Aglais io*
Holcus mollis	*Aglais urticae*
Humulus lupulus	*Agonopterix heracliana*
Hylotelephium telephium	*Agriotes lineatus*
Hypericum maculatum	*Agromyza flaviceps*
Hypericum perforatum	*Allygus modestus*
Hypochaeris radicata	*Altica sp.*
Ilex aquifolium	*Amara aenea*
Juncus conglomeratus	*Amblytylus nasutus*
Juncus effusus	*Amphipoea oculea*
Juniperus communis	*Anaplectoides prasina*
Knautia arvensis	*Anarta trifolii*
Lactuca muralis	*Anaspis frontalis*
Lamium purpureum	*Anax imperator*
Lapsana communis	*Anidorus nigrinus*
Larix sp.	*Anoplotrupes stercorosus*
Lathyrus pratensis	*Anoscopus flavostriatus*
Linaria vulgaris	*Anthocharis cardamines*
Lolium perenne	*Anthocoris confusus*
Lonicera caprifolium	*Anthocoris nemorum*
Lonicera periclymenum	*Anthomyia pluvalis*
Lotus corniculatus	*Anthrenus museorum*
Lotus tenuis	*Apamea monoglypha*
Luzula pilosa	*Apamea scolopacina*
Lycopus europaeus	*Aphantopus hyperantus*
Lysimachia nummularia	*Aphis fabae*
Lysimachia vulgaris	*Aphrophora alni*
Malus sylvestris	*Aphthona atrocaerulea*
Malus toringo	*Apion frumentarium*
Malva sylvestris	*Apion fulvipes*
Matricaria discoidea	*Apion hookerorum*
Medicago lupulina	*Apion urticarium*
Melampyrum pratense	*Apolygus lucorum*
Melica uniflora	*Apotomis betuletana*

Menyanthes trifoliata	*Archips podana*
Moehringia trinervia	*Archips xylosteana*
Molinia caerulea	*Argynnis paphia*
Myosotis arvensis	*Argyresthia goedartella*
Nymphaea alba	*Argyresthia pruniella*
Oxalis acetosella	*Autographa gamma*
Paris quadrifolia	*Axylia putris*
Pastinaca sativa (I)	*Badister bullatus*
Persicaria amphibia	*Balclutha punctata*
Petroselinum crispum	*Biston betularia*
Phalaris arundinacea	*Blepharidopterus angulatus*
Phleum pratense	*Bombus hypnorum*
Phytolacca	*Bombus jonellus*
Picea abies	*Bombus lapidarius*
Picea sitchensis (I)	*Bombus lucorum*
Picea lutzii	*Bombus pascuorum*
Plantago lanceolata	*Bombus pratorum*
Plantago major	*Bombus terrestris*
Poa annua	*Brachycaudus cardui*
Poa compressa	*Cabera exanthemata*
Poa nemoralis	*Cabera pusaria*
Poa palustris	*Cacopsylla sp.*
Poa pratensis	*Caliroa cerasi*
Poa trivialis	*Callisto denticulella*
Polygonatum multiflorum	*Calopteryx splendens*
Polygonum aviculare	*Camptogramma bilineata*
Polypodium vulgare	*Capsus ater*
Populus tremula	*Caradrina morpheus*
Potamogeton natans	*Cartodere nodifer*
Potentilla argentea	*Cassida rubiginosa*
Prunella vulgaris	*Cataclysta lemnata*
Prunus avium	*Cavariella pastinacae*
Prunus cerasifera	*Celypha lacunana*
Prunus spinosa	*Celypha striana*
Pteridium aquilinum	*Cerapteryx graminis*
Quercus patraea	*Cetonia aurata*
Quercus robur	*Ceutorhynchys obstrictus*
Ranunculus acris	*Ceutorhynchis pallidactylus*
Ranunculus flammula	*Cheilosia vernalis*
Ranunculus repens	*Chirosia grossicauda*
Ribes alpinum	*Chloromyia formosa*
Rosa canina	*Chorthippus brunneus*
Rosa rubiginosa	*Chromatomyia periclymeni*
Rosa rugosa (I)	*Chrysogaster solstitialis*
Rubus armeniacus (I)	*Chrysoperla carnea*

Rubus caesius	*Chrysoteuchia culmella*
Rubus fructicosus	*Cicadella veredis*
Rubus idaeus	*Cistogaster globosa*
Rumex acetosa	*Closterotomus fulvomaculatus*
Rumex acetosella	*Closterotomus norwegicus*
Rumex crispus	*Cnephasia stephensiana*
Rumex obtusifolius	*Coccinella septempunctata*
Rumex sanguineus	*Coenagrion sp.*
Sagina procumbens	*Coleophoa spinella*
Salix caprea	*Coleoptera*
Salix cinerea	*Compsidolon salicellum*
Sambucus nigra	*Conomelus anceps*
Sambucus racemosa	*Cordilura ciliata*
Schedonorus arundinaceus	*Coreus marginatus*
Scleranthus perennis	*Corizus hyoscyami*
Scorzoneroides autumnalis	*Cortinicara gibbosa*
Sisybrium officinale	*Craniophora ligustri*
Solanum dulcamara	*Cryptophagus punctipennis*
Solanum nigrum	*Culcidae sp.*
Solidago gigantea (I)	*Curculio betulae*
Solidago virgaurea	*Curculio glandium*
Sonchus asper	*Curculio nucum*
Sorbus aucuparia	*Cybosia mesomella*
Sorbus intermedia	*Cydia fagiglandana*
Sparganium erectum	*Cydia pomonella*
Spirodela polyrhiza	*Cydia splendana*
Stellaria graminea	*Cymus melanocephalus*
Stellaria holostea	*Cynips quercusfolii*
Stellaria media	*Cynomya mortuorum*
Tanacetum parthenium	*Dasineura populeti*
Taraxacum officinale	*Dasineura pteridicola*
Taxus baccata (EN)	*Dasineura pustulans*
Tragopogon pratensis	*Dasineura ulmaria*
Trifolium arvense	*Dasypoda hirtipes*
Trifolium campestre	*Dasytes plumbeus*
Trifolium dubium	*Deilephila elpenor*
Trifolium medium	*Demetrias atricapillus*
Trifolium pratense	*Deporaus betulae*
Trifolium repens	*Deraeocoris flavilinea*
Tripleurospermum inodorum	*Deraeocoris ruber*
Typha angustifolia	*Dexiosoma caninum*
Typha latifolia	*Diarsia brunnea*
Urtica dioica	*Dichrorampha acuminatana*
Vaccinium myrtillus	*Dicyphus epilobii*
Verbascum thapsus	*Dicyphus pallicornis*

Veronica chamaedrys	*Dioryctria abietella*
Veronica officinalis	*Diplolepis rosae*
Veronica persica	*Diptera sp.*
Viburnum opulus	*Ditula angustiorana*
Vicia cracca	*Doliochopodidae sp.*
Vicia hirsuta	*Dolycoris baccarum*
Vicia sativa	*Drosophilidae sp.*
Viola arvensis	*Dysaphis plantaginea*
Fungi	*Dytiscidae sp.*
Acarospora fuscata	*Ecliptoptera silaceata*
Amanita fulva	*Ectobius lapponicus*
Amanita rubescens	*Eilema depressa*
Candelariella coralliza	*Eilema lurideola*
Cladonia fimbriata	*Eilema lutarella*
Cladonia rangiformis	*Elachista utonella*
Clavulinopsis helvola	*Elasmostethus interstinctus*
Daedalea quercina	*Elophilia nymphaeata*
Diplocarpon sp.	*Empis livida*
Entomophthora muscae	*Enallagma cyathigerum*
Epichloe sp.	*Entomobrya nivalis*
Erysiphe alphitoides	*Epinotia solandriana*
Erysiphe heraclei	*Episyrphus balteatus*
Erysiphe lonicerae	*Eremocoris abietis*
Erysiphe ulmariae	*Eriocampa ovata*
Evernia prunastri	*Eriothrix rufomaculatus*
Gymnosporangium cornutum	*Eristalinus sepulchralis*
Gymnosporagium sabinae	*Eristalis interrupta*
Hypogymnia physodes	*Eristalis intricaria*
Lasallia pustulata	*Eristalis pertinax*
Lecanora carpinea	*Eristalis tenax*
Lecanora chlarotera	*Eulithus prunata*
Lecidella elaeochroma	*Eupithecia pulchellata*
Marasimus oreades	*Eupsilia transversa*
Parmelia omphalodes	*Eupterycyba jucunda*
Parmelia saxatilis	*Eurhandina loewii*
Parmelia sulcata	*Eutomostethus ephippium*
Pertusaria pertusa	*Favonius quercus*
Phellinus pomaceus	*Fenusa dohrnii*
Phlyctis argena	*Forficula auricularia*
Physcia adscendens	*Formica fusca*
Physcia caesia	*Formica rufa*
Physcia tenella	*Geomyza tripunctata*
Podosphaera epilobii	*Glyphotaelius pellucidus*
Polycauliona candelaria (DD)	*Gracillaria syringella*
Protoparmeliopsis macrocyclos (NT)	*Harmandiola globuli*

Protoparmeliopsis muralis	*Harpalus affinis*
Puccinia cyani	*Harpalus griseus* (EN)
Puccinia difformis	*Harpalus latus*
Puccinia varaibilis	*Harpalus rubripes*
Ramalina fastigiata	*Harpalus rufipalpis*
Rhizocarpon geographicum	*Harpella forficella*
Taphrina sadebeckii	*Helophilus pendulus*
Umbilicaria deusta (NT)	*Hemerobius humulinus*
Xanthoparmelia conspersa	*Hererobius micans*
Xanthoparmelia loxodes	*Heterocordylus tumidicornis*
Xanthoparmelia stenophylla	*Heterotoma planicornis*
Xanthoria parietina	*Hoplodrina blanda*
Algae	*Hoplodrina octogenaria*
Perenosporales sp.	*Hyperomyzus lactucae*
Mosses	*Hyperomyzus rhinanthi*
Brachythecium rutabulum	*Hyphydrus ovatus*
Hypnum cupressiforme	*Iassus lanio*
Mnium hornum	*Idaea aversata*
Polytrichum formosum	*Idaea biselata*
Rhytidiadelphus squarrosus	*Idaea dimidiata*
	Idaea emarginata
	Idaea fuscovenosa
	Ischnura elegans
	Jaapiella veronicae
	Javesella pellucida
	Kleidocerys resedae
	Lacanobia oleracea
	Lagria hirta
	Lasioglossum sp.
	Laxaniidae sp.
	Lepisma saccharina
	Leptocerus tineiformis
	Leptogaster cylindrica
	Leptophyes punctatissima
	Leptopterna dolabrata
	Lestes sponsa
	Ligdia adustata
	Limnephilus affinis
	Limnephilus auricula
	Limnephilus flavicornis
	Limnephilus lunatus
	Limnephilus marmoratus
	Limnoporus rufoscutellatus
	Liocoris tripustulatus
	Lonchopteridae sp.

	Longitarsus kutscherai
	Lucilla caesar
	Lycaena phlaeas
	Lyciella decempunctata
	Lygocoris pabulinus
	Lygus pratensis
	Macroglossum stellatarum
	Macrospis sp.
	Macrosiphoniella artemisiae
	Malachius bipustulans
	Malthinus biguttatus
	Malthinus flaveolus
	Maniola jurtina
	Meconema thalassinum
	Melanostoma mellinum
	Meligethes aeneus
	Merodon equestris
	Meromyza sp.
	Mesapamea secalis
	Mesoligia furuncula
	Mesotype didymata
	Metallus lanceolatus
	Metylophorus nebulosus
	Microchrysa flavicornis
	Micromus variegatus
	Mikiola fagi
	Mompha epilobiella
	Myrmica sp.
	Myrmus miriformis
	Mystacides longicornis
	Mythimna ferrago
	Mythimna pallens
	Myzocallis castanicola
	Myzus cerasi
	Nabis flavomarginatus
	Nabis limbatus
	Nebria salina
	Neocrepidodera ferruginea
	Neottiglossa pusilla
	Nepa cinerea
	Neuroterus quercusbaccarum
	Noctua comes
	Noctua pronuba
	Notiophilus biguttatus
	Notodonta ziczac

	Notonecta glauca
	Nudaria mundane (EN)
	Nysius sp.
	Ochropleura plecta
	Odonata sp.
	Oedemera virescens
	Oligotrophus juniperinus
	Oncopsis flavicollis
	Ophiomyia sp.
	Opomyza florum
	Orchesella cincta
	Orgyia antiqua
	Orthetrum coerulescens
	Orthonotus rufifrons
	Orthops basalis
	Ostrinia nubilalis
	Otiorhynchus ovatus
	Otiorhynchus raucus
	Otiorhynchus singularis
	Oulema melanopus
	Palomena prasina
	Pammene aurita
	Pammene regiana
	Panorpa communis
	Panorpa germanica
	Paradromius linearis
	Parallelomma paridis
	Paramesia gnomana
	Pasiphila rectangulata
	Peribatodes secundaria
	Phalera bucephala
	Phaonia pallida
	Phasia pusilla
	Philaenus spumarius
	Philorhizus melanocephalus
	Pholidoptera griseoaptera
	Phragmatobia fuliginosa
	Phryganea grandis
	Phyllobius virideaeris
	Phyllonorycter geniculella
	Phyllonorycter leucographella
	Phyllonorycter maestingella
	Phyllonorycter messaniella
	Phyllonorycter nicellii
	Phyllonorycter sorbi

	Phyllotreta vittula
	Phylus coryli
	Phytocoris tiliae
	Phytocoris varipes
	Phytoliriomyza hilarella
	Phytomyza ilicis
	Phytomyza miniscula
	Phytomyza spinaciae
	Phytomyza spondylii
	Pieris brassicae
	Pieris napi
	Pieris rapae
	Pinalitus cervinus
	Plagiognathus arbustorum
	Plagiognathus chrysanthemi
	Plateumaris discolor
	Poecilobothrus nobilitatus
	Pogonognathellus flavescens
	Pollenia sp.
	Polyommatus icarus
	Profenusa pygmaea
	Propylea quartuordecimpunctata
	Psallus lepidus
	Psila fimetaria
	Psococerastis gibbosa
	Psyche casta
	Psylla alni
	Psylla buxi
	Psylliodes chrysocephala
	Psyllobora vigintiduopunctata
	Psyllopsis fraxini
	Pterostichus niger
	Pyrrhalta viburni
	Rhagoletis alternata
	Rhagonycha fulva
	Rhopalus parumpunctatus
	Rhyparochromus pini
	Rutpela maculata
	Sacrophaha sp.
	Scaeva pyrastri
	Scaeva selentica
	Sciaphilus asperatus
	Scolopostethus affinis
	Scolytus laevis (Vu)
	Scopula immutata

	Serica brunnea
	Sermylassa halensis
	Sisyra nigra
	Sitona lineatus
	Sorhagenia sp.
	Speudotettix subfusculus
	Sphaeroderma testaceum
	Sphaerophoria scripta
	Spilonota ocellana
	Spilosoma lubricipeda
	Stathmopoda pedella
	Stenodema laevigata
	Stenoptilia pterodactyla
	Stenotus binotatus
	Stenus flavipes
	Stephanitis oberti
	Stictoleptura rubra
	Stictoleptura abutilon
	Stigmella atricapitella
	Stigmella centifoliella
	Stigmella hemargyrella
	Stigmella hybnerella
	Stigmella plagicolella
	Stigmella speciosa
	Stiroma affinis
	Strophosoma melanogrammum
	Suilllia laevifrons
	Sycophila biguttata
	Sympetrum sanguineum
	Sympetrum vulgatum
	Synaphe punctalis
	Syromastus rhombeus
	Syrphus ribesii
	Tachyporus hypnorum
	Tachyporus solutus
	Tettigonia viridissima
	Thaumatomyia glabra
	Throscidae sp.
	Thymelicus lineola
	Thysanoptera sp.
	Tingis cardui
	Tipula cava
	Tipula lunata
	Trachea atriplicis
	Trichadenotecnum sexpunctatum

	Trichosirocalus troglodytes
	Tytthaspis sedecimpunctata
	Uroleucon hypochoeridis
	Valenzuela flavidus
	Vanessa atalanta
	Vespula vulgaris
	Wachtliella persicariae
	Xanthandrus comtus
	Xanthorhoe fluctuata
	Xanthorhoe spadicearia
	Yponomeuta evonymella
	Yponomeuta plumbella
	Ypsolopha dentella
	Ypsolopha horridella
	Zophomyia temula
	Other Arthropods
	Armadillidium vulgare
	Lithobius sp.
	Oniscus asellus
	Philoscia muscorum
	Porcellio scaber
	Porcellio spinicornis
	Other Invertebrates
	Arianta arbustorum
	Arion ater
	Arion vulgaris (I)
	Arion rufus
	Cepaea hortensis
	Cepaea nemoralis
	Cernuella cisalpina
	Deroceras agreste
	Edwarsia sp.
	Glossiphonia concolor
	Helix pomatia (P5)
	Lehmannia marginata
	Limacus flavus
	Limax maximus
	Lymnaea stagnalis
	Trochulus hispidus

Appendix 2. GEUS Forest structure index evaluation of "Structural Diversity in Woodlands" for the woodland of Sjælegård. 'x' denotes an answer in the affirmative, whereas '-'denotes an answer in the negative.

No	Area	Fill in
1	Area > 1 ha	x
2	Area > 10 ha	-
3	Part of woodland with a coherent area > 100ha	-
4	Bordering on other woodland or nature areas (e.g. wetland, lake, moorland, dunes, but not fields, urban areas or roads along at least 80% of the edge length.	-
5	Distance to cultivated fields, urban area, pig farms, larger roads > 100m for at least 95% of the area.	-
	Stand Structure	
6	Multi-layered stand structure (min. 3 layers) in at least 10% of the tree covered area	X
7	Patchy height variation in the stand on at least 10% of the tree covered area (min. 3 patches of each 400-1000m^2 / Ha)	X
8	Natural, small gaps (> 100m^2)	X
9	No visible signs of planting of the stand. E.g. no sign of planting rows etc. (<5% of planted trees is acceptable)	-
	Tree Species	
10	*Fagus, Quercus robur* or *Q. sessliflora*, dbh ≥ 10 cm	X
11	*Fraxinus*; dbh ≥ 10 cm	X
12	*Alnus glutinosa*; dbh ≥ 10 cm	X
13	*Tilia cordata*; dbh ≥ 10 cm	-
14	*Tilia cordata*; dbh ≥ 25 cm	-
15	*Carpinus*; dbh ≥ 10 cm	X
16	*Ulmus*; dbh ≥ 10 cm	X
17	*Acer campestre, A. platanoides*; dbh ≥ 10 cm	X
18	*Populus tremula, Betula, Sorbus, Prunus avium, Malus silvestris or Corylus*; dbh ≥ 10 cm; Ilex; dbh > 5 cm.	X
19	No larger occurrence of *Prunus serotina, Picea sitchensis* nor other invasive tree species nor occurrency of giant hogweed (*Hieracleum* *mantegazzianum*).	X
	Trees; Independent of species	
20	Large trees; dbh ≥ 50 cm present	X
21	Large trees; dbh ≥ 50 cm ≥ 5/ha	-
22	Large trees; dbh ≥ 50 cm ≥ 10/ha	-
23	Large trees; dbh ≥ 75cm present	X
24	Large trees; dbh ≥ 75cm ≥ 1/ha	-
25	Large trees; dbh ≥ 75cm ≥ 5/ha	-
26	Megatrees (dbh ≥ 100 cm) present	X

27	Megatrees (dbh ≥ 100 cm); ≥ 1/ha	-
28	Megatrees (dbh ≥ 100 cm); ≥ 5/ha	-
29	Living trees with larger holes, hollows, wounds etc.; dbh >25 cm; ≥ 1 tree/ha	-
30	Living trees with larger holes, hollows, wounds etc.; dbh >50 cm, ≥ 1 tree/ha	-
31	Fallen or hanging trees, still living, dbh ≥ 25	X
32	Fallen or hanging trees, still living, dbh ≥ 50	-
	Canopy (the upper crown layer, independent of tree/stand height)	
33	Large diameter variation of trees in canopy (>50 cm i dbh)	X
34	Large age variation of trees in canopy (> 100 years)	x
35	Large shape variation among canopy trees	X
36	At least 4 tree species in canopy	X
37	At least 3 domestic species with at least 25% af canopy	-
	Understorey/regeneration (woody plants > ½ m og < 5 m)	
38	Understorey/regeneration (woody plants incl. Corylus (Hazel), but not bushes) present on 10-35 % of the area.	X
39	Regeneration unevenaged; age variation >50 years	-
40	Regeneration in patches	X
41	≥ 1 domestic tree species in understorey/regeneration	X
42	>5 domestic tree species in understorey/regeneration	X
43	>10 domestic tree species in understorey/regeneration	-
44	>5 domestic bush species in understorey	X
45	>10 domestic bush species in understorey	-
	Dead wood; Non-sawn trees, independent of species dbh= diameter at breast height (1,3 m) in upright position	
46	Dead or dying trees, dbh 10-24 cm	X
47	Dead or dying trees, dbh 24-49 cm	X
48	Dead or dying trees, dbh 50-74 cm	-
49	Dead or dying trees, dbh 75-99 cm	-
50	Dead or dying trees, dbh ≥ 100 cm (megatrees)	-
51	Dead trees, dbh ≥ 25 cm, several (≥ 5/ha)	X
52	Dead trees, dbh ≥ 25 cm, many (≥ 10/ha)	-
53	Dead trees, dbh ≥ 50 cm, many (≥ 5/ha)	-
54	Dead trees, dbh ≥ 50 cm, ≥ 10/ha	-
55	Dead trees, dbh ≥ 75 cm, ≥ 5/ha	-
56	Dead trees, dbh ≥ 75 cm, ≥ 10/ha	-
57	Standing dead trees; dbh 10-24 cm	X
58	Standing dead trees; dbh 25-49 cm	X

59	Standing dead trees; dbh ≥ 50cm	-
60	Dead uprooted, fallen trees, dbh ≥ 25cm	X
61	Dead uprooted, fallen trees, dbh ≥ 50cm	-
62	Dead uprooted, fallen trees, dbh ≥ 75cm	-
63	Dead uprooted, fallen trees, dbh ≥ 100 cm	-
64	Dead logs, exposed to direct sunlight dbh ≥ 25 cm	-
65	Dead logs, exposed to direct sunlight dbh ≥ 50 cm	-
66	Living or dead snags; height > 2m, dbh >25 cm	X
67	Living or dead snags; height > 2m, dbh >50 cm	-
68	Dead trees dbh ≥ 25 cm, at least 3 species	X
69	Dead trees dbh ≥ 25 cm, at least 5 species	-
70	Dead logs dbh ≥ 25 cm, Decay class 1 (Fresh, newly dead, wood hard, bark intact. Unchanged (round) shape in cross-section.	X
71	Dead logs dbh ≥ 25 cm, Decay class 2 (Soft at surface (to approx. 1 cm depth); bark loose or partly fallen off; unchanged (round) shape in crosssection).	X
72	Dead logs dbh ≥ 25 cm, Decay class 3 (soft several cm in depth. Bark lost (except tree species decaying inside the bark (e.g. Ilex and Betula)).	X
73	Dead logs dbh ≥ 25 cm, Decay class 4 (log rotten, with holes, breaks easily in parts. Oval in cross-section.)	-
74	Dead logs dbh ≥ 25 cm, Decay class 5 (log wood more or less decomposed; visible as rough fragments or as different vegetation.)	-
	Flora	
75	Forest floor vegetation of summergreen vascular plants (woodland species) present at at least 10% of the area.	X
76	Living stems (boles) rich in bryophytes (mosses). > 25% coverage up to 3 meters.	-
77	Living stems (boles) rich in lichens (arbuscular or thallose). > 25% coverage up to 3 meters.	X
	Topography and Soil	
78	Large macrotopographic variation (>20 meters within 1 ha)	-
79	Large microtopographic variation (>1m/100m2)	X
80	Large mounds from storm-felled trees present	-
81	Large stones, rocks; min. 1 x 1 meter; natural occurrences in the surface.	X
82	Mull present on at least 5% of the area	x

83	Mor layers present on at least 5% of the area	X
84	Raw humus deposits (mor or peat), layers ≥ 5 cm. On at least 5% of the area	X
85	Chalk visible at the surface.	-
86	Patches with sun exposed, naturally exposed soil surface (landslide, dune etc.)	X
	Water level, Hydrology	
87	Open, treeless wetlands; min 5% of area.	-
88	Swamp forest present (eg. Alderswamp, birch swampforest, mixed swamp forest); min 5% of area	-
89	Temporary waterlogged areas (temporary lakes and ponds).	X
90	Humid hollows present (size min 100 m2)	X
91	Wells present	X
92	Natural, unregulated watercourses	-
93	Wetlands without ditches or ditches efficiently closed	X
94	Wet or humid soil prevailing on min. 25% of the area	X
	Management impacts	
95	No signs of soil cultivation	X
96	No ditches or ditches closed efficiently	X
97	No newly managed ditches (within the last 10 years)	x
98	No tracks from motor vehicles, driving in the stand (deep wheel tracks)	-
99	No signs of cutting (No stumps)	-
100	No younger signs of cutting (No stumps younger than 10 year)	-